ACADEMIC PROGRAM REVIEW

Self-Study Report

Fall 2020

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External Review Team Charge

The Academic Program Review (APR) process at Texas A&M University provides the occasion for academic units to plan strategically, assess the quality and efficacy of their programs, and determine the best courses of action for ongoing improvement. APR is at the heart of our institutional commitment to excellence, and we sincerely thank you for assisting us.

Please examine the department and its programs and make recommendations that will help in planning improvements. Your resources are a self-study report prepared by the department, copies of materials from the program’s last review, information you gain through personal interactions while visiting Texas A&M University, copies of strategic plans and goal-setting documents at the department, college, and/or university level, and any additional information requested by you or provided by the department. Within the broad charge of recommending ways the department can continue to improve, are some specific questions that we would like you to address:

- Based on the data / information provided in the self-study report or gathered by the review team, what are the department’s overall strengths and weaknesses?
- How well do the department’s strategic goals and priorities align with those of its college and with those of Texas A&M University?
- How would you compare this department with its peers?
- What improvements (including student learning and faculty development) has the department made since the previous program review?
- With only current resources or a modest infusion of new ones, what specific recommendations could improve the department’s performance, marginally or significantly?

The Harold Vance Department of Petroleum Engineering strives to provide the best possible education to our students, train the next generation of scientists and engineers, improve the quality of our graduate program, and enhance our reputation in national and international rankings. We believe that your comments and suggestions will significantly contribute towards achieving our goals.

Jeffrey B. Spath
Department Head
Executive Summary

The Harold Vance Department of Petroleum Engineering at Texas A&M University’s graduate program has consistently been ranked in the top 2 Petroleum Engineering graduate programs among public institutions in the country.

Our primary goal is to produce highly-qualified U.S. and international student graduates. To reach this goal, we give our students the best possible preparation to enter the oil and gas industry. We maintain an ABET-accredited program in petroleum engineering. We offer graduate degree programs and course work at the Master of Engineering, Master of Science, or Doctor of Philosophy level. We also offer certificate programs for those who wish to continue their education beyond a degree. Our graduate program in petroleum engineering is recognized for excellence in teaching and research, both nationally and internationally. Our graduate courses and instruction provide the skills and tools needed for understanding and solving the difficult problems the oil and gas industry faces when recovering oil and gas from older reservoirs or producing and managing hydrocarbons from newer resources.

Our graduate program currently has 179 students enrolled. Most students are full-time: approximately 22% Masters of Engineering (MEN) (course-based Masters degree), 29% Masters of Science (MS) (thesis along with course work), and 49% PhD students. In the last 5 years, graduate enrollment has decreased from 399 students due to several reasons, most notably the present downturn in the oil and gas industry and the recent disruptions in the obtaining of visas.

During the timeframe of this report, the number of core faculty has been stable. Some faculty members have retired, however new faculty members have been hired. The student to core faculty ratio is slightly higher than optimum; however, the recent addition of several experienced Academic Professional Track (APT) faculty has offset teaching demands, primarily at the undergraduate level.

The graduate student population is approximately 38% US citizens and 62% international students. This ratio is not uncommon among graduate petroleum engineering programs in the US. Optimally, we strive for parity and our percentage of US citizens in the graduate program has been trending upwards in recent years. The department has substantial fellowship funding for US citizens and tries to use these fellowships as a resource to recruit these students. The department has far fewer fellowships available for attracting the best international students and increasing international fellowships is one area in which the department plans to use the new graduate program fee.
Introduction

Brief History of the Petroleum Engineering Program

In 1928-29, the Board of Directors approved plans to establish a course in petroleum production engineering at A&M, the first in the State. Petroleum Engineering courses were offered for the first time in 1929. The Department of Petroleum Engineering awarded its first bachelor’s degree in 1931. In 1949, Harvey T. Kennedy spearheaded the development of the graduate program in petroleum engineering. The first M.S. degree was conferred in 1951 and the first Ph.D. was conferred in 1953.

J. Berry Joyce was selected to head the new department. Joyce had received a B.S. in electrical engineering from Texas A&M in 1917 and had done additional work at Cornell. He had about 10 years’ industrial experience with the Waggoner Oil Company in various phases of the petroleum industry. Since much of his experience had been in exploration and drilling, the curriculum was largely mechanical engineering slanted toward drilling. When Joyce resigned in 1933, R. L. Mills served as Acting Department Head from 1933-34.

Because of the increasing rate of petroleum discovery in the State, the curriculum attracted increasing numbers of students, necessitating modern physical plant facilities and faculty expansion. The Petroleum Engineering and Engineering Experiment Station and Geology Building was completed in 1933. In 1934, Harold Vance was selected to head the Petroleum Engineering Department. Vance held a B.S. in petroleum engineering from the University of California. He had broad geological and petroleum engineering experience in service with the U.S. Bureau of Mines, the Marland Oil Co. (later Continental Oil Co.) and as a consulting engineer and independent oil producer. Albert B. Stevens also joined the department in 1934. Stevens held a B.S. in petroleum engineering from the University of California and an M.S. in petroleum engineering from the University of Southern California. Mr. Stevens also had petroleum experience with the Gypsy Oil Company (Gulf Oil Corp.) and the Standard Oil Co. of California. These two men developed the curriculum to include not only drilling engineering but also oil and gas production and natural-gas engineering. They planned and constructed laboratory facilities to support this program. The four-year curriculum was accredited by the Engineers Council for Professional Development in 1936 when accreditation was initiated. Five-year curricula were developed and were approved by ECPD. The enrollment continued to increase and reached a maximum of 814 prior to World War II. Because of the large undergraduate enrollment and the rapid technological development within the petroleum industry during this period, there was little time for development of a graduate program.

The influx of veterans after World War II, the rapid acceleration of exploration for petroleum, and the need for research prompted the Board of Directors to several actions. First, the Texas Petroleum Research Committee (TPRC) was formed in 1947 as a consortium between the Railroad Commission of Texas, the University of Texas and Texas A&M. The purpose of TPRC was to conduct research directed to increasing the recovery of oil and gas from Texas fields. Research divisions were established at the University of Texas and Texas A&M and were funded by the respective universities. In 1951 the Railroad Commission of Texas requested $100,000 per year for such research and the monies were appropriated by the State Legislature.

Concurrent with this action the Board of Directors established its first Distinguished Professorship in 1949. The recipient was Harvey T. Kennedy, scientist and researcher. Kennedy had 10 years’ experience with the Bureau of Standards followed by 20 years with the Gulf Research & Development Company,
Pittsburgh, Pennsylvania. Kennedy promptly set about developing a graduate program in petroleum engineering which has evolved into one of the most productive programs in the country.

The department continued to enjoy good undergraduate enrollment and expanding graduate enrollment and research. In 1953 Vance resigned as Department Head and Albert B. Stevens assumed the position.

In 1953 Stevens resigned and Robert L. Whiting was appointed Head of the Department. Whiting had earned B.S. and M.S. degrees in petroleum engineering from the University of Texas. He joined the faculty in 1946 after industrial experience with the Railroad Commission of Texas and Stanolind Oil and Gas Company (later AMOCO Production Co.) and after a year as associate professor of petroleum engineering at the Missouri School of Mines.

In 1954, the department initiated an Advanced Level Continuing Education Program in petroleum engineering. This was expanded to encompass two-week courses in petroleum reservoir engineering, advanced petroleum reservoir engineering, advanced drilling engineering, recovery methods, well-completion and testing and well-log interpretation. Over 600 petroleum industry personnel from virtually all the countries in the world have attended these courses.

Petroleum engineering curricula of the department were broadened to include all aspects of petroleum reservoir engineering encompassing both primary and enhanced recovery. The depth of coverage of drilling, production and natural gas engineering was increased.

With growth of the department and its expanding research activities the Board of Directors in 1957 approved construction of a new petroleum engineering building, the W.T. Doherty Petroleum Building. The building was finished in time for the opening of the 1960-61 academic year.

R. L. Whiting resigned as Head of the Department on February 29, 1976 and W. D. Von Gonten succeeded him on March 1, 1976. Because of continued growth, the Joe C. Richardson Jr. Petroleum Engineering Building was built and completed in 1990. The 10-story building contains spacious study rooms with computer facilities, classrooms, and laboratories.

Von Gonten was department head until his death in 1991. Kenneth R. Hall was appointed Temporary Head until James E. Russell was named as Interim Head. Russell served as Interim Head from 1991-1992 and was appointed Head in 1992. Russell served as Head until 1996. Hans Juvkam-Wold served as Interim Head from 1996-1997. Charles H. Bowman was named the new Head in 1997 and served until 2001.

In 1998, Jim and Audrey Nelson gave $10 million to the Texas A&M Foundation to support petroleum engineering programs. The couple chose to honor one of Nelson’s former professors by naming the Harold J. Vance Department of Petroleum Engineering, which was the first named department on the Texas A&M campus.

In 2001, Ronald J. Robinson was appointed Head and served until 2003. Hans Juvkam-Wold again served as Interim Head until 2004 when Stephen A. Holditch was named as Head. Steve Holditch remained Head until 2012. A. Daniel Hill served as Interim Head in 2012 and as Head from Jan. 2013-Dec. 2017 of the

Quality distinguishes our graduate program. We strive to continuously improve the quality of students, research and instruction. High admission standards and thorough screening of applicants for advanced degrees help assure top-flight students. Our faculty members have substantial industrial experience and a record of high research productivity as measured by publications and grants. These attributes have prepared many of our graduates for the teaching profession and positions within industry. While quality over quantity is our mantra, each year, Texas A&M graduates 18% of MS and 21% of PhD of the nation’s new petroleum engineers.

Vision
Our graduates are our most important product. Our vision is...that the statement "I am an Aggie Petroleum Engineer" is considered to be the most respected, prestigious self-definition within the global petroleum engineering profession.

Mission
We see our mission then, as being able:
… to create, preserve, integrate, transfer and apply petroleum engineering knowledge,
… to produce capable future engineers and leaders and to enhance the capabilities of current practitioners.

Strategic Plan
The department’s new three-year strategy, finalized in 2019, includes the following two major initiatives:

- Building upon our reputation of providing job-ready graduates, expanding the graduate’s knowledge and skillsets to keep pace with our evolving industry. This entails minor changes within the existing curriculum and syllabi as well as expanding the course offerings to include peripheral energy topics which utilize the core competencies of the department.
- Strengthening the department by expanding research efforts from predominantly applied research to include blue-sky research, in order to solve industry’s grand challenges.

Goals
We are currently working on the following projects to achieve the above strategy, thereby improving further our ability to provide the highest quality petroleum engineering graduates.

- Improving our recruiting and admissions of graduate students to increase the quality of our graduate program. We continue to increase the percentage of PhD students in order to improve the quality and depth of our research.
- Upgrading all of our teaching and research computing resources within the department as well as increasing our utilization of world-class university-level high-performance computing equipment.
- Expanding our use of industry-provided software and training to maintain state-of-the-art techniques and workflows in our classrooms and labs, ensuring our graduates are current in industry processes.
- Expanding the number and variety of member companies within the Crisman Institute research consortium in order to generate industry-directed research projects on a wider range of subjects.
• Enhancing our current relationships with upstream companies to ensure we’re exceeding their expectations and extending relationships to peripheral companies and government entities interested in the subsurface knowledge and engineering skillsets of our graduates.
Degree Program Supplements

Facilities
The Harold Vance Department of Petroleum Engineering currently occupies space in three buildings. All faculty, staff and graduate student offices are located in the Richardson Building.

<table>
<thead>
<tr>
<th>Building</th>
<th>SF</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joe C. Richardson Building (RICH)</td>
<td>58,060 sf</td>
<td>Offices, Teaching, Research</td>
<td>Main Campus</td>
</tr>
<tr>
<td>University Services Building (USL)</td>
<td>3,400 sf</td>
<td>Research</td>
<td>Offsite</td>
</tr>
<tr>
<td>RELLIS Building 7184</td>
<td>350 sf</td>
<td>Research</td>
<td>RELLIS Campus</td>
</tr>
</tbody>
</table>

Offices
The Department Head’s office is located on the 5th floor of RICH. Faculty and Staff offices are mostly located in suites on the 4th, 5th and 9th floors of RICH. The Business and IT offices are located in the 9th floor suite of RICH. The Undergraduate Program Advising offices are located in the 5th floor suite of RICH and the Graduate Program Advising offices are located in one of the 4th floor suites of RICH. Currently the department has adequate office space for faculty, administrative support, advising, conference rooms, small kitchens, and visiting scholars/post-docs offices.

The Graduate Program Advising area houses a Graduate Program Director, a Senior Administrative Coordinator, an Administrative Associate, and one student worker who provide advising and support services for graduate students. Additionally, Undergraduate Program Advising area houses an Undergraduate Program Director, an Assistant Director, a Senior Academic Advisor, and a student worker who provide advising and support services for undergraduate students.

The department has twenty-three graduate student rooms with 255 desks available. Our graduate student office space is currently adequate based on our current enrollment. The department also one space available for graduate teaching assistants to use and meet with students. New graduate students are not assigned a desk until the student has officially found a graduate advisor for their research. Graduate students have access to one kitchen area on the 3rd floor in our student lounge.

Classrooms
Most of the department’s graduate classes are taught in RICH. All of the classrooms and computer rooms are equipped with computer projection and other modern instructional equipment. The larger TAMU controlled classrooms are equipped with fixed chairs in conventional lecture room style. Other classrooms are equipped with tables as well as electronic instructional equipment to better support design type classes. Two classrooms are equipped with workstations at each table and electronic instructional equipment to facilitate team activities in design experiences. Wireless microphones and sound systems are available for use in the larger classrooms and many of our medium sized rooms. RICH is equipped with wireless access to the department network so that students can access department software from any location in the building. They can also access the software remotely off campus.

The department has first priority when scheduling classes in two of the TAMU controlled classrooms. Six classrooms are controlled by the department as well as three teaching laboratories. When additional classrooms are needed, they are requested through the Registrar’s office. Two rooms have been set aside for students to study. Student organizations are also provided space to meet in the RICH or ZACH
Buildings. The Department Head’s staff coordinates use of the rooms in RICH outside of regular classroom hours, and some rooms are regularly used by SPE, AADE, IADC and other student organizations from across campus.

Classroom Inventory

<table>
<thead>
<tr>
<th>Bldg</th>
<th>Room</th>
<th>Room Type</th>
<th>Seating Capacity</th>
<th>Size sf</th>
<th>Type</th>
<th>Computers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RICH 101</td>
<td>TAMU Classroom / PETE Priority</td>
<td>98</td>
<td>1453</td>
<td>Auditorium - Fixed</td>
<td>n/a</td>
</tr>
<tr>
<td>2</td>
<td>RICH 106</td>
<td>TAMU Classroom</td>
<td>148</td>
<td>2532</td>
<td>Auditorium - Fixed</td>
<td>n/a</td>
</tr>
<tr>
<td>3</td>
<td>RICH 114</td>
<td>TAMU Classroom</td>
<td>98</td>
<td>1453</td>
<td>Auditorium - Fixed</td>
<td>n/a</td>
</tr>
<tr>
<td>4</td>
<td>RICH 201</td>
<td>PETE Teaching Laboratory</td>
<td>16</td>
<td>1711</td>
<td>Fixed Work Tables</td>
<td>n/a</td>
</tr>
<tr>
<td>5</td>
<td>RICH 208</td>
<td>PETE Computer Classroom</td>
<td>45</td>
<td>1062</td>
<td>Tables and Chairs</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>RICH 212</td>
<td>PETE Teaching Laboratory</td>
<td>16</td>
<td>1161</td>
<td>Fixed Work Tables</td>
<td>n/a</td>
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<tr>
<td>7</td>
<td>RICH 216</td>
<td>PETE Teaching Laboratory</td>
<td>16</td>
<td>1123</td>
<td>Fixed Work Tables</td>
<td>n/a</td>
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<tr>
<td>8</td>
<td>RICH 301</td>
<td>PETE Computer Classroom</td>
<td>20</td>
<td>559</td>
<td>Tables and Chairs</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>RICH 302</td>
<td>TAMU Classroom / PETE Priority</td>
<td>48</td>
<td>977</td>
<td>Tables and Chairs</td>
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<td>10</td>
<td>RICH 311</td>
<td>PETE Interactive Lab Classroom</td>
<td>24</td>
<td>798</td>
<td>Tables and Chairs</td>
<td>5 / station</td>
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<tr>
<td>11</td>
<td>RICH 313</td>
<td>PETE Interactive Lab Classroom</td>
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<td>937</td>
<td>Tables and Chairs</td>
<td>5 / station</td>
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<td>12</td>
<td>RICH 319</td>
<td>PETE Computer Classroom</td>
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<td>753</td>
<td>Tables and Chairs</td>
<td>33</td>
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<td>13</td>
<td>RICH 1009</td>
<td>PETE Classroom</td>
<td>26</td>
<td>883</td>
<td>Tables and Chairs</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Resource Room
The Dr. Stephen A. ’69 and Ann Holditch Resource Room (RICH 309) has available a significant amount of industry and academic material for use by all of our students and faculty members.

Research Laboratories
The Richardson Building was built in 1989. This building provides approximately 23,000 square feet of laboratory research space. At the time the building was constructed, a considerable amount of equipment was purchased. The department has updated the equipment over the years, especially in the area of computerized controls and data capture, since that time. Other specialized equipment has been added, including vent hoods and advanced drilling simulation testing equipment. As a result, available laboratory equipment and instrumentation are in good shape. The department also has 4,437 square feet of space in the USL Building which is located off campus and recently was given a small lab on the RELLIS campus (350 sf).

Research Room Inventory

<table>
<thead>
<tr>
<th>Bldg</th>
<th>Room No.</th>
<th>SF</th>
<th>Type</th>
<th>Name</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RICH</td>
<td>201</td>
<td>1711</td>
<td>Teaching/Research</td>
<td>Tommy E. Lohman Lab</td>
<td>GAS METERING APPARATUS, BROOKFIELD PROGRAMMABLE RHEOMETER, STA 449 JUPITER ANALYZER</td>
</tr>
<tr>
<td>RICH</td>
<td>209</td>
<td>585</td>
<td>Research</td>
<td>Heavy Oil, Oil Shales, Oil Sands, and Carbonate Analysis Lab</td>
<td>ANTON PAAR SVM 3000 STABINGER VISCOMETER, THERMO SCIENTIFIC DS-5 CONDUCTIVITY DETECTOR, ZETA POTENTIAL ANALYZER, BROOKHAVEN</td>
</tr>
<tr>
<td>Bldg</td>
<td>Room No.</td>
<td>SF</td>
<td>Type</td>
<td>Name</td>
<td>Equipment</td>
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<tr>
<td>RICH</td>
<td>212</td>
<td>1161</td>
<td>Teaching/Research</td>
<td>Anadarko Petrophysics Lab</td>
<td>PHOENIX INSTRUMENTS POROSIMETERS</td>
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<td>KRUSS K20 EASYDYNE</td>
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<td>RHEOTEC VISCOMETER BATH</td>
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<td>DEAN STARK</td>
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<td>CL 7000 RETORT-DULA ELEMENT</td>
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<td>RICH</td>
<td>212A</td>
<td>245</td>
<td>Research</td>
<td>Core Drilling and Cutting Lab</td>
<td>CORE AND DRILLING CUTTING EQUIPMENT</td>
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<td>FANN VISCOMETER</td>
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<td>FANN HPHT FILTER PRESS</td>
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<td>FANN SERIES 300 FILTER PRESS</td>
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<td>RIG FLOOR SIMULATOR RE 3000</td>
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<tr>
<td>RICH</td>
<td>216</td>
<td>1382</td>
<td>Teaching/Research</td>
<td>Chevron Drilling and Completions Lab</td>
<td>SUBMICRON PARTICLE SIZE ANALYZER</td>
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<td>MT9900 MICROSCOPE</td>
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<td>KRUSS DSA 30</td>
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<td>ANTON PAAR DENSITY METER</td>
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<td>AGILENT TECHNOLOGIES CARY 630 FTIR</td>
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<tr>
<td>RICH</td>
<td>508</td>
<td>1125</td>
<td>Research</td>
<td>Ramey Thermal Recovery Lab</td>
<td>HPHT VISCOMETER 7600</td>
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<td>RICH</td>
<td>509</td>
<td>487</td>
<td>Research</td>
<td>High Pressure/High Temperature Drilling Lab</td>
<td>EVEX MINI-SEM SX 1500</td>
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<td>BRUKER S2 RANGER</td>
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<td>Advance Instruments Lab</td>
<td>GCTS LOADING FRAME</td>
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<td>Proppant Transport Research Lab</td>
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Acid Fracture Research Lab (RICH 808) was designed to study acid fracture conductivity behavior as functions of important parameters. Each experiment has 4 major steps; rock sample preparation, cell preparation and loading, acid injection, and fracture conductivity measurement. The set-up consists an acid injection apparatus, a fracture conductivity measurement apparatus, and a profilometer for surface scanning.

Acid Stimulation Lab (RICH 809) was designed to study new and better methods involving the matrix acidizing of carbonate rocks.

Advanced Instruments Lab (RICH 512) contains equipment used in the detection, classification, analysis and imaging of rock samples, sediments and fluids.

Anadarko Petrophysics Lab (RICH 212) focuses on teaching petrophysical techniques to our students and involves equipment - distillation, coreflood, sonic sifters, acoustic velocity, helium porosimeter, tensionmeter, centrifuges, and oil baths.
Chaparral Fischer CO2 EOR Lab (RICH 803) was designed to study ways to improve oil recovery from naturally fractured conventional and unconventional reservoirs.

Chevron Drilling and Completions Lab (RICH 216) focuses on teaching students how to use drilling, cementing and stimulation measurement equipment. Through a hands-on approach, students learn the importance of drilling mud properties and how changes can help identify and solve potential drilling programs. The lab also features a drilling rig simulator with software that simulates realistic rig floor equipment and operations.

Chevron Petrophysical Imaging Lab (RICH 823) uses a Toshiba Aquilion RXL CT with 3D advanced visualization software. Its 16-detector row 32 slice computerized tomography system delivers high speed iterative image reconstruction of 0.5 mm data sets at up to 16 images per second. The scanner has a 72 cm gantry opening with +/- 30 degrees tilt with an accurate 0.5 mm x 16-row high-resolution detector. Also, the CT Scanner has an industry leading low contrast resolution of 2mm @ 0.3%. The Toshiba Aquilion RXL CT Scanner is a high-precision instrument that can measure the porosity, fluid density and changes in saturation in cores samples and enhanced oil recovery flood experiments such as water, gas or CO2 flooding. Also, it can be used to visualize natural fractures in cores samples and wormhole propagation in cores exposed to acid treatments.

Core Drilling and Cutting Lab (212A) was developed to drill and cut cores from 1/2 inch to 4 inch up to 20-inch length. This lab also contains two diamond tipped tile saws converted to cut cores and samples. The smaller one can cut to a depth of around 3.5 inch and handle pieces of rock 3.5x24x24. The larger one can cut 6x24x24. This equipment is used for cutting cores of different properties to supply to students for experiments.

Corrosion and Foam Stability Lab (RICH 1010) was designed to study the corrosive effects of chemicals and other substances, and study foam stability for use as drilling and fracturing fluids, proppant delivery, corrosion inhibitors, etc.

Evaluation of Oilfield Chemicals Lab (RICH 822) was designed to perform extensive testing on oilfield chemicals before and after being selected for use in production operations. Some tests include zeta potential to test clay stabilizers or general surface charges and HPLC to determine the molecular weight distribution of polymers.

Formation Damage Studies Lab (RICH 814) was designed to study rheology properties of drilling fluids, the formation damage caused by drilling fluids, and the observations of fluid samples under heat and pressure.

Geomaterials for Geo-energy and Geo-environmental Sustainability Lab (RICH 810) was designed to study chemo-mechanical properties of shale under different environmental conditions and in contact with fluids of interest.

High Pressure/High Temperature Drilling Lab (RICH 509) was designed to study the effect of gas on the rheological properties of drilling fluids in order to develop an extreme high pressure, high temperature gas kick behavior simulator.
Hydraulic Fracture Conductivity Lab (RICH 613) was designed to study hydraulic fracturing issues and make significant contributions to the understanding of unconventional resources development. It mainly consists of 1) the fluid injection module; 2) the closure stress application unit; 3) the conductivity cell assembly; and 4) the data acquisition system.

Yuri F. Makogon Gas Hydrates and Source Rock Petrophysics Lab (RICH 721) was developed to study natural gas hydrates in bulk phase and in porous media; nano-scale characterization of source rocks; multi-component multi-physics measurements of fluid storage and transport in source rocks; molecular simulation of hydrocarbon mixtures phase change and transport under nano-confinement; and modeling of complex hydraulic fracturing fluids under subsurface conditions.

Matrix Acidizing Lab (RICH 1001F/1001G) was developed to simulate the acidizing process and study wormhole efficiency under different conditions and the carbon dioxide behavior during acidizing.

Multiphase Flow Loop Tower Lab (Tower) is a 140-ft tall vertical flow loop and was designed to study and verify various aspects of two-phase flow in riser drilling. The loop can use pipes of various sizes (1 to 6-in ID) to investigate flow through a single tube or through an annulus. The ability to capture high-speed video and pressure at various locations creates unique potential for a multi-media database for two phase upward flow.

Nano Research Lab for Oil and Gas Applications (RICH 1001B/1001C) was developed to study promising uses of nanotechnology for oilfield applications in both conventional and unconventional reservoirs.

Naturally Fractured Reservoir Lab (RICH 614) was designed to study gas injection using CO2 and other modified natural gasses for improving oil recovery from naturally fractured conventional and unconventional reservoirs, study foam stability using nanoparticles and surfactants, and characterize gravity segregation in naturally fractured reservoirs.

Oilfield Chemistry Rock-Fluid Interaction Lab (RICH 802) was designed to study and formulate affordable injection fluids that ensure high performance while favorably altering rock properties for secondary and tertiary modes of recovery.

Productivity Enhancement Lab (RICH 720) was designed to study key factors for well productivity improvement through a wide range of research studies, including optimized acid stimulation strategies and enhanced oil recovery flood experiments.

Proppant Transport Research Lab (RELLIS) was designed to study proppant transport in complex fracture geometries utilizing a combination of numerical, theoretical, and experimental tools.

Ramey Thermal Recovery Lab (RICH 508) was designed to study chemical analysis and thermal recovery studies, such as in-situ combustion, steam flooding, steam assisted gravity drainage, electromagnetic and electrical heating, and three-dimensional experiment set-up for thermal recovery applications.
Reaction of Acids with Reservoir Rocks Lab (RICH 813) was designed to study reactions between fluids and solid surfaces, such as mass transfers and chemical reactions.

Rheology of Non-Newtonian Fluids Lab (RICH 812) was designed to study rheological properties of complex fluids under varying conditions.

Tommy E. Lohman Lab (RICH 201) - This lab is primarily used for teaching and short-term research testing, and for the Drillbotics competition team investigations, testing, and assembly area.

Wellbore Acoustic Lab (RICH 621) was designed to study how acoustic data from wellbore sounds can be used to quantify fluid flow rates, fluid distribution during production and injection, and fluid saturation.

Computer Labs
Graduate petroleum engineering students have access to computer labs in RICH 208, RICH 301, RICH 311, RICH 313, and RICH 319. Graduate student offices also have computers assigned to each desk. Students also have access to printers in each computer room and graduate student offices, and a centralized plotter. We try to replace approximately one-third of the computers annually in these classrooms and workrooms to stay abreast of the latest technology. Part of the funding for this comes from student fees and a dedicated endowment, the “Whiting Technology Fund”.

Finances
At the end of FY20, the department has endowments with a market value of $65.07 million that generate $2.6 million per year of income. This income was used to supplement salaries, to fund research endeavors of our faculty, for technology upgrades, lab expenses and to provide financial assistance to both undergraduate and graduate students. Of the $65 million, $32.13 million funds chairs and professorships, $14.77 million funds scholarships for undergraduate students, $1.29 million funds scholarships/fellowships for graduate students, $5.54 million funds the Crisman Institute for Petroleum Research, $4.95 million funds the Petroleum Ventures Program, and $6.39 million funds special projects at the discretion of the department head. The graduate program is very adequately funded and received $703,547 in Graduate Program Fees.

External Program Accreditations
We had a positive review from ABET in 2016 for our undergraduate degree. The program will be reviewed again in 2022. ABET accreditation occurs every 6 years. No other external program accreditation has been done for the graduate program.

Date of last APR External Review
Our last APR Review of our program was in 2014 by an outside committee.

Analysis
Path for Excellence
The strategic plan for the graduate program was developed out of the department’s commitment to enhancing the quality of education and research, and producing graduates who are confidently prepared for the ever-changing needs of the petroleum engineering profession. This will be achieved through the
goals outlined in the strategic plan, which are focused on increasing research opportunities and funding, evolving our graduate curriculum, and expanding multidisciplinary talent within the department. Specifically, the following objectives have been identified:

- Maintaining, enhancing, and expanding our research portfolio to support the research activities of our Graduate students.
- Ensuring that all of our doctoral students are fully funded to conduct their research.
- Evolving the departmental curriculum to keep pace with an evolving upstream petroleum industry.
- Developing curricula in multiple appropriate focus areas, dependent on workforce needs, for students to earn one-year masters degrees.
- Hiring faculty with expertise beyond traditional petroleum engineering fields to expand the multi-disciplinary talent within the department.
- Developing and evolving our online courses that graduate students and practicing professionals can take to obtain certificates and master’s degrees.

**Strategic Goal Alignment**

The strategic goals of the program are closely aligned with both the university and the college’s commitment to providing high quality engineering education through impactful, quality programs and research, and preparing a diverse student population to be well equipped to serve the greater good in their academic and professional endeavors. Over the past six years, the department has invested time and effort to continually explore ways to improve the graduate program. The result of this endeavor was the development of the initiatives defined by the strategic plan, through which the Department hopes to increase applications from a highly qualified diverse population of students, both domestic and international, enhance learning outcomes, and continue to raise the program’s standing and ranking.

**Degree Appropriate Curriculum**

The curricula for the petroleum engineering graduate program degrees are evaluated by the department’s Graduate Studies Committee which is chaired by the Graduate Program Director. In addition, our extremely active industry advisory board, consisting of over fifty experts from all sectors of the oil and gas industry, play a significant role in ensuring our graduate curriculum is current, relevant and sufficient to fill their recruiting needs. They provide leadership in planning and reviewing the graduate curriculum to strengthen the collective focus of advancing national leadership in teaching innovation, research impact, and service to the petroleum engineering profession. The department’s strategic plan addresses the need to recruit, retain, graduate, and help place our graduate students.

The degrees we offer, Ph.D., MS (thesis option) and MEng are appropriate for the needs of the students and the petroleum engineering profession. Our students are highly sought after and find opportunities in academia, national laboratories, and industry after graduation.

**Successes**

We are pleased to count the following among our successes:

- We continue to build our outstanding reputation and credibility in the global oil and gas community for turning out quality graduates and technical information; as evidenced by our graduate program being perennially ranked in the top two in the US by the US News & World Report.
• We have strong enrollment at both the undergraduate and graduate levels with continued emphasis and improvements on the quality and diversity of our students;
• We have continued to grow our distance learning degree program for graduate degrees as well as our certificate program;
• Broadened research funding sources to include DOE, DOI, NSF and over 67 companies.
• We have enriched our learning outcomes and our relationship with industry by hiring top industry experts as professors of the practice
Academic Programs and Curricula

This section of the academic review report summarizes the Petroleum Engineering graduate program administration and provides details on its operations. A summary of the graduate degrees currently offered are presented, followed by the admission process, financial support, and the graduate student enrollment. Finally, the demographics of the graduate student body and the peer rankings of the department are provided.

Office of Graduate and Professional Studies

The Office of Graduate and Professional Studies (OGAPS) is responsible for administering the graduate program for the University. OGAPS serves Texas A&M graduate students as an advocate for their graduate education and houses the Ombudsperson for Graduate Education. This office:

- establishes procedures to guarantee the highest quality educational experience at the graduate level;
- fosters and facilitates interdisciplinary/intercollegiate graduate programs and research activities; and
- strives to maintain and enhance an environment conducive to creative scholarship and scientific inquiry.

Programs Offered

The Harold Vance Department of Petroleum Engineering offers the Master of Engineering, Master of Science, and Doctor of Philosophy degrees in petroleum engineering. Below is a brief description of each degree within the Petroleum Engineering Department.

Master of Engineering

This Master of Engineering (MEng) degree is practice oriented and requires 36 credit hours of course work beyond a Bachelor of Science degree. Although most of the courses on the degree plan are expected to be in engineering or scientific disciplines, other courses may be selected from different fields that reflect the individual interests and career goals of the student. The work in the major field includes one independent project report and a final exam.

Additional MEng Degree Programs

Master of Engineering IFP – Business
This joint, two-degree program is offered by the Institut Francais du Pétrole (IFP) and Texas A&M University.

Master of Engineering IFP – Geoscience
This joint, two-degree program is offered by the Institut Francais du Pétrole (IFP) and Texas A&M University.

International Petroleum Management Program (IPM certificate)
This is a cooperative program with Texas A&M’s Graduate School of Business.
Master of Science
The MS degree requires 30 credit hours of course work beyond a Bachelor of Science degree. Additionally, the degree requires the student to submit a thesis to the University and defend it in an oral presentation. Students seeking a MS degree are expected to demonstrate proficiency in research in a particular area of petroleum engineering. The student’s degree plan, determined by the student and the advisory committee, consists only of courses in engineering and science that enhance research performance.

Doctor of Philosophy
The degree requires a minimum of 64 credit hours beyond the MS degree or 96 hours beyond the BS degree in your degree plan. All students enrolled in our PhD program must pass a Department Qualifying Exam and a Preliminary Examination to determine their suitability for conducting research and continuing in the program. Additionally, the degree requires the student to defend and submit a dissertation to the University.

Program Curricula
Master of Engineering - Summary of Degree Requirements

Degree Plan
Degree plans for all graduate students should be filed by the end of the 2nd long semester (departmental rule). Students will incur a hold by OGAPS if a degree plan is not filed. Master’s students will be blocked after they have completed 9 hours of graded courses.

Committee Requirements
Master of Engineering committees will consist of a committee chair (PETE), at least one more PETE faculty committee member, and at least one outside member (non PETE faculty). Masters committees should have at least 3 committee members.

Additional Degree Plan Requirements
- Include a minimum of 36 credit hours in your degree plan.
- Take at least 3 of the core courses (required for students without undergraduate petroleum engineering degree)
- Must take 2 occurrences of PETE 681.
- Observe University limits on certain courses:
  - No more than 9 hours transfer credit from another peer department.
  - No more than 12 hours of 689 courses.
  - No more than 3 hours of 692 courses.
- Include courses from outside the department. Minimum 2 (3 hour) courses, maximum 4. Outside courses must be graduate-level courses directly related to your degree study.
- Must take PETE 614 Student Paper Contest. Must participate once during master degree and list course on degree plan.
- Two credit hours of PETE 684 may be used for internships. (Not required)
- No undergraduate coursework may be used for credit on a graduate degree plan in the petroleum engineering department.
Transfer work will be evaluated on a case-by-case basis. Transfer work must be graduate level, taken for a grade of A or B at an accredited University and may not be used for prior degree credit.

Degree Plan Submission
In order to submit a graduate degree plan, students will use the OGAPS Online Degree Plan Submission System (OGSDPSS). Students will need their NetID and password to log in. Committee members will need to be decided upon prior to submission of the degree plan. Students should contact each member and confirm committee acceptance prior to submitting the degree plan online.

Important: Degree plans are not considered “submitted” until they reach OGAPS. Before they reach OGAPS, they must first be approved online by the Graduate Program Coordinator, then by the student’s committee chair and committee members, then the faculty graduate advisor, and then they go to OGAPS for official processing and approval. As a result, this signature routing can take several weeks, and students will need to make sure they are following up with committee members to make sure they are aware they need to log in and approve. The degree plan system is supposed to send an automated notification e-mail, but students should not rely on these e-mails, especially since it is possible for them to get caught up in junk mail. Once the degree plan reaches the “submitted” status, it may take up to 6-8 weeks for it to be processed and approved by OGAPS.

Leveling Courses
Students with undergraduate engineering degrees in fields other than petroleum engineering are typically required to take a series of 3-5 of the following graduate courses designed for non-petroleum majors. PETE: 661, 662, 663, 664, 665. The number of these courses will vary for individual students, as each student is evaluated on his or her own educational background and work experience. If you do not hold a previous degree in Petroleum Engineering, you must have undergraduate coursework in math, or the physical sciences, and you must have credit for mathematics through differential equations and at least a year of calculus-based physics.

Petitions
After the degree plan has been submitted, any changes to the degree plan, including committee members, coursework, degree program, etc. should be made through a petition to the Office of Graduate Studies.

Residency Requirement
Master’s students must complete 9 resident credit hours during one regular semester or one 10-week summer semester.

Final Examination - M. Eng.
The Request and Announcement of the Final Examination should be submitted to OGAPS no later than 10 working days prior to the scheduled final exam, or by the OGAPS deadline for graduation, whichever comes first. The student’s committee must be present during the final exam. The final exam will be an oral presentation of the student’s final project. The exam should not be administered until the project is in substantially final form to the student’s committee, and all concerned have had adequate time to review and tentatively approve the document. Students should submit their final
copy to their advisor at least 2 weeks prior to their scheduled exam date. The Report of the Final Exam form must be submitted to OGAPS within 10 days of the final examination.

Final Project - M. Eng.
The student will be required to submit a final report, which should describe a single project in which the student put forth substantial effort. Project management can be a component of the assignment(s), but the final report should indicate a mastery of applied engineering skills. An evaluation from the student’s supervisor will also be required at the end of the work period.

### Sample MEN Degree Plan

<table>
<thead>
<tr>
<th>Course Name/Number</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
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<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
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<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
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<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 681 Seminar</td>
<td>2 occurrences</td>
</tr>
<tr>
<td>PETE 614 MS Student Paper Contest</td>
<td>0 hour credit</td>
</tr>
<tr>
<td>PETE 684 Internship</td>
<td>1 – 2 hours</td>
</tr>
<tr>
<td>Outside PETE course</td>
<td>3</td>
</tr>
<tr>
<td>Outside PETE course</td>
<td>3</td>
</tr>
<tr>
<td>PETE 692 Professional Study</td>
<td>1 – 4 hours</td>
</tr>
<tr>
<td><strong>Total Hours</strong></td>
<td>36</td>
</tr>
</tbody>
</table>

**PETE 614 MS Graduate Student Paper Contest.** Student must register and participate once during the MEN degree.

**PETE 681 Seminar.** 2 occurrences are required on the MEN degree plan.

**PETE 684 Internship hours are a required.** One hour credit course for international students pursuing an internship. Students must register for PETE 684 for one hour each semester they are pursuing an internship.

**Committee:** Must include 3 members of the Graduate Faculty
- **Advisor** – PETE faculty member
- **Co-advisor or member** – PETE faculty
- **Outside member** – Not a PETE faculty member

**Potential outside the department classes:**
- MATH 609
- MATH 610
- CHEN 629
- CHEN661
- GEOL 619
• GEOL 624
• INEN 621
• MATH 602
• STAT 608
• STAT 616
• STAT 636

Example of courses not allowed for degree plan credit:
• STAT 651
• STAT 652

Master of Science - Summary of Degree Requirements

Degree Plan
Degree plans for all graduate students should be filed by the end of the 2nd long semester (departmental rule). Students will incur a hold by OGAPS if a degree plan is not filed. Master’s students will be blocked after they have completed 9 hours of graded courses.

Committee Requirements
Master of Science committees will consist of a committee chair (PETE), at least one more PETE faculty committee member, and at least one outside member (non PETE faculty). Masters committees should have at least 3 committee members.

Additional Degree Plan Requirements
- Include a minimum of 30 credit hours in your degree plan.
- Take at least 3 of the core courses (required for students without undergraduate petroleum engineering degree)
- Must have 2 occurrences of PETE 681.
- Observe University limits on certain courses:
  - No more than 9 hours transfer credit from another peer department.
  - No more than 12 hours of 689 courses.
  - No more than 8 hours of 691 courses.
  - No more than 6 hours of 685 courses.
- Include courses from outside the department. Minimum 2 (3 hour) courses, maximum 4. Outside courses must be graduate-level courses directly related to your degree study.
- Must take PETE 614 Student Paper Contest. Must participate once during master degree and list course on degree plan.
- Two credit hours of PETE 684 may be used for internships. (Not required)
- No undergraduate coursework may be used for credit on a graduate degree plan in the petroleum engineering department.
- Transfer work will be evaluated on a case-by-case basis. Transfer work must be graduate level, taken for a grade of A or B at an accredited University and may not be used for prior degree credit.

Degree Plan Submission
In order to submit a graduate degree plan, students will use the OGAPS Online Degree Plan Submission System (OGSDPSS). Students will need their NetID and password to log in.
Committee members will need to be decided upon prior to submission of the degree plan. Students should contact each member and confirm committee acceptance prior to submitting the degree plan online.

Important: Degree plans are not considered “submitted” until they reach OGAPS. Before they reach OGAPS, they must first be approved online by the Graduate Program Coordinator, then by the student’s committee chair and committee members, then the faculty graduate advisor, and then they go to OGPS for official processing and approval. As a result, this signature routing can take several weeks, and students will need to make sure they are following up with committee members to make sure they are aware they need to log in and approve. The degree plan system is supposed to send an automated notification email, but students should not rely on these emails, especially since it is possible for them to get caught up in junk mail. Once the degree plan reaches the “submitted” status, it may take up to 6-8 weeks for it to be processed and approved by OGAPS.

Leveling Courses
Students with undergraduate engineering degrees in fields other than petroleum engineering are typically required to take a series of 3-5 of the following graduate courses designed for non-petroleum majors. PETE: 661, 662, 663, 664, 665. The number of these courses will vary for individual students, as each student is evaluated on his or her own educational background and work experience. If you do not hold a previous degree in Petroleum Engineering, you must have undergraduate coursework in math, or the physical sciences, and you must have credit for mathematics through differential equations and at least a year of calculus-based physics.

Petitions
After the degree plan has been submitted, any changes to the degree plan, including committee members, coursework, degree program, etc. should be made through a petition to the Office of Graduate Studies.

Residency Requirement
Master’s students must complete 9 resident credit hours during one regular semester or one 10-week summer semester.

Proposal Submission (MS)
The research proposal is a description of the research which the student intends to undertake and which will be reported in a detailed, comprehensive fashion in the completed thesis. It also offers the student an opportunity to convince the chair and other members of the advisory committee of his/her ability to pursue the projected topic to a successful conclusion. Master of Science students should submit the research proposal by the end of their first year plus 1 semester after commencing graduate studies within the department. A minimum of two weeks is required for review of the proposal by the advisory committee and department head prior to asking for signature.

Final Examination (Thesis Defense)
The Request and Announcement of the Final Examination should be submitted to OGAPS no later than 10 working days prior to the scheduled final exam, or by the OGAPS deadline for graduation, whichever comes first. The exam should not be administered until the thesis is in final form and all concerned have had adequate time to review and tentatively approve the document. The final exam
will be an oral presentation of the student’s thesis. The student should submit the final copy of their thesis to their committee at least 2 weeks prior to their scheduled exam date. The Report of the Final Exam form must be submitted to OGAPS within 10 days of the final examination.

**Thesis Submission**

Upload one approved final copy of thesis as a single PDF file to the University Thesis Office and submit signed thesis approval form to Office of Graduate and Professional Studies. No content changes may be made to the thesis after it has been submitted to the Thesis Office.

### Sample MS Degree Plan

<table>
<thead>
<tr>
<th>Course Name/Number</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETE 6XX</td>
<td>3</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3</td>
</tr>
<tr>
<td>PETE 6XX</td>
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</tr>
<tr>
<td>PETE 6XX</td>
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<td>PETE 6XX</td>
<td>3</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3</td>
</tr>
<tr>
<td>PETE 681</td>
<td>2 occurrences</td>
</tr>
<tr>
<td>PETE 614 MS Stud Paper Contest</td>
<td>0 hour credit</td>
</tr>
<tr>
<td>PETE 684 Internship</td>
<td>1 – 2 hours</td>
</tr>
<tr>
<td>Outside PETE course</td>
<td>3</td>
</tr>
<tr>
<td>Outside PETE course</td>
<td>3</td>
</tr>
<tr>
<td>PETE 691 Research hours</td>
<td>At least one hour up to 8</td>
</tr>
</tbody>
</table>

**Total** 30 hours (required minimum)

**PETE 614** MS Graduate Student Paper Contest. Student must register and participate once during MS degree.

**PETE 681** Seminar. 2 occurrences are required on the MS degree plan.

**PETE 684** Internship hours are a required one hour credit course for international students pursuing an internship. Students must register for PETE 684 for one hour each semester they are pursuing an internship.

**Committee:** A master’s degree plan must include 3 members of the Graduate Faculty

- **Advisor** – PETE faculty member
- **Co-advisor or member** – PETE faculty
- **Outside member** – Not a PETE faculty Member

**Potential outside the department classes:**
- MATH 609
- MATH 610
- CHEN 629
- CHEN661
- GEOL 619
- GEOL 624
- INEN 621
• MATH 602
• STAT 608
• STAT 616
• STAT 636

Example of courses not allowed for degree plan credit:
• STAT 651
• STAT 652

Doctor of Philosophy - Summary of Degree Requirements

Degree Plan
Degree plans for all graduate students should be filed by the end of the 2nd long semester departmental rule). PhD students must have their degree plan approved at least 90 days prior to the Preliminary Exam (OGAPS rule). Students will incur a hold by OGAPS if a degree plan is not filed by the listed deadline. PhD students will be blocked after they have completed 36 hours of graded coursework.

Committee Requirements
PhD committees will consist of a committee chair (PETE), at least two more PETE faculty committee members, and at least one outside member (not PETE faculty). PhD committees should have at least 4 committee members.

Additional Degree Plan Requirements
- Include a minimum of 64 credit hours beyond the master’s degree or 96 hours beyond the bachelor’s degree in your degree plan.
- Minimum course requirement for the Doctoral degree is 8 courses (24 credit hours) with at least 4 of these courses being in PETE.
- Must take 2 occurrences of PETE 681.
- Your graduate committee is in charge of the courses that will be on your degree plan. In general, you should take 1/3 course work and 2/3 research/seminar courses.
- Include courses from outside the department. Minimum 2 (3 hour) courses maximum 4. Outside courses must be graduate-level courses directly related to your degree study.
- Must take PETE 615 Student Paper Contest. Must participate once during PhD degree and list course on degree plan.
- Two credit hours of PETE 684 may be used for internships. (Not required)
- No undergraduate coursework may be used for credit on a graduate degree plan in the petroleum engineering department. Transfer work will be evaluated on a case-by-case basis. Transfer work must be graduate level, taken for a grade of A or B at an accredited University and may not be used for prior degree credit.

Degree Plan Submission
In order to submit a graduate degree plan, students will use the OGAPS Online Degree Plan Submission System (OGSDPSS). Students will need their NetID and password to log in. Committee members will need to be decided upon prior to submission of the degree plan. Students
should contact each member and confirm committee acceptance prior to submitting the degree plan online.

**Important:** Degree plans are not considered “submitted” until they reach OGAPS. Before they reach OGAPS, they must first be approved online by the Graduate Program Coordinator, then by the student’s committee chair and committee members, then the faculty graduate advisor, and then they go to OGPS for official processing and approval. As a result, this signature routing can take several weeks, and students will need to make sure they follow up with committee members to make sure they are aware they need to log in and approve. (The degree plan system is supposed to send an automated notification email, but students should not rely on these emails, especially since it is possible for them to get caught up in junk mail.) Once the degree plan reaches the “submitted” status, it may take up to 6-8 weeks for it to be processed and approved by OGAPS.

**Leveling Courses**
Students with undergraduate engineering degrees in fields other than petroleum engineering are typically required to take a series of 3-5 of the following graduate courses designed for non-petroleum majors. **PETE: 661, 662, 663, 664, 665.** The number of these courses will vary for individual students, as each student is evaluated on his or her own educational background and work experience. If you do not hold a previous degree in petroleum engineering, you must have undergraduate coursework in math, or the physical sciences, and you must have credit for mathematics through differential equations and at least a year of calculus-based physics.

**Petitions**
After the degree plan has been submitted, any changes to the degree plan, including committee members, coursework, degree program, etc. should be made through a petition to the Office of Graduate Studies.

**Residency Requirement**
A PhD student who holds a master’s degree when they enter the doctoral degree program must spend one academic year in resident study. One academic year may include two adjacent regular semesters or one regular semester and one adjacent 10-week summer semester. Enrollment for each semester must be a minimum of 9 credit hours (including the 10-week summer semester) each to satisfy the residence requirement.

**Department Qualifying Examination**
The purpose of the PhD Qualifying Examination (Appendix C) is to ensure that doctoral candidates in the Harold Vance Department of Petroleum Engineering can demonstrate proficiency in the primary areas of petroleum engineering (drilling, production, and reservoir). As policy, all doctoral students admitted to the Harold Vance Department of Petroleum Engineering are required to take the PhD Qualifying Examination at the conclusion of their first semester. A Master of Science student in the Harold Vance Department of Petroleum Engineering (with a GPA of 3.5 or better) who has not been admitted to the PhD program can petition to take the PhD Qualifying Examination after completing two long semesters. The petition must be approved by their advisor and the graduate advisor. For a MS student, passing the PhD Qualifying Examination does not guarantee admission to the PhD program. The student will still have to file a letter of intent, be reviewed by the Graduate Committee and be officially admitted.
Format of Examination and Timing:
The Qualifying Examination consists of three written exams, in the areas of reservoir engineering, production engineering, and drilling engineering. The written exams will be offered twice in an academic year, in January and May. A PhD student who has been admitted in a fall semester takes the exam in January, and a student admitted in spring takes the exam in May. The written exams are closed book (i.e., no materials are permitted in the examination). The exams will be on two consecutive days for the three subjects, and each subject exam is 2 hours.

Exam Preparation:
The suggested books to study to prepare for the examination are:

If additional preparation is desired, candidates are encouraged to take PETE 661 for Drilling, PETE 662 for Production, and PETE 665 for Reservoir. However, taking these courses and completing them successfully are not required for the written exams.

Administration of the Examination:
All new PhD students will be assigned a QE registration number. The candidates will use the registration number throughout the exam. The candidate must not write his/her name on any exam-related papers.

Exam Outcomes:
The results of the Qualifying Examination will be reported back from the Examination Committee to the graduate advisor and announced before the beginning of the following semester. The candidate's continuation in the program will be based on the following rules:

Pass: A student receiving a pass in all three subject areas may continue in the doctoral program. If the student is serving as a GAR or GAT they may have their stipend increased to the PhD level with approval of their supervisor.

Conditional Pass: A student receiving a conditional pass in any of the three subject areas must take a course in the subject area in the following Spring or Fall semester and receive a grade of A or B. Upon successful completion of the course, the student will be issued a pass for that subject area. A course used for the conditional pass cannot be used for graduate degree-plan credits. A grade of C or below will be considered a failure for the subject area.

Failure: A student failing any of the three subject areas will be allowed a second attempt in the failed subject area(s) when the next Qualifying Examination is offered. If a student fails any subject area after the second attempt, he/she will be dismissed from the PhD program. No-shows for the exam will be treated as a failure.
**Annual PhD Student Review System**
Review of student progress once a year to provide an opportunity to assess performance and clarify expectations between student and advisor. Annual assessment of student progress includes goal setting, identifying milestones for the coming year, and clearly setting expectations.

**Preliminary Exam**
The student should complete the Preliminary Examination no later than the end of the semester following the completion of the formal coursework on the degree plan or within 6 hours of completion.

**Check List for Preliminary Examination**
- Approved degree plan on file with OGPAS
- All formal course work complete or within 6 hours of completion *(Does not include 691 hours)*
- GPR on degree plan 3.0 or higher
- Overall GPR 3.0 or higher
- Registered in the semester exam will be taken

**Report of Preliminary Examination**
Credit for the preliminary examination is not transferable in cases where a student changes degree programs after passing a preliminary exam.

If a written component precedes an oral component of the preliminary exam, the chair of the student’s examination committee is responsible for making all written examinations available to all members of the committee. A positive evaluation of the preliminary exam by all members of a student’s examination committee with at most one dissension is required to pass a student on his or her preliminary exam.

The student’s department will promptly report the results of the Preliminary Examination to the Office of Graduate and Professional Studies via the Report of Doctoral Preliminary Examination form. The Preliminary Examination checklist form must also be submitted. These forms should be submitted to the Office of Graduate and Professional Studies within 10 working days of completion of the preliminary examination.

After passing the required preliminary examination for the doctoral degree, the student must complete the final examination for the degree within **four calendar years**. Otherwise, the student will be required to repeat the preliminary examination.

**Retake of Failed Preliminary Examination**
Upon approval of the student’s examination committee, with no more than one member dissenting, and approval of the Office of Graduate and Professional Studies, a student who has failed the preliminary examination may be given one re-examination. Adequate time must be given to permit the student to address the inadequacies emerging from the first preliminary examination. The examination committee must agree upon and communicate in writing to the student, an adequate time-frame from the first examination (normally six months) to retest, as well as a detailed explanation of the inadequacies emerging from the examination. The student and the committee
should jointly negotiate a mutually acceptable date for this retest. When providing feedback on inadequacies, the committee should clearly document expected improvements that the student must be able to exhibit in order to retake the exam. The examination committee will document and communicate the time-frame and feedback within 10 working days of the exam that was not passed.

Proposal Submission
The research proposal is a description of the research which the student intends to undertake and which will be reported in a detailed, comprehensive fashion in the completed thesis.

It also offers the student an opportunity to convince the chair and other members of the advisory committee of his/her ability to pursue the projected topic to a successful conclusion. PhD students should submit their proposal once they have completed the preliminary exam or in conjunction with their preliminary exam. A minimum of two weeks is required for review of the proposal by the advisory committee and department head prior to asking for signature.

Final Examination (Dissertation Defense)
The Request and Announcement of the Final Examination should be submitted to OGAPS no later than 10 working days prior to the scheduled final exam, or by the OGAPS deadline for graduation, whichever comes first. The exam should not be administered until the dissertation is in final form and all concerned have had adequate time to review and tentatively approve the document. The final exam will be an oral presentation of the student’s dissertation. The student should submit the final copy of their dissertation to their committee at least 2 weeks prior to their scheduled exam date. The Report of the Final Exam form must be submitted to OGAPS within 10 days of the final examination.

Dissertation Submission:
Upload one approved final copy of the dissertation as a single PDF file to the University Thesis Office and submit signed dissertation approval form to Office of Graduate and Professional Studies. No content changes may be made to the thesis after it has been submitted to the Thesis Office.

Sample PHD Degree Plan

<table>
<thead>
<tr>
<th>Course Name/Number</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6XX</td>
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<td>PETE 6XX</td>
<td>3 hours</td>
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<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6XX</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 6X 615 PHD Stud Paper Contest</td>
<td>0 hour</td>
</tr>
<tr>
<td>PETE 681 Seminar</td>
<td>2 – 4 occurrences</td>
</tr>
<tr>
<td>PETE 684 internship</td>
<td>1 – 4 hours</td>
</tr>
<tr>
<td>Outside PETE course</td>
<td>3 hours</td>
</tr>
<tr>
<td>Outside PETE course</td>
<td>3 hours</td>
</tr>
<tr>
<td>PETE 691 research hours</td>
<td>1 – 30 hours</td>
</tr>
<tr>
<td><strong>Total Hours</strong></td>
<td><strong>64 Total hours (required minimum)</strong></td>
</tr>
</tbody>
</table>
**PETE 615** PhD Graduate Student Paper Contest. Student must register and participate once during PhD degree.

**PETE 681** Seminar. 2 hours are required on the PhD degree plan and up to 4 hours maybe used toward the degree.

**PETE 684** Internship hours are a required. One hour credit course for international students pursuing an internship. Students must register for PETE 684 for one hour each semester they are pursuing an internship.

**Committee:** PhD Degree plan must include 4 members of the Graduate Faculty
- **Advisor** – PETE faculty member
- **Co-advisor or member** – PETE faculty
- **Member** – PETE Faculty
- **Outside member** – Not a PETE faculty member

**Potential outside the department classes:**
- MATH 609
- MATH 610
- CHEN 629
- CHEN 661
- GEOL 619
- GEOL 624
- INEN 621
- MATH 602
- STAT 608
- STAT 616
- STAT 636

**Example of courses not allowed for degree plan credit:**
- STAT 651
- STAT 652

**Admissions Criteria**

The department’s Graduate Admissions Committee makes all graduate admission decisions for the department. The committee is made up of eight faculty members, including the Director of Graduate Studies and the Director of Distance Learning. The committee will review and evaluate all complete applications and only the most qualified are admitted. All students that are admitted receive an offer of financial support from the department or an advisor that has selected to work with them. Offers of financial support included a graduate assistantship in research, a graduate assistantship teaching, or a fellowship. Fellowship offers range from $1,000 to $30,000 per academic year.

Admission into the petroleum engineering graduate program is based on many factors.
- GRE scores (even if student is graduating from Texas A&M with an undergraduate or graduate degree), with a minimum Verbal Reasoning score of 147 and 155 quantitative.
- A statement of purpose on the following areas:
  - Your academic and professional preparation
  - Your research area of interest
- Your post-graduate plans
  - Résumé or curriculum vitae (to support your application)
  - Three letters of recommendation submitted through EngineeringCAS

For international graduate student applicants, the University requires those whose native language is not English to fulfill an English proficiency requirement. Verification of English proficiency can be achieved by a Test of English as a Foreign Language (TOEFL) score of at least 80, IELTS score of at least 6.0, or GRE Verbal score of 146). Those graduate applicants not so verified must take the English Language Proficiency Examination (ELPE) prior to registering for courses in their first semester. Those applicants with TOEFL scores below 80 and GRE verbal below 146 are required to take and pass the ELPE Oral exam as a condition of their acceptance into the graduate program.

Admission to the Petroleum Engineering Graduate program is highly competitive. Over the past five years the admission criterion has been modified aiming at one goal – improving the quality of the graduate student body. All applicants are evaluated by their academic records and professional development. The admission is based on (in the order on importance) undergraduate program, (school and major), GPA of bachelor’s degree, GRE score, recommendation letters, statement essay, and professional activity and experience.

In the past several years, the number of applications has dramatically decreased, we went from averaging 500-600 each year to 300-350 each year. The quality of the applicants remained constant.
We have continued to focus on recruiting U.S. graduate students from recognized engineering programs, and encouraging women students to pursue graduate degrees. As of Fall 2019, our graduate student population was 39% U.S. and 20% female.

The admitted students include engineering and science majored applicants from national highly ranked programs (MIT, Cornell, Brown University, UC-Berkeley, Cal-Tech, as examples) and impressive international programs (Tsinghua University, Indian School of Mines, Chulalongkorn University, as examples).

As a result, the quality of the graduate student body has improved. The average GPA of admitted students is around 3.45 on a 4.0 scale, and the average GRE scores is 163 for the quantitative and 154 for verbal.

**Quick Admit**
The College of Engineering implemented the Quick Admit Graduate Program (Appendix C) for current college of engineering students. The program expedites the admission for current students graduating from any of the college of engineering bachelor’s degree programs. The program provides automatic admission with a 3.0 GPA.

**Number of Degrees Awarded**
During the review period a total of 1,437 bachelors, masters, and PhD degrees have been awarded by the department.

<table>
<thead>
<tr>
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</tr>
</thead>
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</tr>
<tr>
<td>Master of Engineering (MEN)</td>
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<td>43</td>
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<td>23</td>
</tr>
<tr>
<td>Doctor of Philosophy (PhD)</td>
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<td>14</td>
<td>22</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td><strong>Total Degree Count</strong></td>
<td><strong>296</strong></td>
<td><strong>261</strong></td>
<td><strong>304</strong></td>
<td><strong>314</strong></td>
<td><strong>262</strong></td>
</tr>
</tbody>
</table>
Average Time to Degree

For the review period the average time to degree for the baccalaureate degree is 4.4 years, the average time to degree for the doctoral degree is 5.4 years, and the average time to degree for the master’s degree is 2.8 years.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Degree Level</th>
<th>Entry Type</th>
<th>Degree Count</th>
<th>Year to Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-15</td>
<td>Baccalaureate</td>
<td>Freshman</td>
<td>149</td>
<td>4.45</td>
</tr>
<tr>
<td></td>
<td>Doctoral</td>
<td>Graduate</td>
<td>26</td>
<td>5.23</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>88</td>
<td>2.66</td>
</tr>
<tr>
<td>2015-16</td>
<td>Baccalaureate</td>
<td>Freshman</td>
<td>135</td>
<td>4.38</td>
</tr>
<tr>
<td></td>
<td>Doctoral</td>
<td>Graduate</td>
<td>14</td>
<td>5.68</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>100</td>
<td>2.80</td>
</tr>
<tr>
<td>2016-17</td>
<td>Baccalaureate</td>
<td>Freshman</td>
<td>163</td>
<td>4.27</td>
</tr>
<tr>
<td></td>
<td>Doctoral</td>
<td>Graduate</td>
<td>22</td>
<td>5.20</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>94</td>
<td>2.86</td>
</tr>
<tr>
<td>2017-18</td>
<td>Baccalaureate</td>
<td>Freshman</td>
<td>191</td>
<td>4.34</td>
</tr>
<tr>
<td></td>
<td>Doctoral</td>
<td>Graduate</td>
<td>27</td>
<td>5.35</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>80</td>
<td>2.78</td>
</tr>
<tr>
<td>2018-19</td>
<td>Baccalaureate</td>
<td>Freshman</td>
<td>128</td>
<td>4.35</td>
</tr>
<tr>
<td></td>
<td>Doctoral</td>
<td>Graduate</td>
<td>43</td>
<td>5.55</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>52</td>
<td>3.08</td>
</tr>
</tbody>
</table>

Academic Enhancement/High-Impact Opportunities for Students

Graduate students are encouraged to have at least one internship with industry during their degree study. Ph.D. students interested in an academic career are encouraged to pursue the College of Engineering Graduate Teaching Fellowship that allows them to gain classroom teaching and management experience under the mentorship of a faculty member.

Assessment of Student Learning Outcomes

To effectively measure student learning outcomes the Graduate Programs Office developed the PETE Graduate Student Evaluation Form (Appendix C) to be completed by the student’s advisory committee at the time of the final exam. Forms are specific for each degree program offered, allows the committee to measure student learning outcomes as listed, and provide feedback on the student’s ability to meet department expectations.

Analysis

Implementation of the PETE Graduate Student Evaluation Form measured the student’s ability to meet department expectation in each area listed. Data provided for each student was analyzed at the end of each academic year, results tabulated indicated that all students were meeting department expectations.

In the Fall of 2018 the college of engineering implemented a Graduate Program Fee. Graduate students paid $145 per credit hour in 2018-2019 and in Fall 2019 the fee increased to $285 per credit hour. All of the fee money generated by a Department is returned to the Department and provides additional
funds that are used for various graduate program operations. The Graduate Programs Office worked with a team made up of faculty and graduate students to determine the best use of the additional funds. The current allocation for the additional funding is used for competitive fellowships for all admitted students to help with recruitment. Funds are also used for competitive fellowship for current students. The awards vary each semester depending on the availability of funds.
Faculty Profile

Core Faculty
Core faculty is defined as tenured and tenure-track faculty members.

Number of Core Faculty
During this review period, the department averaged 27 core faculty members, which is defined as tenured and tenure-track faculty.

Core Faculty / Student Ratio
The total number of graduate students decreased during the review period due to the downturn in recent years for the petroleum engineering industry. The average Ph.D. students to core faculty ratio varied from 3.8 to 5.1. Factors which affected this ratio also included the increased costs of graduate student support and the overall challenging funding environment the faculty faced during this period.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MEN</td>
<td>143</td>
<td>129</td>
<td>102</td>
<td>64</td>
<td>48</td>
</tr>
<tr>
<td>MS</td>
<td>147</td>
<td>122</td>
<td>96</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>PhD</td>
<td>137</td>
<td>148</td>
<td>128</td>
<td>119</td>
<td>98</td>
</tr>
<tr>
<td>Faculty</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>PhD/Core Faculty Ratio</td>
<td>5.1</td>
<td>5.5</td>
<td>4.7</td>
<td>4.3</td>
<td>3.8</td>
</tr>
</tbody>
</table>
Publications
The number of core faculty journal publications (by title) for the most recent 5 years shows an overall increase from 9.4 to 11.2. This number reflects improved research productivity of our faculty as well as our graduate students.

<table>
<thead>
<tr>
<th></th>
<th>Full Professor-16</th>
<th>Associate Professor-5</th>
<th>Assistant Professor-6</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>70</td>
<td>14</td>
<td>13</td>
<td>97</td>
</tr>
<tr>
<td>Average</td>
<td>4.4</td>
<td>2.8</td>
<td>2.2</td>
<td>9.4</td>
</tr>
<tr>
<td>2016-2017</td>
<td>Full Professor-17</td>
<td>Associate Professor-4</td>
<td>Assistant Professor-6</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>53.5</td>
<td>15.5</td>
<td>18.5</td>
<td>87.5</td>
</tr>
<tr>
<td>Average</td>
<td>3.1</td>
<td>3.9</td>
<td>3.1</td>
<td>10.1</td>
</tr>
<tr>
<td>2017-2018</td>
<td>Full Professor-17</td>
<td>Associate Professor-4</td>
<td>Assistant Professor-6</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>69.7</td>
<td>14</td>
<td>24</td>
<td>107.7</td>
</tr>
<tr>
<td>Average</td>
<td>4.1</td>
<td>3.5</td>
<td>4</td>
<td>11.6</td>
</tr>
<tr>
<td>2018-2019</td>
<td>Full Professor-20</td>
<td>Associate Professor-3</td>
<td>Assistant Professor-5</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>8</td>
<td>24.5</td>
<td>115.5</td>
</tr>
<tr>
<td>Average</td>
<td>4.4</td>
<td>2.7</td>
<td>4.9</td>
<td>12</td>
</tr>
<tr>
<td>2019-2020</td>
<td>Full Professor-17</td>
<td>Associate Professor-5</td>
<td>Assistant Professor-4</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>86.3</td>
<td>14</td>
<td>9.3</td>
<td>109.6</td>
</tr>
<tr>
<td>Average</td>
<td>5.4</td>
<td>3.5</td>
<td>2.3</td>
<td>11.2</td>
</tr>
</tbody>
</table>

External Grants
The amount of external grant money for our core faculty member (by title) initially showed an increase for the first 4 years. Due to the extreme downturn this past year that our industry has experienced we have seen a substantial decrease in external funding.

<table>
<thead>
<tr>
<th></th>
<th>Full Professor-16</th>
<th>Associate Professor-5</th>
<th>Assistant Professor-6</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>5,338,185</td>
<td>1,028,779</td>
<td>507,430</td>
<td>6,874,394</td>
</tr>
<tr>
<td>Average</td>
<td>355,579</td>
<td>257,195</td>
<td>84,572</td>
<td>697,346</td>
</tr>
<tr>
<td>2016-2017</td>
<td>Full Professor-17</td>
<td>Associate Professor-4</td>
<td>Assistant Professor-6</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>3,131,019</td>
<td>1,300,000</td>
<td>856,645</td>
<td>5,287,664</td>
</tr>
<tr>
<td>Average</td>
<td>208,735</td>
<td>433,333</td>
<td>142,774</td>
<td>784,842</td>
</tr>
<tr>
<td>2017-2018</td>
<td>Full Professor-17</td>
<td>Associate Professor-4</td>
<td>Assistant Professor-6</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>7,349,913</td>
<td>1,904,415</td>
<td>1,371,996</td>
<td>10,626,324</td>
</tr>
<tr>
<td>Average</td>
<td>524,994</td>
<td>476,104</td>
<td>228,666</td>
<td>1,229,754</td>
</tr>
<tr>
<td>2018-2019</td>
<td>Full Professor-20</td>
<td>Associate Professor-3</td>
<td>Assistant Professor-5</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>8,597,518</td>
<td>951,444</td>
<td>301,380</td>
<td>9,850,342</td>
</tr>
<tr>
<td>Average</td>
<td>573,168</td>
<td>317,148</td>
<td>60,276</td>
<td>950,592</td>
</tr>
<tr>
<td>2019-2020</td>
<td>Full Professor-17</td>
<td>Associate Professor-5</td>
<td>Assistant Professor-4</td>
<td>All</td>
</tr>
<tr>
<td>Total</td>
<td>2,641,112</td>
<td>604,513</td>
<td>522,300</td>
<td>3,767,925</td>
</tr>
<tr>
<td>Average</td>
<td>188,651</td>
<td>120,903</td>
<td>130,575</td>
<td>440,129</td>
</tr>
</tbody>
</table>
**Teaching Load**
The typical faculty teaching load for tenure/tenure track faculty teaching load for research active faculty members is 3 courses per year, not including summer. Recently hired faculty are given a reduced teaching load of one course per semester for the first two years. The Texas workload prescribes three courses per semester which is satisfied through teaching, advising graduate students, and service.

**Other Faculty**

**Number of Other Faculty**
The department currently has 15 Academic Professional Track (APT) and one Adjunct Professor teaching. The majority of the APT faculty teach undergraduate level classes and also provide services to the department such as undergraduate student advising. APT faculty members generally do not conduct sponsored research or advise graduate students at the Ph.D. level.

**APT Faculty / Student Ratio**
The total number of undergraduate students has also decreased during the review period due to the downturn in the petroleum engineering industry.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate</td>
<td>636</td>
<td>628</td>
<td>598</td>
<td>499</td>
<td>425</td>
</tr>
<tr>
<td>APT Faculty</td>
<td>14</td>
<td>15</td>
<td>14</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Student/APT Faculty Ratio</td>
<td>45.4</td>
<td>41.9</td>
<td>42.7</td>
<td>35.6</td>
<td>32.7</td>
</tr>
</tbody>
</table>
**Teaching Load**
Faculty members that are not research active teach two to three courses per semester and have service activities if full-time. Academic Professional Track (APT) faculty (Instructors, Instructional Professors, Professors of Practice) are expected to teach three courses per semester or offset teaching with service or research activities.

**Faculty Diversity**
The department faculty highlights good diversity in gender and ethnicity. About 18% of the faculty are women. Overall, in Fall 2020 the department 6 Hispanic faculty, 18 white, and 14 other (Asian, international, etc.).
Faculty Qualifications
The department faculty are very qualified, outstanding instructors, active in research and service. Research is an important part of producing the best petroleum engineers. Our funding comes from federal, state, industry, and other sources. Our research expenditures for 2019 were $6M. Current and future faculty hires in the department emphasize expertise beyond traditional petroleum engineering fields to expand the multi-disciplinary capability of the faculty to foster higher levels of multi-disciplinary collaboration across departments, colleges, and with other institutions and encourage partnership with industry and with government laboratories. With the expanded capabilities of multi-disciplinary research, it will make it possible to organize teams to compete for large center- or consortium-level research grants.

Research Focus Areas
Advanced Drilling Technologies
Well Control, Optimized Drilling Performance, Horizontal Drilling, Dual Gradient Drilling, Applied Drilling, Offshore Drilling Risks

Advanced Well Completion Technologies
Downhole Diagnostic Measurements, Intelligent Completions, Wellbore Models, Oil and Gas Recovery, Fluid/Gas/Foam Behavior
**Environmental management**
Methane hydrates, Geothermal systems, Carbon Capture & Sequestration, Hydrogen Separation and Storage, Water Management

**Prediction Models for Unconventional Reservoirs**
Geologic, Fracture Propagation, Reservoir Simulation, Risk Assessment

**Reservoir Modeling and Imaging**
Simulator Development, Optimization, Upscaling, Numerical Analysis

**Unconventional Reservoir Development and Assessment**
Pore-Scale Rock Physics, Diagnostic Technologies, Nanotechnologies

**Well Stimulation**
Hydraulic Fracturing Methods, Materials, Models, Matrix Acidizing, Acid Fracturing, Injections, Nanotechnology, Thermal Applications, Refracturing, Sand Transport
Analysis

With our current enrollment numbers, the full-time faculty members are adequate to support the mission of the institution and to ensure the quality and integrity of its academic programs. The petroleum engineering faculty are very dedicated in teaching, research, and service. The department has a group of excellent instructors in teaching both undergraduate and graduate classes. The faculty cares about and has a great relationship with our students. The majority of the faculty are research productive, and have strong levels of research involvement. The faculty also has an excellent reputation of service to the profession, the university, and the department. In particular, several of our faculty members are serving as leaders in their professional societies.

There are several areas of concern. The department needs to strengthen its research efforts by expanding from applied to blue-sky to solve the industry’s grand challenges. Looking at the distribution of faculty by rank, it is top heavy lacking junior faculty. The average number of grants and the average research dollar amount per faculty needs to increase and we are increasing our efforts on government grants rather than relying predominantly on industry grants as in the past. The faculty also need to be more competitive on interdisciplinary research initiatives and programs. The department is working to become more active in interdisciplinary research and be in a better position to compete for new research grants.
Student Profile

Enrollment

The department has one of the largest (if not the largest) petroleum engineering graduate student bodies in the country. For Fall 2019, we had 219 graduate students. Out of this total number, 173 are the resident graduate students and 46 are DL students. In the last several years the total number has been decreasing due to the recent downturn in the market.

The number of graduate students that can be properly supervised is controlled by the size of the faculty and the number of post-doctorate fellows we can afford to hire, which, in turn, is controlled by the size of our research budget. Currently, about 23 professors are performing research. Each professor can supervise the research of about 5 to 8 graduate students on average.

![Graduate Enrollment History](image)

Student Diversity

The Graduate Admissions Committee plays an important active role in maintaining a diverse graduate student body. The distribution of the female students among the graduate programs in petroleum engineering is shown below.
For Fall 2019, 20.1% of our enrolled graduate students are female. By degree female students represent 24.6% of the masters students, and 14.4% of the PhD students. The majority of our graduate student population is made up of international studies from all over the world.
Retention Rates
For the purposes of this data, doctoral students were defined as students classified in G8 status. G8 classification represents those students who already have a masters degree, or who have completed at least 30 hours of eligible graduate coursework post the BS degree if pursuing a direct-to-Ph.D. degree.
Graduation Rates

The graduation rate among our students varies since the data is based on when the student begins his/her studies. Ideally, a MEN student will take one and a half to two years taking at least 9 sch per semester, but most of our MEN students are distance learning students so it may take four to five years for a distance learning student to graduate. A MS student will ideally take two years to complete the degree. Typically, a PhD student will take four years to complete their degree.
Average Time to Degree
The time to degree for both doctoral and master’s degrees remain consistent. For the review period the average time to degree for the doctoral degree is 5.4 years, and the average time to degree for the master’s degree is 2.8 years.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Degree Level</th>
<th>Entry Type</th>
<th>Degree Count</th>
<th>Year to Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-15</td>
<td>Doctoral</td>
<td>Graduate</td>
<td>26</td>
<td>5.23</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>88</td>
<td>2.66</td>
</tr>
<tr>
<td>2015-16</td>
<td>Doctoral</td>
<td>Graduate</td>
<td>14</td>
<td>5.68</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>100</td>
<td>2.80</td>
</tr>
<tr>
<td>2016-17</td>
<td>Doctoral</td>
<td>Graduate</td>
<td>22</td>
<td>5.20</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>94</td>
<td>2.86</td>
</tr>
<tr>
<td>2017-18</td>
<td>Doctoral</td>
<td>Graduate</td>
<td>27</td>
<td>5.35</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>80</td>
<td>2.78</td>
</tr>
<tr>
<td>2018-19</td>
<td>Doctoral</td>
<td>Graduate</td>
<td>43</td>
<td>5.55</td>
</tr>
<tr>
<td></td>
<td>Master</td>
<td>Graduate</td>
<td>52</td>
<td>3.08</td>
</tr>
</tbody>
</table>

Average Institutional Financial Support
There are several mechanisms of support for the Texas A&M University graduate students. The petroleum engineering graduate students are offered financial assistance through fellowships, research assistantships, teaching assistantships, and student technicians. We also have students that are sponsored. Fellowships are offered to the most qualified incoming new students for their first year to allow them time to find a research project to work on or other position within the department.

Fellowships (varies)
- $1,000 – $30,000

Graduate Research Assistantships (GAR)
- $2,000 for MS
- $2,000 for PhD
- $2,150 for PhD once they pass the PhD qualifying exam

Graduate Teaching Assistantships (GAT)
- $2,000 for MS
- $2,000 for PhD
- $2,150 for PhD once they pass the PhD qualifying exam

Student Assistants
- $12.00 to $21 per hour

Sponsored by company or government

Percentage of Full-Time Students with Institutional Financial Support
The Department provides institutional funding to students in the form of graduate (research) assistantships, graduate (teaching) assistantships, and fellowships.
Student Publications/Presentations
During the review cycle timeframe, our doctoral students have averaged 1-2 publications per year, and attended at least 2 technical conferences. We continue to encourage students to publish.

Employment Profile
At the end of each semester the Graduate Programs Office sends out a Graduation Check Out form to all students that are listed for graduation clearance. We ask that each student provide information on their current job status or if they are still looking for a job. It is voluntary so not all students return the document.

Analysis
Our graduate program has seen some positive outcomes related to our efforts, including increased funding opportunities and consistent ranking in U.S. News & World Report. However, the intent of the program’s strategic plan is to continually seek ways to enhance key areas including recruiting, student development and graduation outcomes. We are also focused on increasing the number of competitive applications, particularly from U.S. domestic and diversity students, to increase enrollment. We are making progress in this area, but are also seeing some new challenges, such as increased cost of attendance and the current downturn in the energy industry. As with other graduate engineering programs, petroleum engineering graduate enrollment is usually made up of mostly international students, particularly at the Ph.D. level. We do strive to continue to recruit more domestic graduate students, especially from peer institutions. Currently, the majority of our domestic enrollment are distance learning and former undergraduate students of Texas A&M. We will continue to work closely with our undergraduate program to promote the Fast Track Program and encourage research interest. In addition to targeting peer institutions, we are also looking at establishing relationships with various engineering and science undergraduate programs at schools which do not have graduate programs, and schools with higher diversity populations. We also continue to addresses the need for additional funding, as this is a major consideration for students considering graduate school.
There are other significant challenges in recruiting and supporting our graduate students. We have seen a steady decline in the number of applications in recent years possibly due to the changes in visa and immigration laws and procedures, the current downturn in the energy industry, along with the economic and other changes in the foreign countries where we receive most of our applications. While the college’s growth plan called for an increase in enrollment numbers, we feel we need to continue to maintain our high admissions standards in order to graduate quality students. The rising cost for graduate education has had a negative impact on the enrollment of our self-funded students. We are working to develop strategies to provide multiple-year offers to top applicants and to also provide more graduate fellowships to self-funded international students so they can qualify for in-state tuition to offset the rising cost of graduate education.
Concluding Observations

The following is an assessment of the strengths, weakness, opportunities, and threats related to our graduate programs. After the SWOT analyses, the goals of the graduate programs are presented.

Strengths

- Consistently ranked as a top two Petroleum Engineering Graduate Program in the United States
- Strong alumni support for strategic input and recruitment of graduates
- Very strong reputation and credibility within the petroleum engineering industry and academia, both nationally and globally
- World recognized faculty members and researchers
- Comprehensive network of contacts within the industry and proximity to the world’s energy capital
- Graduate students who hit the ground running
- Global access to top incoming students
- Advanced lab and classroom facilities and access to world-class high-performance computing
- Branch PETE program in Middle-East for student recruiting, LNG expertise and career opportunities for both graduate students and faculty
- Renowned industry experts serving as Professors of Practice and Adjunct faculty

Weaknesses

- Inability to be nimble and agile due to college and university bureaucracy

Opportunities

- Recruiting of more high-quality students, both domestically and internationally
- Offering of more certificate programs
- Educate new generation about low cost energy in efficient, safe, clean manner
- Develop environmentally conscience engineers
- Differentiate department by improving internship/job opportunities
- Leverage Professor of Practice faculty members and make more visible

Threats

- Current market conditions make research solicitation and graduate recruitment challenging
- Public perception of oil & gas industry
- Cyclical nature of industry
- Cost of education

Goals

- Improving our recruiting and admissions of graduate students to increase the quality of our graduate program. We continue to increase the percentage of PhD students in order to improve the quality and depth of our research.
• Upgrading all of our teaching and research computing resources within the department as well as increasing our utilization of world-class university-level high-performance computing equipment.
• Expanding our use of industry-provided software and training to maintain state-of-the-art techniques and workflows in our classrooms and labs, ensuring our graduates are current in industry processes.
• Expanding the number and variety of member companies within the Crisman Institute research consortium in order to generate industry-directed research projects on a wider range of subjects.
• Enhancing our current relationships with upstream companies to ensure we’re exceeding their expectations and extending relationships to peripheral companies and government entities interested in the subsurface knowledge and engineering skillsets of our graduates.
Appendix A

Faculty Vitae
Name: Sara Abedi

Academic Rank: Assistant Professor, Petroleum Engineering  
Stephen A. Holditch Faculty Fellow

Degrees: Ph.D. Civil Engineering, University of Southern California, Los Angeles  
M.S. Soil Mechanics, University of Tehran  
B.S. Civil Engineering, University of Tehran

Professional Experience:  
2015-Present  Assistant Professor, Harold Vance Department of Petroleum Engineering, Texas A&M University  
2012-2014  Postdoctoral Associate, Massachusetts Institute of Technology

Selected Publications:  

Scientific and Professional Society Membership/Offices:  
• Member, Society of Petroleum Engineers  
• Member, American Rock Mechanics Association  
• Member, American Geophysical Union  
• Member, American Society of Civil Engineers  
• Member, American Chemical Society

Recent Honors and Awards:  
• Best Paper, American Rock Mechanics Association - 2019  
• Best Paper, American Rock Mechanics Association - 2018  
• Petroleum Engineering Young Faculty Research Initiation Fellowship Award, Society of Petroleum Engineers - 2015

Research Interests:  
• Mechanics and Physics of Geomaterials  
• Multiscale Chemo-Mechanical Characterization and Modeling  
• Reservoir Geomechanics  
• Granular Material Failure and Flow and Granular Physics
Name:  I. Yucel Akkutlu

Academic Rank:  Professor, Petroleum Engineering
Rob L. Adams '40 Endowed Professor

Degrees:  Ph.D., Petroleum Engineering, University of Southern California, Los Angeles
M.S., Petroleum Engineering, University of Southern California, Los Angeles
B.S., Chemical Engineering, Hacettepe University, Ankara

Professional Experience:
2019-Present  Professor, Harold Vance Department of Petroleum Engineering, Texas A&M University
2013-2019  Associate Professor, Harold Vance Department of Petroleum Engineering, Texas A&M University
2012  Visiting Professor, Instituto Tecnológico de Buenos Aires, Buenos Aires, Argentina
2011-2012  Associate Professor, Mewbourne School of Petroleum and Geological Engineering, University of Oklahoma
2007-2011  Assistant Professor, Mewbourne School of Petroleum and Geological Engineering, University of Oklahoma
2002  Visiting Scholar, Fluid Dynamics Laboratory, National Institute of Pure and Applied Mathematics (IMPA), Rio de Janeiro, Brazil

Selected Publications:

Scientific and Professional Society Certification & Memberships:
• Member, Society of Petroleum Engineers
• Member, Fulbright U.S. Scholar Program Peer Review Committee, Chemical Engineering Discipline
• Board Member, SPE Journal

Recent Honors and Awards:
• Lester C. Uren Award, Society of Petroleum Engineers - 2020
• Distinguished Member, Society of Petroleum Engineers - 2018
• Association of Former Students Distinguished Achievement Award in Teaching-College Level, Texas A&M University - 2017
• Association of Former Students Distinguished Achievement Award-Individual Student Relationship, Texas A&M University - 2016
• Rossiter W. Raymond Memorial Award, American Institute of Mining, Metallurgical - 2014

Research Interests:
• Shale Gas and Oil Resource Assessment and Characterization
• CO2 Enhanced Shale Gas and Oil Recovery
• Shale Oil Recovery Using Surfactants and Microemulsions
• Digital Rock Physics and Pore-Network Modeling
• Compositional Reservoir Flow Simulation Coupled with Geomechanics
• Natural Gas Hydrates
Name: Gia Alexander

Academic Rank: Graduate Assistant Lecturer, Petroleum Engineering (part-time)

Degrees: M.A., English, Texas A&M University  
B.A., English, Northwestern State University of Louisiana

Professional Experience:

2019-Present  Graduate Assistant Lecturer, Harold Vance Department of Petroleum Engineering, Texas A&M University, College Station, TX

2016-2019  Teaching Assistant, Department of English, Texas A&M University, College Station, TX

2014-2019  Graduate Student Assistant, Harold Vance Department of Petroleum Engineering, Texas A&M University, College Station, TX

2012-2014  Independent Living Facilitator, Brazos Valley Center for Independent Living, Bryan, TX

1991-1995  Writing Instructor, Blinn College, Bryan, TX

1989-1991  Teaching Assistant/Assistant Lecturer, Department of English, Texas A&M University, College Station, TX

Selected Publications:


Research Interests:

• Effects of Preliminary Writing
• Intercultural Technical Communication
• Accessibility in Digital Environments
Name: Ibere Nascentes Alves

Academic Rank: Professor of Engineering Practice, Petroleum Engineering

Degrees:
- Ph.D. Petroleum Engineering, Tulsa University
- M.S. Petroleum Engineering, Federal University of Ouro Preto
- B.S. Mechanical Engineering, Catholic University of Rio De Janeiro
- MBA, Business and Administration, Federal University of Rio de Janeiro, R.J., Brazil

Professional Experience:
- 2015-present Professor of Engineering Practice, Harold Vance Department of Petroleum Engineering, Texas A&M University,
- 2012-2014 Senior Flow Assurance Engineer, Petrobras America Inc.
- 2011-2012 Senior Petroleum Engineer, Petrobras
- 2007-2011 Senior Petroleum Engineer, Computer Modelling Group, Ltd., Calgary, Canada
- 2000-2007 Manager of Technical Support, Petrobras
- 1988-1991 Production Engineer, Petrobras
- 1986-1987 Production Engineer II, Petrobras
- 1981-1986 Production Engineer I, Petrobras
- 1980-1981 Production Engineer Trainee, Petrobras
- 1978-1980 Industrial Engineer Trainee, S.A. White Martins

Selected Publications:

Scientific and Professional Society Membership/Offices:
- Member, Society of Petroleum Engineers
Recent Honors and Awards:
- Association of Former Students Distinguished Achievement Award in Teaching – College Level - 2020
- Doug Von Gonten Award for Excellence in Teaching, Department of Petroleum Engineering - 2019
- Instructional Faculty Teaching Award, College of Engineering, Texas A&M University - 2018
- ConocoPhillips Non-Tenured Track Faculty Award for Excellence in Teaching - 2018
- Doug Von Gonten Award for Excellence in Teaching, Department of Petroleum Engineering, 2018
- Doug Von Gonten Award for Excellence in Teaching, Department of Petroleum Engineering, 2017
- ConocoPhillips Non-Tenured Track Faculty Award for Excellence in Teaching, 2016

Research Interests:
- Gas and Oil Production
- Two Phase Flow Modeling
- Artificial Lift
- Flow Assurance
- Intelligent Fields
- Deep Water Petroleum Production
Name: Maria A. Barrufet

Academic Rank: Professor, Petroleum Engineering
Baker Hughes Endowed Chair
Assistant Department Head, Staff Administration
Director, Online Learning for Petroleum Engineering

Degrees: Ph.D. Chemical Engineering, Texas A&M University
M.S. Chemical Engineering, Universidad Nacional de Salta Argentina
B.S. Chemical Engineering, Universidad Nacional de Salta Argentina

Professional Experience:
- 2004-Present Professor, Harold Vance Department of Petroleum Engineering, Texas A&M University
- 2007-Present Adjunct Professor, Department of Chemical Engineering, Texas A&M University
- 1997-2004 Associate Professor, Department of Petroleum Engineering, Texas A&M University
- 1991-1997 Assistant Professor, Department of Petroleum Engineering, Texas A&M University
- 1987-1991 Postdoctoral Research Associate, Department of Chemical Engineering, Texas A&M University

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, American Institute of Chemical Engineers
- Member, Society of Petroleum Engineers
- Member, Omega Chi Epsilon Honor Society of Chemical Engineers

Recent Honors and Awards:
- Faculty Fellow of Mary Kay O Connor Process Safety Center, Texas A&M University - 2016
- Regional Distinguished Achievement Award for Petroleum Engineering Faculty, Society of Petroleum Engineers - 2015
- Distinguished Member, Society of Petroleum Engineers - 2013
• Dean’s Fellow for Innovation in Distance Learning, Texas A&M University, College of Engineering - 2012-2013
• Charles Crawford Distinguished Service Award, Texas A&M University - 2006 and 2012
• Faculty Fellow, Texas A&M Engineering Experiment Station - 2004-2005
• Assessing Technology in Teaching Award, Office of Distance Education - 2004

Research Interests:
• Reservoir Confined Fluid Properties Evaluation
• Reservoir Near-Critical Fluids and Compositional Simulation, Hydrocarbon Characterization
• Equations of State (EOS) for multiphase equilibria
• Enhanced Oil Recovery
• Modeling of CO2 Storage and Capture
• Multiphase Flow, Flow Assurance and Leak Detection Methods
Name: Peter Bastian

Academic Rank: Professor of Engineering Practice, Petroleum Engineering (part time)

Degrees: M.S. Petroleum Engineering, Texas A&M University  
B.S. Petroleum Engineering, Texas A&M University

Professional Experience:

2014-Present  Professor of Engineering Practice, Department of Petroleum Engineering,  
              Texas A&M University

2007-Present  Vice President Engineering, Unconventional Resources, LLC

2006-2007    Consultant, Bastian Consulting

2001-2006    Manager of Reservoir Evaluation and Simulation, Quicksilver Resources, Inc.,

1998-2001    Schlumberger OFS Data and Consulting Services, Manager, Reservoir Engineering


Selected Publications:

   UGR Blair Creek Ltd.: “Probabilistic Forecasting of Horizontal Well Performance in  
   Unconventional Reservoirs Using Publicly-Available Completion Data”, SPE 168978, Presented  

   dry Horseshoe Canyon CBM play in Canada”, SPE 96899, Presented at the 2005 Annual  
   Technical Conference and Exhibition, Dallas, TX, 09-12 Oct.

Scientific and Professional Society Certifications & Memberships:

- Member, Society of Petroleum Engineers

Research Interests:

- Unconventional Reservoirs
- Data Analytics
- Numerical Reservoir Simulation
- Reservoir Engineering
- Oil and Gas Economics
Name: Thomas A. Blasingame

Academic Rank: Professor, Petroleum Engineering
Robert L. Whiting Endowed Professor

Degrees:
Ph.D., Petroleum Engineering, Texas A&M University
M.S., Petroleum Engineering, Texas A&M University
B.S., Petroleum Engineering, Texas A&M University

Professional Experience:
2005-Present Professor, Harold Vance Department of Petroleum Engineering, Texas A&M University
1996-2005 Associate Professor, Harold Vance Department of Petroleum Engineering, Texas A&M University
1991-1996 Assistant Professor, Department of Petroleum Engineering, Texas A&M University

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Associate Member, American Association of Petroleum Geologists (AAPG)
- Member, American Institute of Chemical Engineers (AIChE)
- Member, American Society for Engineering Education (ASEE)
- Member, Society of Exploration Geophysicists (SEG)
- Member, Society of Petroleum Engineers (SPE)
- Registered Professional Engineer, Texas (77391)
- Honorary Member, Society of Petroleum Engineers, 2015
Recent Honors and Awards:

- William Keeler Memorial Service Award, Texas A&M University, College of Engineering - 2020
- Petroleum Engineering Academy of Distinguished Graduates - Department of Petroleum Engineering, Texas A&M University - 2017
- Honorary Member, Society of Petroleum Engineers, 2015
- Distinguished Achievement Award for Petroleum Engineering Faculty, Society of Petroleum Engineers - 2014
- DeGolyer Distinguished Service Medal, Society of Petroleum Engineers - 2013
- Anthony F. Lucas Gold Medal, Society of Petroleum Engineers - 2012

Research Interests:

- Unconventional reservoirs
- Production data analysis
- Pressure transient data analysis
- Petroleum reservoir engineering
- Technical mathematics
Name: J.C. Cunha

Academic Rank: Professor of Engineering Practice, Petroleum Engineering

Degrees: Ph.D. Petroleum Engineering, University of Tulsa, Oklahoma
M.S. Petroleum Engineering, Ouro Preto Federal University, Brazil
B.S. Civil Engineering, Juiz De For a Federal University, Brazil

Professional Experience:
2019-Present  Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University
2016-2019  Senior Petroleum Engineer, Bureau of Safety and Environmental Enforcement, U.S., Department of Interior
2014-2016  Drilling & Completion Technical Training Leader, Chevron Energy Technology Company
2011-2014  Drilling Manager, Center of Offshore Excellence, Ecopetrol America Inc.
2007-2011  Well Operations Manager, Petrobras America Inc.
2003-2007  Associate Professor, School of Mining and Petroleum Engineering, University of Alberta, Edmonton, Canada
1979-2003  Technology Manager, Petrobras and Petrobras International

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers
- Member, American Society of Drilling Engineers

Recent Honors and Awards:
- Distinguished Lecturer Award, Society of Petroleum Engineers - 2010-2011
- Outstanding Service Award, Society of Petroleum Engineers - 2009
- Outstanding Service Award, Society of Petroleum Engineers - 2008
- Faculty of Engineering Undergraduate Teaching Award, University of Alberta, Canada - 2005

Research Interests:
- Drilling Optimization
- Deepwater Drilling
- Drill String Mechanics
- Risk Analysis Applications
Name: Akhil Datta-Gupta

Academic Rank: University Distinguished and Regents Professor, Petroleum Engineering
L.F. Peterson ’36 Chair I
University Distinguished Professor
Associate Department Head, Faculty Administration

Degrees: Ph.D. Petroleum Engineering, University of Texas at Austin
M.S. Petroleum Engineering, University of Texas at Austin
B.S. Petroleum Engineering, Indian School of Mines, Dhanbad

Professional Experience:
2016-Present University Distinguished Professor, Department of Petroleum Engineering, Texas A&M University
2011-Present Regents Professor, Department of Petroleum Engineering, Texas A&M University
2003-2011 Professor, Department of Petroleum Engineering, Texas A&M University
2000-2003 Associate Professor, Department of Petroleum Engineering, Texas A&M University
1994-2000 Assistant Professor, Department of Petroleum Engineering, Texas A&M University
1992-1994 Staff Scientist II, Reservoir Engineering and Hydrogeology Group, Earth Sciences Division, Lawrence Berkeley National Laboratory
1989-1990 Engineering Specialist, Fluid Flow Unit, BP Research
1985-1989 Reservoir Engineer, BP Exploration

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, National Academy of Engineering
- Member, The Academy of Medicine, Engineering and Science of Texas
- Registered Professional Engineer, Texas
- Member, Society of Petroleum Engineers
Recent Honors and Awards:

- The Southeastern Universities Research Association Distinguished Scientist Award - 2019
- Honorary Member, Society of Petroleum Engineers - 2017
- Distinguished Achievement Award for Petroleum Engineering Faculty, Society of Petroleum Engineers - 2015
- John Franklin Carll Award, Society of Petroleum Engineers - 2009
- Cedric K. Ferguson Award, Society of Petroleum Engineers - 2006
- Lester C. Uren Award, Society of Petroleum Engineers - 2003
- Distinguished Member, Society of Petroleum Engineers - 2001
- Rossiter W. Raymond Award of AIME - 1992

Research Interests:

- Rapid Flow Simulation Techniques
- Streamline Simulation and Applications
- Inverse Modeling and Multi-Scale Data Integration
- Geostatistics and Stochastic Reservoir Characterization
- Modeling and Scale-Up of Enhanced Oil Recovery
Name: Iskander Diyashev

Academic Rank:  Professor of Engineering Practice, Petroleum Engineering (part time)

Degrees:  Ph.D. Petroleum Engineering, Texas A&M University  
M.S. Chemical Physics, Moscow Institute of Physics and Technology  
B.S. Chemical Physics, Moscow Institute of Physics and Technology

Professional Experience:
2020-Present  Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University
2016-Present  Director, Petroleum and Energy Technology Advisors
2008-Present  Instructor, PetroSkills
2006-2008  Director-At-Large, Society of Petroleum Engineers
2001-2006  Chief Engineer, CIBNEFT
2000-2001  Senior Reservoir Engineer, Schlumberger
1990-1994  Senior Research Engineer, TatNEFT Oil Company

Selected Publications:

Scientific and Professional Society Membership/Offices:
- Member, Society of Petroleum Engineers
- Member, Russian Academy of Natural Sciences
- Member, Phi Kappa Phi
Research Interests:

- Reservoir and Production Engineering
- Oil and Gas Reserves Evaluation
- Well Test Design and Analysis
- Gas Reservoir Management
Name: Fred Dupriest

Academic Rank: Professor of Engineering Practice, Petroleum Engineering (part time)

Degrees: B.S. Petroleum Engineering, Texas A&M University

Professional Experience:
- 2013-Present: Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University
- 2010-2012: Chief Drilling Engineer, ExxonMobil Drilling
- 2008-2010: Senior Consultant, Drilling Technical
- 1999-2008: Senior Advisor, Drilling Technical
- 1995-1997: Staff Engineer, New Orleans Drilling
- 1989-1995: Senior Staff Engineer, Houston Drilling
- 1985-1989: Exploration/Drilling Liaison, Houston Exploration

Retired Chief Drilling Engineer, ExxonMobil

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers

Recent Honors and Awards:
- Regional Distinguished Achievement Award for Petroleum Engineering Faculty, Society of Petroleum Engineers Gulf Coast North America Region - 2019
- Distinguished Member, Society of Petroleum Engineers - 2016
- Tony Krepp Memorial Award for Excellence, K&M Technology Group - 2015
- Instructional Faculty Teaching Award, Texas A&M University College of Engineering - 2014
- Drilling Engineering Award, Society of Petroleum Engineers - 2013
- Drilling Fluids Hall of Fame, American Association of Drilling Engineers - 2012

Research Interests:
- Drilling performance workflows
- Drilling mechanics theory and practices
- Lost circulation theory and practices
- Stuck pipe avoidance
- Borehole quality management practices
- Advanced well control practices
Name: Edwardo Gildin

Academic Rank: Associate Professor, Petroleum Engineering
Class of 1975 DVG Career Development Professor

Degrees: Ph.D. Aerospace Engineering, University of Texas
M.S. Mechanical Engineering, University of Sao Paulo, Brazil
B.S. Mechanical Engineering, Faculdade de Engenharia Industrial, Brazil

Professional Experience:
2015-Present  Associate Professor, Department of Petroleum Engineering, Texas A&M University
2009-2015  Assistant Professor, Department of Petroleum Engineering, Texas A&M University
2007-2009  Postdoctoral Fellow, Institute for Computational Engineering and Sciences, Center for Subsurface Modeling, The University of Texas at Austin
2006-2007  Postdoctoral Researcher, Electrical and Computer Engineering, Rice University
2000-2006  Assistant Instructor, Aerospace Engineering, The University of Texas at Austin

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers
- Member, Society of Industrial and Applied Mathematics
- Member, Institute of Electrical and Electronics Engineers
- Member, International Society for Porous Media
- Member, European Association of Geoscientists and Engineers

Recent Honors and Awards:
- William O. and Montine P. Head Memorial Research Fund-Engineering Outstanding Contributions Award, Texas A&M University College of Engineering - 2020
Energi Simulation Chair in Robust Reduced Complexity Modeling, Foundation CMG - 2013-2019
Dean of Engineering Excellence Award - 2018
Superior Energy Excellence in Service Faculty Award - 2018

Research Interests:
- Model Reduction of Large-Scale Dynamical Systems
- Control and Optimization of Large-Scale Dynamical Systems
- Reservoir Modeling and Simulation
- Closed-Loop Reservoir Management
Name:  Berna Hascakir

Academic Rank:  Associate Professor, Petroleum Engineering
              Flotek Industries, Inc. Career Development Professor

Degrees:  Ph.D. Petroleum Engineering, Middle East Technical University, Ankara
         M.S. Environmental Technology, Dokuz Eylul University
         B.S. Environmental Engineering, Dokuz Eylul University

Professional Experience:
2018-Present  Associate Professor, Department of Petroleum Engineering, Texas A&M University
2012-2018    Assistant Professor, Department of Petroleum Engineering, Texas A&M University
2011-2012    Senior Heavy Oil Reservoir Engineering, Schlumberger
2011         Reservoir Simulation Engineering, Schlumberger
2008-2010    Postdoctoral Researcher, Stanford University

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
• Member, Society of Petroleum Engineers
• Member, American Chemical Society
• Member, American Association of University Professors

Recent Honors and Awards:
• Distinguished Member, Society of Petroleum Engineers - 2018
• Innovative Teaching Award, Society of Petroleum Engineers - 2015
• Top 10 Associate Editors, Journal of Petroleum Science and Engineering, Elsevier - 2014
• Junior Faculty Research Grant, Society of Petroleum Engineers - 2014

Research Interests:
• Heavy Oil and Oil Shale Recovery with Enhanced Oil Recovery Methods
• Diagnostic Studies on Reservoir Rock and Fluids
• Produced Water Management
Name: A. Daniel Hill

Academic Rank: Regents Professor, Petroleum Engineering
Noble Chair

Degrees: Ph.D. Chemical Engineering, The University of Texas
M.S. Chemical Engineering, The University of Texas
B.S. Chemical Engineering, Texas A&M University

Professional Experience:

2019-Present Regents Professor, Noble Chair, Department of Petroleum Engineering, Texas A&M University
2018-2019 Professor, Noble Chair, Department of Petroleum Engineering, Texas A&M University
2013-2018 Department Head, Department of Petroleum Engineering, Texas A&M University, College Station, TX
2012-2013 Interim Department Head, Department of Petroleum Engineering, Texas A&M University
2008-2012 Associate Department Head, Department of Petroleum Engineering, Texas A&M University
2006-2008 Assistant Department Head for Graduate Affairs, Department of Petroleum Engineering, Texas A&M University
2004-2019 Professor, Department of Petroleum Engineering, Texas A&M University
1993-2004 Professor, Department of Petroleum Engineering, The University of Texas at Austin, Austin, TX
1987-1993 Associate Professor, Department of Petroleum Engineering, The University of Texas at Austin
1982-1987 Assistant Professor, Department of Petroleum Engineering, The University of Texas at Austin
1978-1982 Research Engineer, Marathon Oil Denver Research Center

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
Member, Society of Petroleum Engineers

Recent Honors and Awards:
- Honorary Membership, Society of Petroleum Engineers - 2020
- John Franklin Carll Award, Society of Petroleum Engineers - 2014
- Director for Academia, Society of Petroleum Engineers Board of Directors - 2013
• Gulf Coast Regional Distinguished Achievement Award, Society of Petroleum Engineers - 2013
• Pipeline Award, Society of Petroleum Engineers - 2012
• Production and Operations Award, Society of Petroleum Engineers - 2008

Research Interests:
• Production Engineering
• Well Completions
• Well Simulation
• Production Logging
• Complex Well Performance
Name: John Jochen

**Academic Rank:** Senior Lecturer, Petroleum Engineering (part time)

**Degrees:** M.S. Petroleum Engineering, Texas A&M University  
B.S. Petroleum Engineering, Texas A&M University

**Professional Experience:**
- 2012-Present  Senior Lecturer, Department of Petroleum Engineering, Texas A&M University
- 2007-Present  Senior Petroleum Engineer, Unconventional Gas Resources
- 1997-2007  Principal Production/Reservoir Engineer, Schlumberger Data & Consulting Services
- 1986-1989  Corporate Staff Engineer, Tenneco Oil E&P
- 1979-1986  Senior Production Engineer, Tenneco Oil E&P

**Selected Publications:**

**Scientific and Professional Society Certifications & Memberships:**
- Registered Professional Engineer, Texas
- Member, Society of Petroleum Engineers

**Research Interests:**
- Conventional and Unconventional Shales
- Production Data Analysis
- Production Forecasting
- Modelling Multi-Fracture, Horizontal Wells
Name: Valerie Jochen

Academic Rank: Professor of Engineering Practice, Petroleum Engineering (part time)

Degrees: Ph.D. Petroleum Engineering, Texas A&M University  
M.S. Petroleum Engineering, Texas A&M University  
B.S. Petroleum Engineering, Texas A&M University

Professional Experience:
2018-Present  Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University  
2010-2016  Fellow and Unconventional Technical Director Reservoir/Production, Schlumberger  
2008-2010  Reservoir Stimulation Technology Director, Schlumberger  
2005-2008  Unconventional Gas Technical Director, Schlumberger  
2004-2005  Data and Consulting Services Manager, Schlumberger  
1997-2003  Operations Manager, Schlumberger  
1984-1989  Reservoir Engineering and Planning Supervisor, Mobil Exploration & Production  
1979-1984  Reservoir Engineer, Superior Oil Company

Selected Publications:

Scientific and Professional Society Membership/Offices:
- Registered Professional Engineer, Texas  
- Member, Society of Petroleum Engineers  
- Member, Society Women Engineers  
- Member, Society of Petrophysicists and Well Log Analysts

Recent Honors and Awards:
- 2005 Performed by Schlumberger Silver Award for "Creating Value in Shale Gas Opens Thousands of Acres to Development"  
- 2002 Performed by Schlumberger Silver Award for "Vicksburg Basin Study"

Research Interests:
- Unconventional Resources  
- Property Evaluation
Name: John Killough

**Academic Rank:** Professor, Petroleum Engineering
George K. Hickox, Jr. Professor

**Degrees:**
- Ph.D. Math Sciences, Rice University
- M.S. Chemical Engineering, Rice University
- B.A. Chemical Engineering, (Phi Beta Kappa), Rice University

**Professional Experience:**
- 2012-Present  Professor, Department of Petroleum Engineering, Texas A&M University
- 2005-2012 Halliburton Technology Fellow, Halliburton
- 2000-2005 Senior Research Fellow, Landmark Graphics Corporation
- 1997-2000 Direct of Reservoir Simulation, Landmark Graphics Corporation
- 1988-1997 Associate Professor, Department of Chemical Engineering, University of Houston
- 1983-1988 Senior Research Advisor, Arco Oil and Gas Co.
- 1982-1983 Manager of Reservoir Simulation Department, Scientific Software-Intercomp
- 1976-1982 Director of Mathematical Modeling Group, Arco Oil & Gas Co.
- 1971-1976 Senior Research Engineer, Exxon Production

**Selected Publications:**

**Scientific and Professional Society Certifications & Memberships:**
- Member, Society of Petroleum Engineers

**Recent Honors and Awards:**
- Distinguished Member, Society of Petroleum Engineers - 2016
- Karen and Larry A. Cress '76 Teaching Excellence Award, Harold Vance Department of Petroleum Engineering - 2016
- Reservoir Description and Dynamics Award, Society of Petroleum Engineers - 2013
Research Interests:

- Unconventional Reservoir Simulation/High Performance Computing
- Coupled Surface/Sub-Surface Reservoir Models
- Upscaling and Multiscale Reservoir Simulation
- Hysteresis and Relative Permeability
Name: Jihoon Kim

Academic Rank: Associate Professor, Petroleum Engineering
Larry A. Cress ’76 Faculty Fellow

Degrees: Ph.D. Petroleum Engineering, Stanford University
M.S. Civil, Urban, and Geosystem Engineering, Seoul National University
B.S. Civil, Urban, and Geosystem Engineering, Seoul National University

Professional Experience:
2020-Present  Associate Professor, Department of Petroleum Engineering, Texas A&M University
2014-2020  Assistant Professor, Department of Petroleum Engineering, Texas A&M University
2012-2014  Geological Research Scientist, Lawrence Berkley National Laboratory
2010-2012  Geological Postdoctoral Fellow, Lawrence Berkley National Laboratory

Selected Publications:

Scientific and Professional Society Certifications & Memberships:

Recent Honors and Awards:
• Director's Award for Exceptional Achievement, Lawrence Berkeley National Laboratory – 2012
• Outstanding Reviewer for the Journal of Petroleum Science and Engineering - 2011

Research Interests:
• Coupled flow and geomechanics in hydrate, shale and tight gas, and geothermal reservoirs
• Hydraulic fracturing, hydro-shearing, coupled geomechanic-geophysical modeling
• Reservoir simulation, computational geomechanics
Name: Michael King

Academic Rank: Professor, Petroleum Engineering
LeSuer Chair in Reservoir Management

Degrees: Ph.D. Physics, Syracuse University
M.S. Physics, Syracuse University
B.S. Physics and Mathematics, The Cooper Union for the Advancement of Science and Art

Professional Experience:
- 2009-Present Professor, Department of Petroleum Engineering, Texas A&M University
- 2005-2009 Senior Advisor, BP America/BP Amoco E&P Upstream Technology Group
- 2002-2005 Advisor, BP America/BP Amoco E&P Upstream Technology Group
- 1999-2001 Technology Network Leader, BP America/BP Amoco E&P Upstream Technology Group
- 1995-1999 Senior Reservoir Engineer, BP Exploration Operating Co, Ltd.
- 1991-1995 Reservoir Engineer, BP Research and BP Exploration, UK
- 1982-1990 Senior Project Leader/Research Scientist, Sohio/Standard Oil/BP Research

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers

Recent Honors and Awards:
- Energi Simulation Chair in Robust Reduced Complexity Modeling, Foundation CMG - 2013-2019
- 25 Year Volunteer Recognition Award, Energistics RESQML SIG - 2015
- Karen and Larry A. Cress '76 Excellence in Teaching Faculty Award, Petroleum Engineering Department - 2014
- Distinguished Member, Society of Petroleum Engineers - 2013
- Reservoir Description and Dynamics Award, Society of Petroleum Engineers - 2011
Research Interests:

- 3D Reservoir Modeling and Characterization
- Pressure and Rate Transient Analysis for Unconventional Reservoirs
- Upscaling of Geologic Models for Flow Simulation
- Streamline-Based Simulation and Flow Analysis
Name: Marcelo Laprea-Bigott

Academic Rank: Professor of Engineering Practice, Petroleum Engineering

Degrees: Ph.D. Petroleum Engineering, Texas A&M University  
M.S. Petroleum Engineering, Texas A&M University  
B.S. Petroleum Engineering, University de Zulia, Venezuela

Professional Experience:
2016-Present  Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University
2001-2016  Director of Curriculum, Network of Excellence in Training (NeXT), Schlumberger
1999-2000  Development Manager, Schlumberger Holditch – Reservoir Technologies Venezuela, Trinidad and Tobago
1983-1996  President, SIMUPET, C.A., Puerto La Cruz, Venezuela
1980-1983  Associate Professor, Petroleum Engineering Department, Universidad de Oriente, Puerto La Cruz, Venezuela

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
• Member, Society of Petroleum Engineers

Recent Honors and Awards:
• Distinguished Membership, Society of Petroleum Engineers - 2020
• Advisor Award, Schlumberger - 2014

Research Interests:
• Pressure and Rate Transient Well Analysis
• Reservoir Engineering and Production Optimization
• Unconventional Reservoirs and Heavy Oil Recovery Methods
Name: W. John Lee

Academic Rank: Professor, Petroleum Engineering
Kelly L. ’87 and William D. ’87 Von Gonten, Jr. DVG Chair

Degrees: Ph.D. Chemical Engineering, Georgia Institute of Technology
M.S. Chemical Engineering, Georgia Institute of Technology
B.S. Chemical Engineering, Georgia Institute of Technology

Professional Experience:
2015-Present Professor, Department of Petroleum Engineering, Texas A&M University
2011-2015 Professor, Petroleum Engineering Program, The University of Houston
1977-2011 Regents Professor, Department of Petroleum Engineering, Texas A&M University
1971-1976 District Reservoir Engineer of Exxon Company
1968-1971 Associate Professor, Petroleum Engineering Department, Mississippi State University
1962-1968 Senior Research Specialist, Exxon Production Research Company

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Academic Engineering Fellow, U.S. Securities & Exchange Commission - 2009
- Member, National Academy of Engineering - 1993
- Member, Russian Academy of Natural Sciences - 2006

Recent Honors and Awards:
- Honorary Life Member, Society of Petroleum Evaluation Engineers - 2017
- DeGolyer Distinguished Service Medal, Society of Petroleum Engineers - 2004
- Anthony F. Lucas Gold Medal, AIME/SPE - 2003
- Honorary Member, Society of Petroleum Engineers - 2001
- Academy of Distinguished Graduates, Georgia Institute of Technology - 1994

Research Interests:
- Oil and gas reserves
- Resources evaluation
- Production forecasting
- Unconventional resources
Name: Jenn-Tai Liang

Academic Rank: Professor, Petroleum Engineering
John E. & Deborah F. Betancourt Professor
Director, Graduate Studies, Petroleum Engineering

Degrees: Ph.D. Petroleum Engineering, The University of Texas
M.S. Petroleum Engineering, University of Alabama
B.S. Chemistry, Tamkang University

Professional Experience:
2014-Present  Professor, Department of Petroleum Engineering, Texas A&M University
2011-2014  Professor, Chemical and Petroleum Engineering Department, The University of Kansas
2003-2011  Associate Professor, Chemical and Petroleum Engineering Department, The University of Kansas
1996-2001  Senior Research Engineer, New Mexico Petroleum Recovery Research Center
1991-1996  Senior Research Associate, New Mexico Petroleum Recovery Research Center
1989-1991  Research Associate, New Mexico Petroleum Recovery Research Center
1988-1989  Post-Doctoral Research Associate, New Mexico Petroleum Recovery Research Center

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
• Member, Society of Petroleum Engineers

Recent Honors and Awards:
• Superior Energy Services Excellence in Service Faculty Award, Harold Vance Department of Petroleum Engineering - 2019
• SPE Outstanding Technical Editor Award - 2018
• Distinguished Member, Society of Petroleum Engineers - 2016
• SPE IOR Pioneer Award - 2016
• Distinguished Lecturer, Society of Petroleum Engineers - 2015-2016

Research Interests:
• Using Nano Drug Delivery Technologies for Transport and Controlled Release of Oilfield Chemicals
• Hydraulic Fracturing Fluid Cleanup
• Microbial Enhanced Oil Recovery
• Scale, Wax, and Asphaltene Inhibition
• In-Depth Conformance Control
• CO2 Injection for Carbon Sequestration and Improved Oil Recovery
Name: Heitor Lima

Academic Rank: Professor of Engineering Practice, Petroleum Engineering

Degrees: Ph.D. Petroleum Engineering, Texas A&M University  
M.S. Petroleum Engineering, State University of Campinas, Brazil  
B.S. Civil Engineering, University of Sao Paulo

Professional Experience:

<table>
<thead>
<tr>
<th>Year</th>
<th>Position</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-Present</td>
<td>Professor of Engineering Practice, Petroleum Engineering</td>
<td>Texas A&amp;M University</td>
</tr>
<tr>
<td>2010-2014</td>
<td>Senior Technical Advisor, E&amp;P Department</td>
<td>Petrobras, Rio de Janeiro, Brazil</td>
</tr>
<tr>
<td>2002-2010</td>
<td>Senior Technical Advisor, Petrobras University</td>
<td>Salvador, Brazil</td>
</tr>
<tr>
<td>1986-2002</td>
<td>Drilling Engineer/Instructor</td>
<td>Petrobras University, Salvador, Brazil</td>
</tr>
<tr>
<td>1982-1986</td>
<td>Drilling Engineer, Petrobras E&amp;P</td>
<td>Salvador, Brazil</td>
</tr>
<tr>
<td>1980-1982</td>
<td>Drilling Engineer, Petrobras University</td>
<td>Salvador, Brazil</td>
</tr>
<tr>
<td>1979</td>
<td>Civil Engineer, Civil Aviation Department</td>
<td>Rio de Janeiro, Brazil</td>
</tr>
</tbody>
</table>

Selected Publications:


Scientific and Professional Society Certifications & Memberships:

- Member, International Association of Drilling Contractors (IADC)

Recent Honors and Awards:

- ConocoPhillips Non-Tenured Track Faculty Award for Excellence in Teaching - 2017

Research Interests:

- Deepwater drilling
- Deepwater well design
- Advanced well control
Name: J. Bryan Maggard

Academic Rank: Senior Lecturer, Petroleum Engineering

Degrees:
- Ph.D. Petroleum Engineering, Texas A&M University
- M.S. Petroleum Engineering, Texas A&M University
- B.S. Petroleum Engineering, Texas A&M University

Professional Experience:
- 2004-Present Senior Lecturer, Department of Petroleum Engineering, Texas A&M University
- 2000-2004 Lecturer, Department of Petroleum Engineering, Texas A&M University
- 1998-2000 Assistant Lecturer, Department of Petroleum Engineering, Texas A&M University
- 1995-1997 Research Associate, Department of Petroleum Engineering, Texas A&M University
- 1991 Reservoir Engineer, Chevron Exploration and Production Services Co., Houston, TX
- 1987-1988 Drilling and Production Engineer, Pierce Oil & Gas Corporation, Ft. Worth, TX

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers

Recent Honors and Awards:
- William O. and Montine P. Head Memorial Research Fund Award, Texas A&M University College of Engineering - 2017-2018
- Superior Energy Services Faculty Excellence Award - 2014

Research Interests:
- Thermal recovery methods
- Applied reservoir simulation
- Numerical methods and application of computing
Name: Duane McVay

Academic Rank: Professor, Petroleum Engineering
Albert B. Stevens Chair Professor
Assistant Department Head, Academics
Associate Director, Crisman Institute for Petroleum Research

Degrees: Ph.D. Petroleum Engineering, Texas A&M University
M.S. Petroleum Engineering, Texas A&M University
B.S. Petroleum Engineering, Texas A&M University

Professional Experience:
2011-Present  Professor, Department of Petroleum Engineering, Texas A&M University
2014 Interim Department Head, Department of Petroleum Engineering, Texas A&M University
2012-Present Assistant Department Head-Academics, Department of Petroleum Engineering, Texas A&M University
1999-2011 Associate Professor, Department of Petroleum Engineering, Texas A&M University
1998-1999 Visiting Assistant Professor, Department of Petroleum Engineering, Texas A&M University
1999 Principal Consultant, Schlumberger Holditch-Reservoir Technologies
1980-1982 Petro Engineering Consultant, Reservoir Simulation Technology

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Registered Professional Engineering, Texas
- Member, Society of Petroleum Engineers
Recent Honors and Awards:
  • Distinguished Lecturer, Society of Petroleum Engineers - 2015-2016
  • Member, Petroleum Engineering Academy of Distinguished Graduates of Texas A&M University - 2015
  • Distinguished Member, Society of Petroleum Engineers - 2007
  • Practice Award, Decision Analysis Society of the Institute for Operations Research and the Management Sciences - 2006

Research Interests:
  • Risk and Uncertainty Assessment
  • Unconventional Resource Assessment
  • Petroleum Reservoir Simulation
  • Integrated Reservoir Characterization and Management
Name: Siddharth Misra

Academic Rank: Associate Professor, Petroleum Engineering
Douglas Von Gonten Faculty Fellow

Degrees: Ph.D. Petroleum Engineering, The University of Texas, Austin
M.S. Petroleum Engineering, The University of Texas, Austin
B.Tech. Electrical Engineering, Indian Institute of Technology, Bombay

Professional Experience:
2019-Present  Associate Professor, Department of Petroleum Engineering, Texas A&M University
2015-2019  Assistant Professor, Mewbourne School of Petroleum and Geological Engineering, University of Oklahoma
2007-2009  Wireline Field Engineer, Halliburton Energy Services

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers
- Member, Society of Petrophysicists and Well Log Analysts
- Member, Society of Exploration Geophysicists

Recent Honors and Awards:
- J. Clarence Karcher Award, Society of Exploration Geophysicists - 2020
- Young Professional Technical Award, Society of Petrophysicists and Well Log Analysts - 2020
- Early Career Award, Department of Energy - 2018
- Doctoral New Investigator Award, American Chemical Society - 2018
- Mid-Continent Formational Evaluation Award, Society of Petroleum Engineers - 2018
Research Interests:
- Data-driven modeling and machine learning
- Petrophysics and formation evaluation
- Subsurface characterization
- Sensors and sensing
- Inverse problems
Name: George Moridis

Academic Rank: Professor, Petroleum Engineering
Robert L. Whiting Chair

Degrees: Ph.D. Agricultural Engineering, Texas A&M University
M.S. Agricultural Engineering, Texas A&M University
MEN Chemical Engineering, National Metsovion Technical University
B.S. Chemical Engineering, National Metsovion Technical University

Professional Experience:
2016-Present Professor, Department of Petroleum Engineering, Texas A&M University
2013-2016 Head, Hydrocarbon Resource Program, Lawrence Berkley National Laboratory
2009-2013 Deputy Program Lead for Energy Resources, Lawrence Berkley National Laboratory
2003-2009 Research Area Lead, Transport and Thermodynamics, Lawrence Berkley National Laboratory
1997-2003 Staff Scientist Group Leader, Contaminant Hydrology, Program, Lawrence Berkley National Laboratory
1993-1997 Staff Scientist Group Leader, Subsurface Containment Technologies, Lawrence Berkley National Laboratory
1989-1991 Joint Research Engineer, Agricultural Engineering Department and Civil Engineering Department, Texas A&M University
1987-1989 Associate Engineer/Senior Scientist, International Rice Research Institute, Department of Water Management

Selected Publications:
Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers
- Member, Advisory Committee, National Gas Hydrate Program, Directorate General of Hydrocarbons, Ministry of Petroleum and Natural Gas of India
- Member, Board of Regents, Kavala Institute of Technology, Greece

Recent Honors and Awards:
- Karen E. Olson '87 and Louis H. Turner Excellence in Research Faculty Award, Harold Vance Department of Petroleum Engineering - 2019
- John Franklin Carll Award, Society of Petroleum Engineers - 2019
- Director's Award for Exceptional Achievement, Lawrence Berkeley National Laboratory - 2012
- Secretarial Honor Award, U.S. Department of Energy – 2011
- Distinguished Member, Society of Petroleum Engineers – 2010

Research Interests:
- Numerical Simulation and Advanced Numerical Methods
- Unconventional Gas Resources
- Thermal Operations
- Enhanced Oil Recovery Processes
- High Performance Computing Coupled Processes
Name: Nobuo Morita

Academic Rank: Professor, Petroleum Engineering

Degrees:
- Ph.D. Petroleum Engineering, The University of Texas
- M.S. Petroleum Engineering, The University of Texas
- B.S. Petroleum Engineering, University of Tokyo

Professional Experience:
- 2015-Present: Professor, Department of Petroleum Engineering, Texas A&M University
- 1995-2015: Professor, Rock Mechanics, Drilling and Petroleum Production Engineering Labs, Waseda University
- 1982-1995: Research Fellow, Conoco, Inc
- 1979-1982: Research Scientist Associate V, Center for Earth Sciences and Engineering, The University of Texas at Austin
- 1977-1979: Reservoir and Production Engineering, Teikoku Oil Company Ltd., Japan
- 1974-1977: Research Scientist Associate IV, Center for Earth Sciences and Engineering, The University of Texas at Austin

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Distinguished Member, Society of Petroleum Engineers - 2017
Recent Honors and Awards:

- Cedric K. Ferguson Medal, Society of Petroleum Engineers - 2013
- SPE Northern Asia Pacific Distinguished Achievement Award for Petroleum Engineering Faculty - 2013

Research Interests:

- Geomechanics Numerical Modeling
- Geomechanics Field Analyses
Name: Hadi Nasrabadi

Academic Rank: Associate Professor, Petroleum Engineering
Aghorn Energy Career Development Professor

Degrees: Ph.D. Petroleum Engineering, Imperial College
B.S. Civil Engineering, Sharif University of Technology

Professional Experience:
2019-Present  Associate Professor, Department of Petroleum Engineering, Texas A&M University
2013-2019  Assistant Professor, Department of Petroleum Engineering, Texas A&M University
2012  Visiting Assistant Professor, Department of Petroleum Engineering, Texas A&M University
2010-2011  Assistant Professor, Department of Petroleum Engineering, Texas A&M University at Qatar
2007-2009  Visiting Assistant Professor, Department of Petroleum Engineering, Texas A&M University at Qatar
2006  Visiting Assistant Professor, Department of Petroleum Engineering, Texas A&M University

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Society of Petroleum Engineers
- Member, American Society of Mechanical Engineers

Recent Honors and Awards:
- Karen and Larry A. Cress '76 Excellence in Teaching Faculty Award, Harold Vance Department of Petroleum Engineering - 2019
- Society of Petroleum Engineers, Outstanding Technical Editor Award for SPE Journal – 2015, 2018
Research Interests:
  • Phase Behavior of Reservoir Fluids
  • Shale Gas and Oil Recovery
  • Compositional Modeling of Multiphase/Multicomponent Fluid Flow in Porous Media
  • Modeling Asphaltene Precipitation in Porous Media
Name: Sam Noynaert

Academic Rank: Associate Professor of Practice, Petroleum Engineering

Degrees: Ph.D. Petroleum Engineering, Texas A&M University  
M.S. Petroleum Engineering, Texas A&M University  
B.S. Agricultural and Biological Engineering, Texas A&M University

Professional Experience:
2020-Present  Associate Professor of Practice, Department of Petroleum Engineering, Texas A&M University  
2013-2020  Assistant Professor, Department of Petroleum Engineering, Texas A&M University, College Station, TX  
2009-2013  Lecturer, Department of Petroleum Engineering, Texas A&M University, College Station, TX  
2010-2012  Drilling Engineering Consultant, EOG Resources, Fort Worth, TX  
2009-Present  Managing Partner, Sacono Oil & Gas LLC, College Station, TX  
2008-2009  Drilling Engineer and Rig Supervisor, EOG Resources, Fort Worth, TX  
2004-2007  Rig Supervisor, BP America and BP Alaska

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Certified E.I.T., Texas Board of Professional Engineers
- Member, Society of Petroleum Engineers (SPE)
- Member, Pi Epsilon Tau (Petroleum Engineering Honor Society)
- Member, American Association of Drilling Engineers (AADE)
- Member, American Association of Petroleum Geologists (AAPG)
Research Interests:

- Drilling Performance
- Applied Drilling Research
- Horizontal/Deviated Drilling
- Automation of the Drilling Process
- Solutions to Drilling-Related Problems in Unconventional Reservoirs
Name: David Schechter

Academic Rank: Professor, Petroleum Engineering
George and Joan Voneiff Professor

Degrees: Ph.D. Physical Chemistry, University of Bristol
B.S. Chemical Engineering, The University of Texas

Professional Experience:
2018-Present  Professor, Department of Petroleum Engineering, Texas A&M University
2000-2018   Associate Professor, Department of Petroleum Engineering, Texas A&M University
1996-2000   Adjunct Associate Professor, Petroleum and Chemical Engineering Department, New Mexico Institute of Mining and Technology
1993-2000   Senior Scientist, Petroleum Recovery Research Center, New Mexico Institute of Mining and Technology
1990-1993   Acting Assistant Professor, Department of Petroleum Engineering, Stanford University
1989-1990   Post-Doctoral Research Associate, Department of Petroleum Engineering, Stanford University

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
• Registered Professional Engineer, Texas
• Member, Society of Petroleum Engineers

Recent Honors and Awards:
• Distinguished Member, Society of Petroleum Engineers - 2014
Research Interests:
- Spraberry Trend Area
- Geological and Petrophysical Analysis
- Wettability Determination and Imbibition Experiments
- Numerical Modeling
- Reservoir Simulation
- CO2 Flooding and Gas Injection
Name: Cathy Sliva

Academic Rank: Associate Professor of Engineering Practice, Petroleum Engineering
Director, Undergraduate Advising, Petroleum Engineering

Degrees: B.S. Petroleum Engineering, Texas A&M University

Professional Experience:
- 2018-Present: Director, Undergraduate Advising, Department of Petroleum Engineering, Texas A&M University
- 2013-Present: Associate Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University
- 2002-2013: President and CEO, BlueRock Energy Capital
- 1998-2000: Senior Vice President, Range Resources Corporation (formerly Domain Energy)
- 1996-1998: Executive Vice President, Domain Energy (formerly Tenneco Ventures)
- 1990-1996: Director, Tenneco Ventures Corporation
- 1989-1990: District Acquisitions Engineer, General Atlantic Resources
- 1980-1989: Senior Petroleum Engineering, Tenneco Oil Exploration and Production

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
- Member, Independent Petroleum Association of America (IPAA)
- Member, Society of Petroleum Engineers (SPE)
- Member, Texas Alliance of Energy Producers
- Member, Texas Independent Producers and Royalty Owners Association (TIPRO), and
- Member, National Stripper Well Association (NSWA)

Recent Honors and Awards:
- Instructional Faculty Teaching Award, Texas A&M University College of Engineering - 2020
- Conoco-Phillips Non-Tenured Track Excellence in Teaching Award, Harold Vance Department of Petroleum Engineering - 2019

Research Interests:
- Petroleum Economics and Analysis
- Finance and Investor Relations
- Corporate Strategy
Name: Glenn Sliva

Academic Rank: Associate Professor of Engineering Practice, Petroleum Engineering (part time)

Degrees: B.S., Petroleum Engineering, Texas A&M University

Professional Experience:
- 2013-Present: Associate Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University
- 2017-present: Senior Vice President, Lonquist & Co., LLC, Denver, CO
- 1982-1991: Sanchez-Obrien Oil & Gas Corp.
- 1981-1982: Cities Service Corporation

Scientific and Professional Society Certifications & Memberships:
- Registered Professional Engineer
- Member, Society of Petroleum Engineers
- Member, Society of Petroleum Evaluation Engineers
- Member, Society of Professional Well Log Analysts

Research Interests:
- Economic Evaluations
- Economic Planning and Analysis
- Corporate Strategy
Name: Jeff Spath

Academic Rank: Department Head and Professor, Petroleum Engineering
Director, Crisman Institute for Petroleum Research
Stephen A. Holditch ’69 Department Head Chair in Petroleum Engineering

Degrees: Ph.D. Petroleum Engineering, Montanuniversitat Leoben, Austria
M.S. Petroleum Engineering, Texas A&M University
B.S. Petroleum Engineering, Texas A&M University

Professional Experience:

2018-Present  Department Head and Professor, Department of Petroleum Engineering, Texas A&M University
2015-2018  CEO, Texas Oil & Gas Institute, The University of Texas System, Austin, TX
2013-2015  Vice President, Industry Affairs, Schlumberger Limited
2006-2013  President, Reservoir Management Group, Schlumberger
2003-2006  President, Data Consulting Services, Schlumberger
2001-2003  Vice President, North and South America, Schlumberger

Selected Publications:


Scientific and Professional Society Certifications & Memberships:
- Member, National Petroleum Council – 2019-present
- President, Society of Petroleum Engineers - 2013-2014

Recent Honors and Awards:
- Honorary Member, Society of Petroleum Engineers - 2019
- Distinguished Member, Society of Petroleum Engineers – 2011
- Petroleum Engineering Academy of Distinguished Graduates of Texas A&M University - 2008
- Distinguished Lecturer, Society of Petroleum Engineers

Research Interests:
- Analytical Simulation and Pressure Transient Techniques
Name: George Voneiff

Academic Rank: Professor of Engineering Practice, Petroleum Engineering (part time)

Degrees: M.S. Petroleum Engineering, Texas A&M University
         B.S. Petroleum Engineering, Texas A&M University

Professional Experience:
2007-present  Professor of Engineering Practice, Department of Petroleum Engineering, Texas A&M University
2006-2020    CEO & President, Unconventional Resources, LLC, College Station, TX
1997-2006    President, MGV Energy Inc., Calgary, Alberta, Canada
1985-1990    Engineer, Enserch Exploration, Inc., Dallas, Texas

Selected Publications:

Scientific and Professional Society Certification & Memberships:
- Member, Society of Petroleum Engineers

Recent Honors and Awards:
- Texas A&M University Petroleum Engineering Academy of Distinguished Graduates - 2013
- Joint owner of Aggie 100 #1 Company, Texas A&M University, Mays Business School - 2005
- Sproule Lifetime Achievement Award, Canadian Society for Unconventional Gas - 2005
- Finalist, Ernst & Young Canadian Entrepreneur of The Year - 2004

Research Interests:
- Applied Petroleum Economics in Unconventional Plays
- Statistical Analysis of Large Datasets from Unconventional Formations
- Large-Scale Production Data Analysis Using Empirical Techniques
Name: William D. Von Gonten, Jr.

Academic Rank: Adjunct Professor, Petroleum Engineering (part time)

Degrees: B.S. Petroleum Engineering, Texas A&M University

Professional Experience:
2020-present Adjunct Professor, Department of Petroleum Engineering, Texas A&M University
2013-present President and Owner, W.D. Von Gonten Laboratories, LLC, Houston, TX
1995-present President and Owner, W.D. Von Gonten & Co., Houston, TX

Selected Publications:
2. Roberto Suarez-Rivera*(1), W.D. Von Gonten (2),, et al: Optimizing Lateral Landing Depth for Improved Well Production, URTeC 2460515, Unconventional Resources Technology Conference, August 2016

Scientific and Professional Society Certification & Memberships:
- Registered Professional Engineer
- Member, Society of Petrophysicists and Well Log Analysis
- Member, Houston Producers Forum
- Member, Society of Petroleum Engineers

Recent Honors and Awards:
- Texas A&M University, College of Engineering, Outstanding Alumni – 2014
- Texas A&M University Petroleum Engineering Academy of Distinguished Graduates - 2013

Research Interests:
- Conventional and Unconventional Shale Plays
- Oil and Gas Reserve Estimations
- Property Acquisitions
- Reservoir Simulations
- Well Test Analysis
- Feasibility Studies
- Economic Projections
Name: Ruud Weijermars

Academic Rank: Professor, Petroleum Engineering

Degrees: Ph.D. Geodynamics, University of Uppsala
         M.S. Structural Geology, University of Amsterdam
         B.S. Geology, University of Amsterdam

Professional Experience:
2014-2020  Professor, Department of Petroleum Engineering, Texas A&M University
2013-2014  Associate Professor, Department of Geoscience & Engineering, Delft University, Netherlands
2012-2013  Research Associate, Bureau of Economic Geology, University of Texas at Austin
2010-2013  Director of the Delft Unconventional Gas Program, Department of Geotechnology, Delft University of Technology, Netherlands
2005-2010  Director of Education, Department of Geotechnology, Delft University of Technology, Netherlands

Selected Publications:

Scientific and Professional Society Certifications & Memberships:
• Member, Society of Petroleum Engineers

Recent Honors and Awards:
• Distinguished Member, Society of Petroleum Engineers - 2017

Research Interests:
• Petroleum economics and decision making
• Reservoir models and production forecasting
• Geothermal reservoir models
• Wellbore stresses and hydraulic fracturing
Name:  Kan Wu

Academic Rank:  Assistant Professor, Petroleum Engineering  
Chevron Corporation Faculty Fellow

Degrees:  Ph.D. Petroleum Engineering, The University of Texas  
M.S. Petroleum Engineering, China University of Petroleum (east)  
B.S. Petroleum Engineering, China University of Petroleum (east)

Professional Experience: 
2015-Present  Assistant Professor, Department of Petroleum Engineering, Texas A&M University  
2014  Summer Intern, ConocoPhillips  
2013  Summer Intern, Chevron  
2012  Summer Intern, Schlumberger

Selected Publications: 

Scientific and Professional Society Certifications & Memberships:  
• Society of Petroleum Engineers  
• American Rock Mechanics Association

Recent Honors and Awards:  
• A Future Leader of American Rock Mechanics Association (ARMA), 2016- 2020  
• SPE Gulf Coast Region Paper Contest, First Place in Ph.D. Division, 2013

Research Interests:  
• Hydro-Mechanical Coupling  
• Multi-Phase Flow  
• Hydraulic Fracturing  
• Data Interpretation and Geomechanics Modeling of Optical Fiber Sensing  
• Well Production Optimization in Unconventional Reservoirs
Name:  Ding Zhu

Academic Rank:  Professor, Petroleum Engineering  
L. F. Peterson ’36 Professor

Degrees:  Ph.D. Petroleum Engineering, The University of Texas  
M.S. Petroleum Engineering, The University of Texas  
B.S. Mechanical Engineering, Beijing University of Science & Technology

Professional Experience:
2013-Present  Professor, Department of Petroleum Engineering, Texas A&M University
2008-2013  Associate Professor, Department of Petroleum Engineering, Texas A&M University
2004-2008  Assistant Professor, Department of Petroleum Engineering, Texas A&M University
2000-2004  Research Scientist, The University of Texas at Austin
1994-1999  Research Associate, The University of Texas at Austin
1992-1994  Postdoctoral Researcher, The University of Texas at Austin
1982-1985  Mechanical Engineer, China National Offshore Oil Co., Bejing, China

Selected Publications:
2. Yoshida, N., Hill, A. D. and Zhu, D.:” Temperature Prediction Model for a Horizontal Well with  
5. Tabatabaei, M., Zhu, D., and Hill A.D., “Theoretical Basis for Interpretation of Temperature  

Scientific and Professional Society Certifications & Memberships:
• Member, Society of Petroleum Engineers

Recent Honors and Awards:
• Faculty Excellence in Research Award, Harold Vance Department of Petroleum Engineering  
  Texas A&M University - 2014
• Award for Excellence in Teaching, Harold Vance Department of Petroleum Engineering Texas  
  A&M University - 2013
• Distinguished Lecturer, Society of Petroleum Engineers - 2011-2012
• Distinguished Achievement Award for Petroleum Engineering Faculty, Society of Petroleum  
  Engineers – 2010
Research Interests:

- Production Engineering
- Well Simulation
- Complex Well Performance
- Intelligent Completion Technology
Appendix B

Course Syllabi
Course: Well Stimulation, PETE 602
Term: Fall 2019
Meeting times and location: MW 12:40-1:55 pm

Course Description and Prerequisites

Design and analysis of well stimulation methods, including acidizing and hydraulic fracturing as well as the causes and solutions to low well productivity.

Prerequisites

Graduate classification in the Department of Petroleum Engineering or instructor approval

Learning Outcomes

The course is designed for engineers who deal with well performance enhancement. The course will go through various techniques that can be used to enhance productivity of oil and gas wells. This is followed by an overview of acid and hydraulic fracturing, matrix treatments for carbonate and sandstone formations. Issues related to candidate selection, treatment design, selection of acid additives, lab testing, acid placement, QA/QC, job execution, and treatment evaluation, all of which will be discussed in detail. The course will end with an introduction new technologies for carbonate and sandstone acidizing. Field cases will be presented to highlight problems and how lab testing is used to find cost effective solutions to these problems.

Instructor Information

Name: Hisham A. Nasr-El-Din
Telephone number: 979.862.1473
Email address: hisham.nasreldin@tamu.edu
Office hours: TBD
Office location: RICH 710BA

Textbook and/or Resource Material

Several textbooks will be used including, but not limited to:

Economides et al., Petroleum Production Systems, 1993
Economides and Nolte, Reservoir Stimulation, 3rd Ed., 2000
Civan, Reservoir Formation Damage, 2000
Economides et al., Well Construction, 1998
SPE Reprint Series, Hydraulic Fracturing, 1990
Gidley et al., Recent Advances in Hydraulic Fracturing, 1989
Williams et al., Acidizing Fundamentals, 1979
Grading Policies

Homework 20%
Quizzes 15%
Midterm 25%
Final 40%

Letter grades will be assigned to the following guideline:

A=90-100 (Excellent)
B= 80-89 (Good)
C=70-79 (Satisfactory)
D=60-69 (Passing)
F=59 and below (Failing)
I=Incomplete.

Attendance and Make-up Policies

Texas A&M views class attendance as an individual student responsibility (http://studentrules.tamu.edu/rule07). Attendance is essential to complete the course successfully. Material presented in lecture and class discussion may expand upon points only briefly considered in the required text.

Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Introduction</td>
<td>Mineralogy of oil and gas reservoirs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Well types based on function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Well types based on completion</td>
</tr>
<tr>
<td></td>
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<td>Matrix versus fracture acidizing</td>
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<tr>
<td></td>
<td></td>
<td>Formation damage issues</td>
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<tr>
<td>3-6</td>
<td>Acid Types and their Reaction with Various Rocks</td>
<td>Carbonates – Chemistry Issues</td>
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<td></td>
<td></td>
<td>Carbonates – Physics Issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sandstone Formations- Chemistry Issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sandstone Formations – Physics Issues</td>
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<tr>
<td>7-9</td>
<td>Acid Additives</td>
<td>Criteria used for selecting acid additives</td>
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<tr>
<td></td>
<td></td>
<td>Anti-sludge agents</td>
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<td></td>
<td></td>
<td>Mutual solvents</td>
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<td></td>
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<td>Drag reducing agents</td>
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<td></td>
<td></td>
<td>Low-surface tension surfactants</td>
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<td></td>
<td></td>
<td>Corrosion inhibitors</td>
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<td></td>
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<td>Hydrogen sulfide scavengers</td>
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<td></td>
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<td>Scale inhibitors</td>
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<td></td>
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<td>Clay Stabilizers</td>
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<td>Damage due to acid additives</td>
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<td>10</td>
<td>Reaction Kinetics</td>
<td>Methods to measure reaction rate</td>
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<td>Surface reaction kinetics</td>
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<td>Mass transfer kinetics</td>
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<td>Impact of additives</td>
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<td></td>
<td>Effect of clays</td>
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<td>Temperature effects</td>
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<tr>
<td>11</td>
<td>Acid Placement Techniques</td>
<td>Bull heading</td>
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<tr>
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<td>Drill pipe</td>
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<td>HW3</td>
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<tr>
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<td>HW4</td>
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<tr>
<td>Coiled tubing</td>
<td>Methods to extend CT reach in long horizontal wells</td>
<td></td>
</tr>
<tr>
<td>Entry into various laterals in multilateral wells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field cases</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 12 | Acid Fracturing | Candidate selection |
| Fluid selection |
| Rock and fluid properties |
| Lab testing before the job |
| Fracture conductivity |
| Field testing |
| Simulation |
| Field examples |

| 13-14 | Hydraulic Fracturing | Rock mechanics |
| Proppant characteristics |
| Fluid selection |
| Lab and field testing |
| Methods to control proppant flow back |
| Damage due to polymer residue |

**Americans with Disabilities Act (ADA)**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit [http://disability.tamu.edu](http://disability.tamu.edu).

**Academic Integrity**

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number: PETE 603
Term (e.g., Fall 200X): Summer 2020 (10-week)
Meeting times and location: TR 2:00-3:50, Distance Learning

Course Description and Prerequisites

Graduate Catalog:


Informal Course Description

This course includes basic equations, derivations and underlying principles used in reservoir modeling, including validation with analytic solutions and computation of numerical solutions.

Subject Prerequisites

Differential, integral, and vector calculus, ordinary and partial differential equations, fluid dynamics and heat transfer, reservoir fluid properties, reservoir petrophysics.

Learning Outcomes

1. Students will be able to match results from simulations of reservoir performance to analytic solutions expressed using dimensionless variables, including both early and late-time solutions.
2. Students will be able to program simple finite difference simulation models using a structured programming language, including models of the diffusivity equation and convection-diffusion equation.
3. Students will be able to calculate gridblock transmissibility for heterogeneous reservoirs.
4. Students will be able to calculate well index for wells located in gridblocks.
5. Students will be able to solve systems of linear equations using direct and iterative methods, and describe relative advantages and disadvantages of the approaches discussed.
6. Students will be able to calculate streamline trajectories based on volumetric flux between gridblocks.

Instructor Information

Name: Dr. Bryan Maggard
Telephone number: 979-845-0592 (voice mail checked daily, use email /office hours)
Email address: bryan.maggard@tamu.edu
Office hours: TR 2-3:50, and by appointment
Office location: See ecampus.tamu.edu, Announcements for zoom meeting ID

Textbook and/or Resource Material

Texts:
1. Lecture notes and class handouts [ecampus.tamu.edu]
2. PETE 603 notes (R.A. Wattenbarger), chapters 1-8 [ecampus.tamu.edu]

**Supplemental Texts (optional):**

1. SPE Monograph 13, *Reservoir Simulation*
2. SPE Textbook 11, *Streamline Simulation: Theory and Practice*
3. SPE Textbook 7, *Basic Applied Reservoir Simulation*

**Grading Policies**

**Basis for Course Grade:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework, and Projects</td>
<td>25%</td>
</tr>
<tr>
<td>Exam 1</td>
<td>25%</td>
</tr>
<tr>
<td>Exam 2</td>
<td>25%</td>
</tr>
<tr>
<td>Exam 3</td>
<td>25%</td>
</tr>
</tbody>
</table>

**Course Grade:**

A: ≥ 90  B: 89.99 to 80  C: 79.99 to 70  D: 69.99 to 60  F: < 59.99

**Attendance and Make-up Policies**

See [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07).

**Course Topics, Calendar of Activities, Major Assignment Dates**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic (2 modules per class period, one module described on each line below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course Introduction, VBA Introduction&lt;br&gt;Vector Notation, Darcy's Law, Permeability Tensor, Capillary Pressure, Multiphase Flow&lt;br&gt;Continuity Equation, Chain Rule, Linearity, Classification of PDE's&lt;br&gt;Diffusivity Equation Derivations, Nonlinearities, Coordinate Systems</td>
</tr>
<tr>
<td>3</td>
<td>Fully Implicit Method, Newton-Raphson Iteration, IMPES Iteration&lt;br&gt;*** Exam 1, Thursday, 6/18</td>
</tr>
<tr>
<td>4</td>
<td>Fully Implicit Method: Jacobian, Convergence, Timestep Control&lt;br&gt;Convection Equation and Convection-Diffusion Equation: Gridblock Approach&lt;br&gt;Introduction to Streamline Simulation&lt;br&gt;Tracing Streamlines: Minimum Time Algorithm, Time of Flight Coordinate Transformation</td>
</tr>
<tr>
<td>5</td>
<td>Gridblock Simulation: Well Rates and Pressures&lt;br&gt;Peaceman's Approach, Sharpe &amp; Ramesh, Yildiz &amp; Archer&lt;br&gt;*** Exam 2, Thursday, 7/9</td>
</tr>
<tr>
<td>6</td>
<td>Matrix Solution Methods, Direct: Naive Gaussian&lt;br&gt;Matrix Solution Methods, Direct: LU Factorization&lt;br&gt;Matrix Solution Methods, Direct: Thomas Algorithm, A3 and D4 Orderings</td>
</tr>
<tr>
<td>7</td>
<td>Iterative Solution Methods: Gauss-Seidel, Over-Relaxation Methods&lt;br&gt;Iterative Solution Methods: Minimization Methods - ORTHOMIN&lt;br&gt;Iterative Solution Methods: Minimization Methods - CSR storage, FGMRES&lt;br&gt;Accuracy of Simulation Results, Data Modifications for Special Cases&lt;br&gt;History Matching&lt;br&gt;*** Exam 3, Thursday, 7/30</td>
</tr>
</tbody>
</table>

**Americans with Disabilities Act (ADA)**
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**Academic Integrity**

For additional information please visit: [http://aggiehonor.tamu.edu](http://aggiehonor.tamu.edu)

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”

- Do not share computer files, including spreadsheets or computer programs.
- Do not turn in anything as your work that is not exclusively your individual work.
Petroleum Engineering 605
Phase Behavior of Petroleum Fluids
Syllabus and Administration Procedures
Fall 2019

Instructor: William D. (Bill) McCain, Jr.
Office: Room 501-N, Richardson Building
Office Hours: MWF, 9:00 – 10:20 am
Office Phone: 979-845-4801, (Fax) 979-862-1272, (E-Mail) mccain@tamu.edu

Text: Primarily handouts from literature and course notes. Some reading assignments in The Properties of Petroleum Fluids, 3rd Ed., McCain, PennWell (purchase not necessary but should have copy available). NOTE: Occasionally there will be a difference among the information in the book, the handouts, the course notes or the class discussions – if so the information in the course notes or class discussions is the correct information.

Class Schedule:
Lecture: MWF, 10:20 am -11:10 am, room 302 Richardson

Basis for grade:
Class Exams (3) .......................................................... 54%
Final Examination ......................................................... 28%
Homework ................................................................. 18%
100%

Class Exams: Friday 27 Sep 2019, Friday 25 Oct 2019, and Friday 22 Nov 2019
(DL students will have until 10 am the following Monday to turn-in the completed quiz)

Final Exam: Tuesday, 10 Dec 2019, 8:00 am to 10:00 pm
(DL students will have until 9am, Wednesday, 11 Dec 2019 to turn-in the completed exam)

Americans with Disabilities Act (ADA) Policy Statement
The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the University Curriculum Committee by the Department of Student Life. The policy statement was forwarded to the Faculty Senate for information.

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room 126 of the Koldus Building or call 845-1637.
**Academic Integrity Statement**

"An Aggie does not lie, cheat, or steal or tolerate those who do."

All syllabi shall contain a section that states the Aggie Honor Code and refers the student to the Honor Council Rules and Procedures on the web [http://www.tamu.edu/aggichonor](http://www.tamu.edu/aggichonor).

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 Aug</td>
<td>Review of Organic Chemistry</td>
<td>Chap 1 <em>PRF3</em></td>
</tr>
<tr>
<td>28 Aug</td>
<td>Review of Organic Chemistry</td>
<td>MOD 1, lec 1</td>
</tr>
<tr>
<td>30 Aug</td>
<td>Petroleum Chemistry</td>
<td>MOD 1, lec 2</td>
</tr>
<tr>
<td>2 Sep</td>
<td>Origin of Petroleum, Compositional Measurement</td>
<td>Chap 3 <em>PRF3</em></td>
</tr>
<tr>
<td>4 Sep</td>
<td>The Five Petroleum Fluids</td>
<td>Chap 4 <em>PRF3</em></td>
</tr>
<tr>
<td>6 Sep</td>
<td>The Five Petroleum Fluids</td>
<td>MOD 2</td>
</tr>
<tr>
<td>9 Sep</td>
<td>The Five Petroleum Fluids</td>
<td></td>
</tr>
<tr>
<td>11 Sep</td>
<td>Properties of Black Oils – Reservoir Fluid Studies</td>
<td>MOD 4</td>
</tr>
<tr>
<td>13 Sep</td>
<td>Properties of Black Oils – Reservoir Fluid Studies</td>
<td>Chap 11-12 <em>PRF3</em></td>
</tr>
<tr>
<td>16 Sep</td>
<td>Properties of Black Oils – Reservoir Fluid Studies</td>
<td>Chap 13-14 <em>PRF3</em></td>
</tr>
<tr>
<td>18 Sep</td>
<td>Properties of Gas Condensates – Reservoir Fluid Studies</td>
<td>Chap 8 <em>PRF3</em></td>
</tr>
<tr>
<td>20 Sep</td>
<td>Properties of Gas Condensates – Reservoir Fluid Studies</td>
<td>MOD 5</td>
</tr>
<tr>
<td>23 Sep</td>
<td>Properties of Gas Condensates – Reservoir Fluid Studies</td>
<td>Chap 9 <em>PRF3</em></td>
</tr>
<tr>
<td>25 Sep</td>
<td>A Method of Evaluating Separator Samples</td>
<td>MOD 11</td>
</tr>
<tr>
<td>27 Sep</td>
<td>QUIZ 1</td>
<td></td>
</tr>
<tr>
<td>30 Sep</td>
<td>SPE ATCE</td>
<td></td>
</tr>
<tr>
<td>2 Oct</td>
<td>SPE ATCE</td>
<td></td>
</tr>
<tr>
<td>4 Oct</td>
<td>A Method of Evaluating Separator Samples</td>
<td>MOD 11</td>
</tr>
<tr>
<td>Date</td>
<td>Topic</td>
<td>Module</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>7 Oct</td>
<td>A Method of Evaluating Separator Samples</td>
<td>MOD 6</td>
</tr>
<tr>
<td>9 Oct</td>
<td>Swelling Tests – Gas</td>
<td>MOD 8</td>
</tr>
<tr>
<td>11 Oct</td>
<td>Swelling Tests &amp; MMP Tests – Oil</td>
<td>MOD 9</td>
</tr>
<tr>
<td>14 Oct</td>
<td>Gas-Liquid Equilibria with K-Factors</td>
<td></td>
</tr>
<tr>
<td>16 Oct</td>
<td>Gas-Liquid Equilibria with K-Factors</td>
<td></td>
</tr>
<tr>
<td>18 Oct</td>
<td>Equations of State – A History</td>
<td>MOD 12</td>
</tr>
<tr>
<td>21 Oct</td>
<td>Equations of State – A History</td>
<td>MOD 12</td>
</tr>
<tr>
<td>23 Oct</td>
<td>Equations of State, BIC, Properties of Plus Fraction</td>
<td>MOD 15 &amp; 16</td>
</tr>
<tr>
<td>25 Oct</td>
<td>QUIZ 2</td>
<td></td>
</tr>
<tr>
<td>28 Oct</td>
<td>Gas- Liquid Equilibria with Equations of State</td>
<td>MOD 14</td>
</tr>
<tr>
<td>30 Oct</td>
<td>Gas-Liquid Equilibria with Equations of State</td>
<td></td>
</tr>
<tr>
<td>1 Nov</td>
<td>Gas-Liquid Equilibria with Equations of State</td>
<td></td>
</tr>
<tr>
<td>4 Nov</td>
<td><strong>Splitting</strong>, i.e., Extend the Plus Fraction</td>
<td>MOD 17</td>
</tr>
<tr>
<td>6 Nov</td>
<td>Splitting</td>
<td></td>
</tr>
<tr>
<td>8 Nov</td>
<td>Compositional Gradients</td>
<td>MOD 3</td>
</tr>
<tr>
<td>11 Nov</td>
<td>Condensate Buildup Around Wellbores</td>
<td>Lecture Part 1</td>
</tr>
<tr>
<td>13 Nov</td>
<td>Condensate Buildup Around Wellbores</td>
<td>Lecture Part 2 and Part 3</td>
</tr>
<tr>
<td>15 Nov</td>
<td><strong>Grouping</strong></td>
<td>MOD 18</td>
</tr>
<tr>
<td>18 Nov</td>
<td>Grouping</td>
<td></td>
</tr>
<tr>
<td>20 Nov</td>
<td>Properties of Volatile Oils – Reservoir Fluid Studies</td>
<td>MOD 7, Chap 15 PRF3</td>
</tr>
<tr>
<td>22 Nov</td>
<td>QUIZ 3</td>
<td></td>
</tr>
<tr>
<td>27 Nov</td>
<td>Reading day - no class</td>
<td></td>
</tr>
</tbody>
</table>
29 Nov  Thanksgiving - no class.

2 Dec  “Tuning”

4 Dec  Last day of classes

10 Dec  FINAL EXAM, 8:00-10:00 am, room 302

NOTE: PRF3 is The Properties of Petroleum Fluids, 3rd Ed. PennWell Publishing
PETE 606-300 Course Syllabus – Summer 2017
M-W 01:00-02:50 pm- RICH 208-On Campus Section

Instructor: Dr. Berna Hascakir, Texas A&M University - Petroleum Engineering Department
Office: Richardson 401 N
Telephone: 979-845-6614
e-mail: hascakir@tamu.edu
Office Hours: M/W 3:00 pm to 5:00 pm CST.

Catalog Description: Fundamentals and theory of thermal enhanced oil recovery methods; hot water flooding, steam flooding, cyclic steam injection (CCS), steam assisted gravity drainage (SAGD), solvent-steam processes, in-situ combustion, advances in thermal EOR; application of heat and mass transfer in thermal-EOR methods; strategies and displacement performance calculations. Lecture videos will be posted on e-campus after the class.

Teaching Assistant: Taniya Kar (atat7142710@tamu.edu)
Office Hours: TBD

Instructional Objectives

Topics Covered:
1. Introduction
2. Heat Transfer
3. Hot-Water Drives
4. Steam Injection
5. In-Situ Combustion
6. Other thermal processes

Contributions to Meeting the Curriculum Requirements of Criterion:

<table>
<thead>
<tr>
<th>Math and Science</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum Engineering</td>
<td>This course provides students with a fundamental background on the determination and evaluation of thermal EOR methods.</td>
</tr>
<tr>
<td>General Education</td>
<td>None</td>
</tr>
</tbody>
</table>

Course Learning Outcomes and Relationship to Program Outcomes:

<table>
<thead>
<tr>
<th>Course Learning Outcome: At the end of the course, students will be able to...</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the thermal EOR methods used in recovery high density and viscosity crude oils.</td>
<td>11</td>
</tr>
<tr>
<td>Calculate the oil recovery factor, water recovery factor, water cut, steam to oil ratio, air requirement.</td>
<td>5</td>
</tr>
<tr>
<td>Describe the laboratory procedures required for a successful thermal EOR process.</td>
<td>1,3,5</td>
</tr>
<tr>
<td>Determine and propose the most effective and environmental friendly thermal EOR technology.</td>
<td>2,3</td>
</tr>
</tbody>
</table>

Related Program Outcomes:

<table>
<thead>
<tr>
<th>No.</th>
<th>PETE graduates must have...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An ability to apply knowledge of mathematics, science, and engineering.</td>
</tr>
<tr>
<td>2</td>
<td>An ability to design a thermal EOR project by analyzing and interpreting data.</td>
</tr>
<tr>
<td>3</td>
<td>An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.</td>
</tr>
<tr>
<td>5</td>
<td>An ability to identify, formulate, and solve engineering problems.</td>
</tr>
<tr>
<td>11</td>
<td>An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
</tr>
</tbody>
</table>
## COURSE SCHEDULE FOR SUMMER 2017

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Lecture Number</th>
<th>Topic</th>
<th>Assignment</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-May</td>
<td>Wednesday</td>
<td>L1</td>
<td>Introduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-June</td>
<td>Monday</td>
<td>L2</td>
<td>Heat and Mass Transfer</td>
<td>HW1</td>
<td></td>
</tr>
<tr>
<td>7-June</td>
<td>Wednesday</td>
<td>L3</td>
<td>Heat and Mass Transfer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-June</td>
<td>Monday</td>
<td>L4</td>
<td>Hot Fluid Injection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-June</td>
<td>Wednesday</td>
<td>L5</td>
<td>Hot Fluid Injection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-June</td>
<td>Monday</td>
<td>L6</td>
<td>Hot Fluid Injection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-June</td>
<td>Wednesday</td>
<td>L7</td>
<td>Steam Drives</td>
<td>HW1</td>
<td></td>
</tr>
<tr>
<td>26-June</td>
<td>Monday</td>
<td>L8</td>
<td>Steam Drives</td>
<td>HW2</td>
<td></td>
</tr>
<tr>
<td>28-June</td>
<td>Wednesday</td>
<td>L9</td>
<td>Steam Drives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-July</td>
<td>Monday</td>
<td>L10</td>
<td>Cyclic steam and SAGD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-July</td>
<td>Wednesday</td>
<td>L11</td>
<td>SAGD &amp; Solvent-Steam Processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-July</td>
<td>Monday</td>
<td>L12</td>
<td>SAGD &amp; Solvent-Steam Processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12-July</td>
<td>Wednesday</td>
<td>L13</td>
<td>In-Situ Combustion</td>
<td>HW2</td>
<td></td>
</tr>
<tr>
<td>17-July</td>
<td>Monday</td>
<td>L14</td>
<td>In-Situ Combustion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-July</td>
<td>Wednesday</td>
<td>L15</td>
<td>In-Situ Combustion</td>
<td></td>
<td></td>
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<tr>
<td>24-July</td>
<td>Monday</td>
<td>L16</td>
<td>In-Situ Combustion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-July</td>
<td>Wednesday</td>
<td>L17</td>
<td>Other application, oil shale extraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-July</td>
<td>Monday</td>
<td>L18</td>
<td>Other application, coal extraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-August</td>
<td>Wednesday</td>
<td>L19</td>
<td>Other application, electrical heating</td>
<td>HW3</td>
<td></td>
</tr>
<tr>
<td>7-August</td>
<td>Monday</td>
<td>L20</td>
<td>Other application, dielectric heating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/9-August</td>
<td>Tu/W</td>
<td></td>
<td>Final Examination Date TBD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Scheduled program and the exam dates may change.

## COURSE POLICIES

**Prerequisites:** PETE 310


**Communication:** Note that class instructor may not be available during some office hours due to business related travels. Thus, all requests from students must be sent via e-mail. E-mails must be sent to class TA and CCed to the instructor via e-mail. Concerns on technical issues such as video capturing, e-campus access, remote connections, etc. should be directed to distance learning coordinators (https://engineering.tamu.edu/petroleum/academics/distance-learning/contact-info). The communication can also be done through phone (see instructor contacts at the first page of the syllabus), through skype (skype name: bernahascakir) and facebook (https://www.facebook.com/profile.php?id=100004619437921). Students should send an e-mail and get an appointment for skype communication.

**Classroom Behavior:** Texas A&M University supports the principle of freedom of expression for both instructors and students. The university respects the rights of the instructors to teach and the students to learn. Maintenance of these rights requires classroom conditions that do not impede their exercise. Classroom behavior that seriously interferes with either (1) instructor’s ability to conduct the class or (2) the ability of other students to profit from the instructional program will not be tolerated. An individual engaging in disruptive classroom behavior may be subject to disciplinary action. For additional information please visit http://student-rules.tamu.edu/rule21.

**Attendance:** Texas A&M views class attendance as an individual student responsibility (http://student-rules.tamu.edu/rule07). Attendance is essential to complete the course successfully. Material presented in lecture and class discussion may expand upon points only briefly considered in the required text.

**Excused Absences:** Rules concerning excused absences may be found at http://student-rules.tamu.edu/rule07. Except for absences due to religious obligations, the student must notify her or his instructor in writing (acknowledged e-mail
message is acceptable) prior to the date of absence if such notification is feasible. In cases where advance notification is not feasible (e.g. accident, or emergency) the student must provide notification by the end of the second working day after the absence. This notification should include an explanation of why notice could not be sent prior to the class. If the absence is excused, the instructor must either provide the student with an opportunity to make up any quiz, exam or other graded activities or provide a satisfactory alternative to be completed within 30 calendar days from the last day of the absence. **Excused Absences for Religious Holy Days:** Texas House Bill (effective 9/1/03) states “An institution of higher education shall excuse a student from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student whose absence is excused under this subsection may not be penalized for that absence and shall be allowed to take an examination or complete an assignment from which the student is excused within a reasonable amount of time after the absence.”

**Makeup Policy:** Makeup exams will be given without question for excused absences as defined by University Regulations. If you miss an exam for any other reason, you may request a makeup, but the makeup exam may have a different format from that given in class, must be completed within one week of the original exam date, and there will be a 5% penalty.

**Exams:** There will be NO exam during the semester. Students will earn their grades from homework and in-class activity assignments.

**Assignments:** Late assignments will normally be given a grade of zero. Once in two or three week, a homework assignment will be posted to e-campus. Students are responsible to answer all homework problems and submit their work to the TA. Assignments should be neat, easy to understand, and straight forward. If the assignment is not legible or easy to follow then a grade of zero will be given.

**In-Class Activities (ICA):** There will be several in-class activity assignments throughout the semester. They will be assigned randomly and announced through e-campus under assignments. Students should follow the lecture videos to complete the ICA assignments. While the answers of some ICA assignments will be shared in the classroom (verbally or written), some of them will be in the test format with multiple choice questions or in question and answer format (regular exam format).

**Extra Credits:** There may be opportunities to earn extra credit during the semester. These activities will be announced in class. There are no make-ups or substitutions for extra-credit opportunities.

**Student Conduct:** Academic Integrity Statement and Policy, Aggie Code of Honor “An Aggie does not lie, cheat, or steal or tolerate those who do.” Upon accepting admission to Texas A&M University, a student immediately accepts a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System. For more information: http://aggiehonor.tamu.edu/.

Each work that you turn in for this class MUST include your signature and the following statement. “On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work.”

**Grading Policy:** Your grading will be calculated according to the table given below. Letter grades will be assigned to the following guideline: A=90-100 (Excellent), B= 80-89 (Good), C=70-79 (Satisfactory), D=60-69 (Passing), F=59 and below (Failing); I=Incomplete.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Details</th>
<th>% of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Syllabus</td>
<td>Reading syllabus and acknowledging via e-campus on the first week of the semester. If any communication (personal or e-mail) with student indicates that student did not read the syllabus, then, student will not earn this grade.</td>
<td>5</td>
</tr>
<tr>
<td>1. HW</td>
<td>HW1 (15%), HW2 (15%), HW3 (15%)</td>
<td>45</td>
</tr>
<tr>
<td>2. In Class Activity</td>
<td>The solution of in class activities may be given during the class, students are responsible for watching all classes and following all class activities, not all class activities will be submitted, submission will be requested randomly by the class instructor.</td>
<td>50</td>
</tr>
</tbody>
</table>

**Your grade in this class is earned, not awarded.** I will NOT consider rounding up your overall grade. Throughout the semester, after each assignment or exam, you will be informed about your earned grade from that assignment. The class instructor is the only authority who will judge the students’ performances. There will be no negotiation on students’ grades. Students are allowed to discuss their grades on each assignment (HW, Quiz, Exam, report, in class activity, etc.) within only one week after grades are posted on e-campus. This discussion can only be made with class TA and can only be carried to the class instructor by the class TA. Students cannot request to review of their exam papers or any other
assignments after one week past their grade announcement. Instructor is the only authority to decide on students overall performances. Decision made or claimed to be made by class TA on students’ performances or grades are not accepted. Undocumented or documented communications on grade decision with class TA will not be accepted as evidences for any circumstances.

**ADA Policy Statement:** (Texas A&M University Policy Statement) Americans with Disabilities Act (ADA) Policy Statement
The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy Statement was forwarded to the Faculty Senate for information. The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu).

**Coursework Copyright Statement:** (Texas A&M University Policy Statement)
The handouts used in this course are copyrighted. The term "handouts" refers to all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, **you do not have the right to copy them**, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writing, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section “Scholastic Dishonesty”.

**Prepared by:** Berna Hascakir, April 11, 2017.
Well Logging Methods
PETE 608, Sections 600 and 700
Spring 2018

Instructor

David Kennedy
Professor of Engineering Practice
Texas A&M University
Harold Vance Department of Petroleum Engineering

Office: 401M Richardson
Telephone: 979 – 458 - 0721
email: david_kennedy@tamu.edu

Instructor Office Hours

Students are encouraged to use office hours during the semester. The instructor’s office hours are as follows:

Group office hours: Tuesdays and Thursdays 9:00 AM-4:00 PM
Location: 401M Richardson

Individual office hours: Tuesdays and Thursdays 6:00 PM-6:30 PM
Location: 401M Richardson

The instructor encourages all the students to attend group office hours to benefit from the discussions and learn from their peers. Distance learning students can join the discussions online.

Additional office hours can be scheduled in advance upon the request from students based on instructor’s availability.

E-Campus Course Website

All the homework assignments, lecture notes, and project assignments will be uploaded on the e-campus webpage designed for this course. Students are responsible to check their university e-mails and e-campus e-mails at least once a day after 6:00 PM for announcements and any required action for the course.
Course Description

The content of Well Logging Methods course is as follows:

- Introduction to well logging methods for determining nature and fluid content of formations penetrated by drilling. The application of well-log interpretation methods will be practiced for the following cases:
  - Core-log integration, rock typing, and resource assessment
  - Quantitative interpretation of well logs to estimate rock and fluid properties, including porosity, net pay thickness, fluid saturations, fluid type/density, volumetric/weight concentrations of minerals, and dynamic petrophysical properties such as permeability and saturation-dependent capillary pressure
  - Well-log interpretation in clay-free, shaly-sand, carbonate, and organic-shale formations
- Theory and physics of well-log measurements
- Development of computer models for well-log analysis

Credit: 3 hrs
Prerequisites: Students are expected to have basic knowledge of Formation Evaluation, Geology, algebra and calculus, and knowledge of how to use spreadsheets (e.g., Excel)

Teaching Assistant

TBA
E-mail: TBA  Office hours: TBA  Location: TBA

Responsibilities of teaching assistants include:

a. Helping students with conceptual and technical questions.
b. Guiding students in homework and project assignments.
c. Helping students in the preparation for exams.
d. Training students for using a commercial Formation Evaluation software.

Class/Laboratory Schedule

<table>
<thead>
<tr>
<th>Section</th>
<th>Lecture</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>TR 8:00 AM - 9:15 AM (RICH 1009)</td>
<td>TBD</td>
</tr>
<tr>
<td>700</td>
<td>TR 8:00 AM - 9:15 AM (RICH 1009)</td>
<td>TBD</td>
</tr>
</tbody>
</table>
Suggested References

- Introduction to Wireline Log Analysis, Baker Hughes CD.

References for Introduction to Petrophysics:


Additional Instructional Material

- The instructor will distribute the following material in the class:
  - Formation Evaluation Log Responses Poster, Baker Hughes, 2011.

Handouts and Class PowerPoint Presentations

PowerPoint presentations will be posted on the e-campus website in PDF format. The instructor will not print and distribute the PowerPoint presentations in the class.

Handouts including field examples will be distributed in the class.
Additional Reading Assignments and References

Additional reading assignments and references will be uploaded on the e-campus website under “References” folder.

Useful Websites

- Society of Petrophysicists and Well Log Analysts
  http://www.spwla.org/
- Schlumberger Oil Field Glossary
  http://www.glossary.oilfield.slb.com/
- Mnemonics Data Search
  http://www.spwla.org/technical/curve-mnemonics
- Log Interpretation Charts, Schlumberger
- Log Interpretation Charts, Halliburton

Course Objectives and Outcomes

At the end of the course, students will be able to:

- Understand the physics of nuclear, electrical resistivity, and acoustic measurements from openhole, cased hole, wireline, and LWD well logs
- Analyze the effect of static (e.g., porosity, volumetric concentration of shale, water saturation, and volumetric concentrations of mineral constituents) and dynamic (e.g., permeability and saturation-dependent capillary pressure) petrophysical properties on well logs
- Evaluate the quality of well logs
- Estimate petrophysical and compositional properties (e.g., porosity, water saturation, volumetric concentration of shale, volumetric concentrations of minerals, permeability, and saturation-dependent capillary pressure) using combined interpretation of well logs and core measurements in different formations such as clay-free, shaly-sand, carbonate, and organic-shale formations
- Estimate elastic properties of the formation using well logs
- Identify rock types for quantifying reservoir quality using well logs
- Make decisions for candidates for perforation and fracturing jobs based on combined interpretation of well logs and core data
- Use a commercial software (e.g., Interactive Petrophysics (IP) and/or Techlog) for well-log interpretation
Grading Policy

The distribution of the final grade will be as follow:

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight (%)</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework and Project Assignments</td>
<td>35</td>
<td>Thursdays before 11:00 PM</td>
</tr>
<tr>
<td>Class Contribution and quizzes</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>30</td>
<td>Tuesday, October 24, 2018 at 8:00 AM</td>
</tr>
<tr>
<td>Final Exam/Final Project</td>
<td>30</td>
<td>Monday, December 9, 2018 at 1:00 PM</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Grade Cutoffs: The regular university grading scale will be used in determining letter grades.  
A: > 90% B: 89.99% to 80% C: 79.99% to 70% D: 69.99% to 60% F: < 59.99%

Course Policies

- Class Attendance: Students are expected to attend every session of the class. Always bring your logging charts, well logs, and a calculator to the class. There is always the possibility of having pop quizzes and solving examples of well-log interpretation in the class, which will not be repeated later.

- Team Work and Individual Performance: Collaboration on examinations and assignments is forbidden except when specifically authorized. See Policy on Academic Integrity. For additional information, visit http://www.tamu.edu/aggiehonor. We have two types of homework and project assignments; individual and group assignments. Individual assignments should be submitted individually. However, group project assignments are team exercises. Collaboration within teams is required; collaboration between teams is forbidden except when specifically authorized. Team reports will be assigned a team grade.

- Teams: Teams will be formed during the first week of the semester. Students can choose their team members themselves. The instructor suggests you to team up with students from different majors. Having a combination of on-campus and distance learning students in each team is also highly encouraged. There will be an end-of-term peer-evaluation of individual group members based on their contribution to group work and their collaboration with other group members.

- Homework and Project Assignments: Homework and project assignments will be uploaded on e-learning every other week on Thursdays. The deadline for the assignments will be in two weeks after uploading the assignment before 11:00 PM on the e-campus website. Homework assignments will be considered late if they are not turned in before 11:00 PM on the due date. Late or not, all assignments must be turned in. Late homework assignments should be e-mailed to the TA responsible for your section and the instructor should be carbon copied (CC) in that e-mail. The e-mailed/late assignments will only receive partial credit. A course grade of “Incomplete” will be given if any assignment is missing, and this grade will be changed only after all required work has been submitted.
• **Exams and pop quizzes:** The students who miss any of the exams will not be given any additional exam. The final grade will be re-distributed for the students who miss the midterm exam with valid excuses without including the exam that they missed. Valid excuses include only university-approved reasons in accordance with Texas A&M University Student Rules (see [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07)). Pop quizzes can be taken any time during lecture hours.

• **Laboratory Sessions:** All the laboratory sessions are optional. The purpose of Laboratory sessions is software training. The students will learn the fundamentals of Interactive Petrophysics during laboratory sessions.

• **Grading and Regrading:** The policies regarding grading and regrading of exams and homework and project assignments are as follows:
  a. It is the general policy for this class that homework and exams shall be graded on the basis of answers only — partial credit, if given, is given solely at the discretion of the instructor.
  b. All work requiring calculations shall be properly and completely documented for credit.
  c. All grading shall be done by the instructor or GAT’s, or under the instructor’s direction and supervision, and the decision of the instructor is final.
  d. Only in very rare cases will exams be considered for regrading; e.g., when the total number of points deducted is not consistent with the assigned grade. Partial credit (if any) is not subject to appeal.
  e. Work, which, while correct, cannot be followed, will be considered incorrect and will not be considered for a grade change.
  f. The request for homework and project regrading should be submitted to the instructor within one week from the date returned.
  g. If regrading is necessary for the exams, the student should submit a regrading request to the instructor within one week from the date returned.

• **University Regulations Concerning Attendance, Grades, and Scholastic Dishonesty:** Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an examination or homework assignment will be removed from the class roster and given an F (failure grade) in the course. Please see **Appendix A** for more details about Academic Integrity Policy for this course.

• **Americans with Disabilities Act (ADA) Policy Statement (Texas A&M University Policy Statement):** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu).

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generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy them, unless you are expressly granted permission.

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• **Aggie Code of Honor:**

  An Aggie does not lie, cheat, or steal or tolerate those who do.
**Tentative Course Schedule**

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>DOW</th>
<th>Type</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>01/16/18</td>
<td>T</td>
<td>Lecture</td>
<td>Introduction to Well Logging, Course Policies</td>
</tr>
<tr>
<td></td>
<td>01/18/18</td>
<td>R</td>
<td>Lecture</td>
<td>Review on Petrophysics and Geology Concepts</td>
</tr>
<tr>
<td>2</td>
<td>01/23/18</td>
<td>T</td>
<td>Lecture</td>
<td>Quick-look well-log interpretation</td>
</tr>
<tr>
<td></td>
<td>01/25/18</td>
<td>R</td>
<td>Lecture</td>
<td>Quick-look well-log interpretation</td>
</tr>
<tr>
<td>3</td>
<td>01/30/18</td>
<td>T</td>
<td>Lecture</td>
<td>Logging environment</td>
</tr>
<tr>
<td></td>
<td>02/01/18</td>
<td>R</td>
<td>Lecture</td>
<td>Data quality control</td>
</tr>
<tr>
<td>4</td>
<td>02/06/18</td>
<td>T</td>
<td>Lecture</td>
<td>Caliper, tension, and temperature logs</td>
</tr>
<tr>
<td></td>
<td>02/07/18</td>
<td>W</td>
<td>Lab**</td>
<td>Introduction to Interactive Petrophysics (IP)</td>
</tr>
<tr>
<td></td>
<td>02/08/18</td>
<td>R</td>
<td>Lecture</td>
<td>GR Logs</td>
</tr>
<tr>
<td>5</td>
<td>02/13/18</td>
<td>T</td>
<td>Lecture</td>
<td>Spontaneous Potential (SP) logs</td>
</tr>
<tr>
<td></td>
<td>02/14/18</td>
<td>W</td>
<td>Lab**</td>
<td>Introduction to IP</td>
</tr>
<tr>
<td></td>
<td>02/15/18</td>
<td>R</td>
<td>Lecture</td>
<td>Density logs</td>
</tr>
<tr>
<td>6</td>
<td>02/20/18</td>
<td>T</td>
<td>Lecture</td>
<td>PEF logs</td>
</tr>
<tr>
<td></td>
<td>02/22/18</td>
<td>R</td>
<td>Lecture</td>
<td>Electrical resistivity logs, electromagnetic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>properties of rocks</td>
</tr>
<tr>
<td>7</td>
<td>03/06/18</td>
<td>T</td>
<td>Lecture</td>
<td>Examples on $S_v$ assessment, Introduction to</td>
</tr>
<tr>
<td></td>
<td>03/08/18</td>
<td>R</td>
<td>Lecture</td>
<td>Pickett Plot</td>
</tr>
<tr>
<td>8</td>
<td>03/13/18</td>
<td>T</td>
<td>Lecture</td>
<td>Spring Break</td>
</tr>
<tr>
<td></td>
<td>03/15/18</td>
<td>R</td>
<td>Lecture</td>
<td>Spring Break</td>
</tr>
<tr>
<td>9</td>
<td>03/20/18</td>
<td>T</td>
<td>Lecture</td>
<td>Neutron porosity logs, gas and mineralogy</td>
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<tr>
<td></td>
<td>03/22/18</td>
<td>R</td>
<td>Exam</td>
<td>Midterm Exam</td>
</tr>
<tr>
<td>10</td>
<td>03/27/18</td>
<td>T</td>
<td>Lecture</td>
<td>Acoustic logs, Basic rock mechanics, Fluid</td>
</tr>
<tr>
<td></td>
<td>03/28/18</td>
<td>W</td>
<td>Lab**</td>
<td>substitution</td>
</tr>
<tr>
<td></td>
<td>03/29/18</td>
<td>R</td>
<td>Lecture</td>
<td>NMR logs</td>
</tr>
<tr>
<td>11</td>
<td>04/03/18</td>
<td>T</td>
<td>Lecture</td>
<td>Pulsed neutron devices and spectroscopy</td>
</tr>
<tr>
<td></td>
<td>04/05/18</td>
<td>R</td>
<td>Lecture</td>
<td>Assessment of dynamic petrophysical properties,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Conventional vs. new methods</td>
</tr>
</tbody>
</table>
| 12   | 04/10/18   | T   | Lecture | Lithology assessment based on well logs, Multi-
|      | 04/12/18   | R   | Lecture | mineral Analysis                               |
|      | 04/17/18   | T   | Lecture | Well-log interpretation in shaly-sand          |
|      | 04/19/18   | R   | Lecture | formations                                      |
| 14   | 04/24/18   | T   | Lecture | Rock typing techniques based on well logs      |
| 15   | 05/01/18   | T   | Lecture | Last Day of Classes Image logs, High-angle     |
|      | 05/03/18   | R   | Lecture | wells                                          |
| Final| 05/TBA/18  | TBA | Exam   | Final Exam (hours TBA)                         |

* This course schedule is tentative and subject to change.
** All the laboratory sessions are optional. The purpose of Laboratory sessions is software training. The laboratory schedule is tentative and subject to change.
APPENDIX A: ACADEMIC INTEGRITY POLICY

Rationale - Why I Do What I Do?

Technical competence: I want you to be able to perform well technically as an engineer. I want each of you to be able to perform well individually, not just when you are working with your buddies. It is very unlikely that you and your buddies will end up working together. To remain employed and prosper in your career, you will have to perform individually. In addition to developing technically, deciding that you will not cheat will force you to develop self discipline and time management skills in order to get good grades, which will also help you immensely in your career.

Ethical competence: I want you to be ethically competent. While you may be able to succeed in the short term by being unethical, just as you may get good grades by cheating in school, long-term success can only be achieved with ethical behavior. Don’t think that cheating in school is different from being unethical in the workplace, or that once school is over you will change or won’t need to cheat anymore. If you cheat in school, you won’t think twice about padding your expense account. If you do that, then overstating reserves to increase your bonus won’t bother you. It’s not a big step from there to cooking the books of your company to inflate the value of your stock options. I don’t want any Aggies involved in the next Enron debacle, and it starts with cheating in school.

Fairness: Those who cheat have an unwarranted advantage over those who don’t. I want to be fair to those who don’t cheat.

The Aggie Honor Code: As a Texas A&M University faculty member, I am also bound by the Aggie Honor code, which includes that I will not tolerate those who cheat.

What I Will Do?
For the reasons above, and because I feel quite strongly about them,
1. I will do everything I reasonably can to prevent cheating. I don’t do everything I possibly can because this would be a full-time job.
2. Because I can’t do everything possible to prevent cheating, when I determine a cheating violation has occurred I will (a) report it through the Aggie Honor System Office (AHSO), and (b) punish to the full extent that I am able to.

What Constitutes Academic Dishonesty?
You may be surprised at what is considered academic dishonesty. For example,
- During an examination, looking at another student’s examination or using external aids (for example, books, notes, calculators, conversation with others, or electronic devices) unless specifically allowed in advance by the instructor.
- Acquiring answers for any assigned work or examination from any unauthorized source. This includes, but is not limited to, using the services of commercial term paper companies, purchasing answer sets to homework from tutoring companies, and obtaining information from students who have previously taken the examination.
- Collaborating with other students in the completion of assigned work, unless specifically authorized by the instructor teaching the course.
Knowingly allowing another to copy from one's paper during an examination or test. See http://aggiehonor.tamu.edu/Descriptions/ for a complete list.

Reporting an Academic Violation - What Happens?
- I will report the violation to the AHSO, regardless of the magnitude of the violation.
- The report is submitted online and includes (1) the details of the violation, (2) an election to handle autonomously or refer to the Honor Council, (3) specification of sanction, and (4) student acknowledgement of acceptance/rejection of violation and/or sanction.
  - I will usually handle the first offense autonomously; e.g., I decide the sanction. My minimum sanction will usually be a one-letter-grade reduction in your course grade. The maximum sanction I can and will award is an F* (failure of the course and notation of “FAILURE DUE TO ACADEMIC DISHONESTY” on transcript until cleared by taking the Academic Honesty Remediation Course).
  - I will usually include taking the Academic Honesty Remediation Course as part of the sanction. This is a three-class, one-month course on academic integrity. I will usually give you one semester to take the course. If you do not take the course by this time your grade will be changed to an F*.
- Importantly, you are now logged into the AHSO system. If there is a second violation, in any course, you will automatically go before the Honor Council, and you will likely be expelled from the university.
- Note that upper division students found guilty of a violation are ineligible to graduate with honors. I will treat students giving unauthorized help the same as students receiving unauthorized help.
- In all cases, you have the right to appeal to the AHSO.

Final Words
Please understand that none of this is personal. My desire is for academic integrity, regardless of who you are. I want you all to do well. I just want you to do it honestly. You will be a better engineer because of it.
You now know what I will do. Don’t claim ignorance or ask for a second chance if you are caught. I have given the consideration I will give by telling you in advance and in no uncertain terms what I will do so that you can make an informed decision about cheating.
PETE609/409 Course Syllabus – Summer 2020
Tuesday and Thursday 12:00-03:40 pm

Instructor: Dr. Berna Hascakir, Texas A&M University - Petroleum Engineering Department
Office: Richardson 401 N
Telephone: 979-845-6614
e-mail: hascakir@tamu.edu
Office Hours: Monday-Wednesday-Friday from 12:00 pm till 2:00 pm through e-mail or zoom only

Catalog Description: Fundamentals and theory of enhanced oil recovery; polymer flooding, surfactant flooding, miscible gas flooding and steam flooding; application of fractional flow theory; strategies and displacement performance calculations.

Instructional Objectives

Topics Covered:
1. Introduction
2. Microscopic Displacement of Fluids in a Reservoir
3. Displacement in Linear Systems
4. Macroscopic Displacement of Fluids in a Reservoir
5. Mobility-Control Processes
6. Miscible Displacement Processes
7. Chemical Flooding
8. Thermal Recovery
9. Microbial EOR
10. Mining

Contributions to Meeting the Curriculum Requirements of Criterion:

<table>
<thead>
<tr>
<th>Math and Science</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum Engineering</td>
<td>This course provides students with a fundamental background on the determination and evaluation of EOR methods. It also provides mathematical tools for the analysis and interpretation of data.</td>
</tr>
<tr>
<td>General Education</td>
<td>None</td>
</tr>
</tbody>
</table>

Course Learning Outcomes and Relationship to Program Outcomes:

<table>
<thead>
<tr>
<th>Course Learning Outcome: At the end of the course, students will be able to...</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the EOR methods used to recovery unconventional reservoirs or depleting conventional reservoirs. Explain the physical meaning and evaluate the impact of fluid properties in reservoir engineering and production problems.</td>
<td>11</td>
</tr>
<tr>
<td>Compute the oil bank, water bank, injected fluid bank movements.</td>
<td>1</td>
</tr>
<tr>
<td>Calculate the oil recovery factor, water recovery factor.</td>
<td>5</td>
</tr>
<tr>
<td>Describe the laboratory procedures required for a successful EOR process.</td>
<td>1,3,5</td>
</tr>
<tr>
<td>Determine and analyze the differences in EOR methods.</td>
<td>5</td>
</tr>
<tr>
<td>Design an EOR technology to recover a specific reservoir.</td>
<td>2,3,5</td>
</tr>
<tr>
<td>Determine and propose the most effective and environmental friendly EOR technology.</td>
<td>2,3</td>
</tr>
</tbody>
</table>

Related Program Outcomes:

<table>
<thead>
<tr>
<th>No.</th>
<th>PETE graduates must have...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An ability to apply knowledge of mathematics, science, and engineering.</td>
</tr>
<tr>
<td>2</td>
<td>An ability to design an EOR project by analyzing and interpreting data.</td>
</tr>
<tr>
<td>3</td>
<td>An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.</td>
</tr>
<tr>
<td>5</td>
<td>An ability to identify, formulate, and solve engineering problems.</td>
</tr>
<tr>
<td>11</td>
<td>An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
</tr>
</tbody>
</table>
COURSE SCHEDULE

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Lecture Number</th>
<th>Topic</th>
<th>In-Class Activity Assignment (ICA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-Jun-20</td>
<td>Tuesday</td>
<td>L1</td>
<td>Introduction</td>
<td>ICA1</td>
</tr>
<tr>
<td>02-July-20</td>
<td>Thursday</td>
<td>L2</td>
<td>Microscopic Displacement</td>
<td>ICA2</td>
</tr>
<tr>
<td>07-July-20</td>
<td>Tuesday</td>
<td>L3</td>
<td>Displacement in Linear Systems</td>
<td>ICA3</td>
</tr>
<tr>
<td>09-July-20</td>
<td>Thursday</td>
<td>L4</td>
<td>Macroscopic Displacement</td>
<td>ICA4</td>
</tr>
<tr>
<td>14-July-20</td>
<td>Tuesday</td>
<td>L5</td>
<td>Mobility Control</td>
<td>ICA5</td>
</tr>
<tr>
<td>16-July-20</td>
<td>Thursday</td>
<td>L6</td>
<td>Miscible Processes</td>
<td>ICA6</td>
</tr>
<tr>
<td>21-July-20</td>
<td>Tuesday</td>
<td>L7</td>
<td>Chemical Processes</td>
<td>ICA7</td>
</tr>
<tr>
<td>23-July-20</td>
<td>Thursday</td>
<td>L8</td>
<td>Thermal Processes</td>
<td>ICA8</td>
</tr>
<tr>
<td>28-July-20</td>
<td>Tuesday</td>
<td>L9</td>
<td>Microbial EOR</td>
<td>ICA9</td>
</tr>
<tr>
<td>30-July-20</td>
<td>Thursday</td>
<td>L10</td>
<td>Mining</td>
<td>ICA10</td>
</tr>
<tr>
<td>4-Aug-20</td>
<td>Tuesday</td>
<td></td>
<td>Final Exam</td>
<td>Multiple Choice-1:00-3:00 pm</td>
</tr>
</tbody>
</table>

* Scheduled program and number of in-class activities may change.

COURSE POLICIES

**Prerequisites:** PETE 310 and PETE 314-
A student as an undergraduate who enrolled and completed before PETE 489 or PETE 409 before is not allowed to take PETE 609 as a graduate student.


**Attendance:** Texas A&M views class attendance as an individual student responsibility (http://student-rules.tamu.edu/rule07). Attendance is essential to complete the course successfully. Material presented in lecture and class discussion may expand upon points only briefly considered in the required text.

**Excused Absences:** Rules concerning excused absences may be found at http://student-rules.tamu.edu/rule07. Except for absences due to religious obligations, the student must notify her or his instructor in writing (acknowledged e-mail message is acceptable) prior to the date of absence if such notification is feasible. In cases where advance notification is not feasible (e.g. accident, or emergency) the student must provide notification by the end of the second working day after the absence. This notification should include an explanation of why notice could not be sent prior to the class. If the absence is excused, the instructor must either provide the student with an opportunity to make up any quiz, exam or other graded activities or provide a satisfactory alternative to be completed within 30 calendar days from the last day of the absence.

**Excused Absences for Religious Holy Days:** Texas House Bill (effective 9/1/03) states “An institution of higher education shall excuse a student from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student whose absence is excused under this subsection may not be penalized for that absence and shall be allowed to take an examination or complete an assignment from which the student is excused within a reasonable amount of time after the absence.”

**ASSIGNMENTS**

1. **In Class Activities (ICA):** Students are responsible to follow every lecture and submit in class activities within given period (usually by the end of each lecture or one day before each lecture). In class activities cover the material given in the lecture, moreover the solutions of each individual in class activity are also provided during the lecture time, thus, students are responsible to follow lecture videos to complete the in class activities. During lecture videos, the tasks to complete each in class activities will be mentioned, if a student will fail to watch the entire lecture videos, then they may miss the tasks for each assignment which can lower the overall grade that a student will gain. Thus, it is entirely students’ responsibility to watch the lecture videos and complete the in class activities properly. Detailed explanation for each in class activity will only appear on the lecture videos not on e-campus with a separate word document. E-campus will only mention the in-class activity number. It is planned to have 10 in-class activities for this semester, however, there might be more or less than this number.

   If a student does not pay enough attention to the in class activities, their grades will be dropped 10%. If a student or students will do plagiarism, their works will be graded ZERO and they will be reported to the university according to the University Honor Code.

2. **Exams:** There will be only one multiple choice exam during the final exam period. Exam will cover all material presented in the class.
Extra Credits: There may be opportunities to earn extra credit during the semester. These activities will be announced in class. There are no make-ups or substitutions for extra-credit opportunities.

Assignments: Late assignments will normally be given a grade of zero. Assignments should be neat, easy to understand, and straight forward. If they are copied and pasted statements (not your words), there will be 20 points penalty for each copied and pasted statement and you will be reported to Aggie Honor office.

Makeup Policy: Makeup exams will be given without question for excused absences as defined by University Regulations. If you miss an exam for any other reason, you may request a makeup, but the makeup exam may have a different format from that given in class, must be completed within one week of the original exam date, and there will be a 5% penalty.

Student Conduct: Academic Integrity Statement and Policy, Aggie Code of Honor “An Aggie does not lie, cheat, or steal or tolerate those who do.” Upon accepting admission to Texas A&M University, a student immediately accepts a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophies and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System. For more information: http://aggiehonors.tamu.edu/

ADA Policy Statement: (Texas A&M University Policy Statement) Americans with Disabilities Act (ADA) Policy Statement

The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy Statement was forwarded to the Faculty Senate for information.

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu.

READ CAREFULLY BELOW STATEMENTS IF YOU ARE A STUDENT WITH DISABILITY, BY ENROLLING MY CLASS YOU AUTOMATICALLY ACCEPT BELOW RULES.

- Students with a disability should inform the class instructor at the beginning of the semester (within the first week of every semester) to request accommodations with an official note from TAMU Disability Center. Otherwise, students will be accommodated same with the rest of the class, additional time or separate classroom will not be provided for any exam or assignment for the students who did not notify the class instructor within the first week of every semester.

- Students who provided an official document from TAMU Disability Center within the first week of the semester to the class instructor will be able to get their accommodation needs only at TAMU Disability Center. In other words, those students will ONLY be able to take all of their assignments at the TAMU Disability Center. There will be no exam for those students at TAMU Petroleum Engineering building or any other place that regular class scheduled for exams and those students will never be able to take their exams with the entire class at regular time and location mentioned in the syllabus.

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Grading Policy: Your grading will be calculated according to the table given below. Letter grades will be assigned to the following guideline: A=90-100 (Excellent), B= 80-89 (Good), C=70-79 (Satisfactory), D=60-69 (Passing), F=59 and below (Failing); I=Incomplete.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Details</th>
<th>% of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. In Class Activity</td>
<td>The solution of in class activities will be given during the class, students responsibility is to attend all classes/watch lecture videos and follow all class activities, not all class activities may be asked to submit, submission may be requested randomly by class instructor.</td>
<td>80</td>
</tr>
<tr>
<td>3. Final Exam</td>
<td>Written Exam, multiple choice</td>
<td>20</td>
</tr>
</tbody>
</table>

Your grade in this class is earned, not awarded. I will NOT consider rounding up your overall grade. Throughout the semester, after each assignment or exam, you will be informed by your average grade. In other words, if your earned grade by the end of the semester is 89, your grade will be a B on Howdy. Or if your earned grade by the end of the semester is 79, your grade will be a C on Howdy. Or if your earned grade by the end of the semester is 69, your grade will be a D on Howdy. Or if your earned grade by the end of the semester is 59, your grade will be a F on Howdy.

ADA Policy Statement: (Texas A&M University Policy Statement) Americans with Disabilities Act (ADA) Policy Statement

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READ CAREFULLY BELOW STATEMENTS IF YOU ARE A STUDENT WITH DISABILITY, BY ENROLLING MY CLASS YOU AUTOMATICALLY ACCEPT BELOW RULES.

- Students with a disability should inform the class instructor at the beginning of the semester (within the first week of every semester) to request accommodations with an official note from TAMU Disability Center. Otherwise, students will be accommodated same with the rest of the class, additional time or separate classroom will not be provided for any exam or assignment for the students who did not notify the class instructor within the first week of every semester.

- Students who provided an official document from TAMU Disability Center within the first week of the semester to the class instructor will be able to get their accommodation needs only at TAMU Disability Center. In other words, those students will ONLY be able to take all of their assignments at the TAMU Disability Center. There will be no exam for those students at TAMU Petroleum Engineering building or any other place that regular class scheduled for exams and those students will never be able to take their exams with the entire class at regular time and location mentioned in the syllabus.
• Students who provided an official documentation from TAMU Disability Center will be responsible to make every arrangement for their exam time and location with Disability Center, if they fail to make those arrangements, their exam will not take place at regular scheduled time with the entire class and their grade from the exam that they missed to take at Disability Center will be zero.

• Class instructor in general will be very busy and will not follow up if the students made all of their arrangements with the TAMU Disability Center or not for taking exams. It is sole students’ responsibility and students who notified the class instructor with their official notice from disability center will never have a chance to change their preference to take the exam in the classroom with entire class.

• Students who provided an official documentation from TAMU Disability Center will take their exam at the TAMU Disability Center exactly at the same time given in syllabus with an extended option (or any other option mentioned in their official documentation). Those students should be at the TAMU Disability Center during the regular exam period and they will not have access to their phone, computers or any other device with internet access. If they need internet to take their exams, there will be an observer from the TAMU Disability Center who will watch their actions throughout that period. They will not be able to e-mail to any classmates, instructor, TA, or anybody for any type of inquiry.

• If a student with disability decides to not provide the documentation related to his/her disability to the class instructor within the first week of classes, that student will never have a chance again to share that document with the class instructor. And the treatment that student will be observed exactly the same with the rest of the class, exam times will be within regular hours of the exams, there will be no additional accommodations for those students for the entire of the semester and final exam period.

• If a student with disability needs a consultation on their disability or any other situation they are in, because the instructor is not an expert on this area, this consultation need will be directed to TAMU Student Assistance Services (please visit https://studentlife.tamu.edu/sas/) and TAMU Disability Center (please visit https://disability.tamu.edu/).

Coursework Copyright Statement: (Texas A&M University Policy Statement)
The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy them, unless you are expressly granted permission. 
As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writing, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section “Scholastic Dishonesty”.

Course title and number: PETE 611  
Term: FALL 2020  
Meeting times and location: Web-Based Distance Learning (ecampus)

Course Description and Prerequisites

PETE 611 Application of Petroleum Reservoir Simulation, Credits 3. 3 Lecture Hours.  
Use of simulators to solve reservoir engineering problems too complex for classical analytical techniques. 
Prerequisites: PETE 400 and PETE 401.

Consideration will be given to appropriate course work and/or professional experience in the areas of reservoir engineering, reservoir simulation, and/or numerical methods for meeting course prerequisites.

Learning Outcomes or Course Objectives

Course Outcomes: At the end of this course, students will be able to:

1. Explain reservoir simulation fundamentals - the underlying equations and the numerical techniques used to solve them. 
2. Design a reservoir simulation model, construct the data set, execute the simulator, and view simulation results visually using post-processing software. 
3. Plan and conduct the calibration of a reservoir simulation model. 
5. Apply reservoir simulation technology to solve production and reservoir engineering problems in individual wells or patterns. 
6. Apply reservoir simulation technology to solve production and reservoir engineering problems in entire fields or reservoirs. 
7. Apply equation-of-state regression technology to construct a fluid model by matching laboratory PVT test data. 
8. Apply compositional reservoir simulation to solve production and reservoir engineering problems. 
9. Apply streamline simulation to solve reservoir engineering problems. 
10. Effectively present the results of an engineering study in a written report.

Instructor Information

Name: Dr. Bryan Maggard  
Telephone number: Office, 979-845-0592 (voicemail active)  
Email address: bryan.maggard@tamu.edu  
Office hours: Will be posted on ecampus announcement (live zoom)  
Office location: 916C RICH

Textbook and/or Resource Material

Lecture notes and supplemental papers will be provided on ecampus.

Optional Texts:

Grading Policies

1. **Work Quality**: Neat, legible, systematic and complete presentation is required in assignments. Units (for example, Newton-meters) must be documented wherever appropriate, including table column titles and chart axes.

2. **No Extra Credit**: Extra credit opportunities will NOT become available after course grades are assessed.

Grading Scale

*Standard Letter Grading Scale:*

- A = 90-100; B = 80-89; C = 70-79; D = 60-69; F = <60

*Course Average:*
- Projects (Approx. 3-4) 75 %
- Homework (Approx. 3-4) 25 %

Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – August 20</td>
<td>Course Introduction; Intro. to Conventional Simulation</td>
</tr>
<tr>
<td>2 – August 25, 27</td>
<td>Intro. to Conv. Sim; Type Curve Matching</td>
</tr>
<tr>
<td>3 – September 1, 3</td>
<td>History Matching</td>
</tr>
<tr>
<td>4 – September 8, 10</td>
<td>Scale-Up</td>
</tr>
<tr>
<td>5 – September 15, 17</td>
<td>Scale-Up / Pseudo-Functions</td>
</tr>
<tr>
<td>6 – September 22, 24</td>
<td>Pseudo-Functions</td>
</tr>
<tr>
<td>7 – September 29, October 1</td>
<td>Modeling Well Performance / Coning</td>
</tr>
<tr>
<td>8 – October 6, 8</td>
<td>Modeling Well Performance / Coning</td>
</tr>
<tr>
<td>9 – October 13, 15</td>
<td>Tuesday – No class, SPE-ATCE</td>
</tr>
<tr>
<td></td>
<td>Thursday – EOS Compositional Fluid Models</td>
</tr>
<tr>
<td>10 – October 20, 22</td>
<td>EOS Compositional Fluid Models</td>
</tr>
<tr>
<td>11 – October 27, 29</td>
<td>Compositional Simulation</td>
</tr>
<tr>
<td>12 – November 3, 5</td>
<td>Compositional Simulation</td>
</tr>
<tr>
<td>13 – November 10, 12</td>
<td>Introduction to Streamline Simulation</td>
</tr>
<tr>
<td>14 – November 17, 19</td>
<td>Streamline Simulation</td>
</tr>
<tr>
<td>15 – November 24, 26</td>
<td>Tuesday – Project Workshop</td>
</tr>
<tr>
<td></td>
<td>Thursday – No class, Thanksgiving holiday</td>
</tr>
<tr>
<td>16 – November 30</td>
<td>Monday, at noon – Last project due</td>
</tr>
</tbody>
</table>

Other Pertinent Course Information

**Accommodation for Religious Observance**: See student-rules.tamu.edu, Appendix IV. A sincere effort will be made to accommodate students’ needs for religious observance. Students must contact the instructor during the first week of class in order to make arrangements.

**Americans with Disabilities Act (ADA)**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.
Academic Integrity

For additional information please visit: http://aggiehonor.tamu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”

There is no tolerance for cheating in any form.

- Do not share computer files, including spreadsheets, simulation data files, or computer programs.
- Do not turn in anything as your work that is not exclusively your individual work. An exception would be in the instance of team assignments, in which case, this instruction applies to the team.

Accommodation of Religious Observance: See student-rules.tamu.edu, Appendix IV. Please review your religious calendar during the first week of the semester, so we can begin discussion of any accommodation issues.

Title IX and Statement on Limits to Confidentiality: Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

Statement on Mental Health and Wellness: Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

COVID-19 Temporary Amendment to Minimum Syllabus Requirements:

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

Campus Safety Measures: To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020
academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

• Self-monitoring—Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.

• Face Coverings—Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.

• Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

• Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.

• To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

Personal Illness and Quarantine: Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.
Course Description and Prerequisites:

Graduate Catalog: As conventional oil and gas resources are depleted, unconventional resources, including heavy oil and gas from low-permeability sandstones, fractured shales, coal beds, and hydrates, will assume greater roles in meeting USA and world energy demands; this course emphasizes resources, geologic and geographic occurrences, recovery technology and economics of unconventional hydrocarbon resources. Prerequisites: Graduate classification and approval of instructors.

Text Materials:

No textbook required. A collection of articles and other lecture materials will be used throughout the semester.

Basis for Grade: (components given as percentage of total grade average)

<table>
<thead>
<tr>
<th>Module 1 (Akkutlu)</th>
<th>Hwk/Quizzes/Projects/Module Exam</th>
<th>33.33 percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 2 (Lee)</td>
<td>Hwk/Quizzes/Projects/Module Exam</td>
<td>33.33 percent</td>
</tr>
<tr>
<td>Module 3 (Blasingame)</td>
<td>Hwk/Quizzes/Projects/Module Exam</td>
<td>33.33 percent</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100.00 percent</td>
</tr>
</tbody>
</table>

Grade Cutoffs: (Percentages)

A: 100 to 90  B: 89.99 to 80  C: 79.99 to 70  D: 69.99 to 60  F: < 59.99

Policies and Procedures:

1. Students are expected to attend class every session. Resident students (not Distance Learning students) are REQUIRED to attend class every session. Distance Learning students are expected to review lecture materials within 24 hours of the lecture being given. This is not a casual requirement; penalties can and will be assigned for missing class.

2. Always bring your textbook, notes, homework problems, and calculator to class.

3. Homework and other assignments will be given at the lecture session. All work shall be done in an acceptable engineering manner; work done shall be as complete as possible. Assignments are due as stated. Late assignments will receive a grade of zero.

4. Policy on Grading
   a. It shall be the general policy for this class that homework and exams shall be graded on the basis of answers only — partial credit, if given, is given solely at the discretion of the instructor.
   b. All work requiring calculations shall be properly and completely documented for credit.
   c. All grading shall be done by the instructor, or under his supervision, and the decision of the instructor is final.

5. Policy on Regrading
   a. Only in very rare cases will exams be considered for regrading; e.g., when the total number of points deducted is not consistent with the assigned grade. Partial credit (if any) is not subject to appeal.
   b. Work which, while correct, but cannot be followed, will be considered incorrect — and will not be considered for a grade change.
   c. Grades assigned to homework problems will not be considered for regrading.
   d. If regrading is necessary, the student is to submit a letter to the instructor explaining the situation that requires consideration for regrading and the material to be regraded must be attached to this letter. The letter and attached material must be received within one week from the date returned.

6. The grade for a late assignment is zero. Homework will be considered late if it is not turned in by the due date/time as specified on a given assignment. If a student comes to class after homework has been turned in and after class has begun, the student's homework will be considered late and given a grade of zero. Late or not, all assignments must be turned in.

7. Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an examination or collaborating on an assignment where collaboration is not specifically allowed will be removed from the class roster and given an F (failure grade) in the course. Specifically, you are NOT AUTHORIZED to collaborate any individual assignment, exam, quiz, etc.; this includes discussions, sharing materials, etc. You are expressly FORBIDDEN from such actions on any and all assignments. You are only permitted to collaborate on assignments if the instructor specifically authorizes such collaborations, and then for only for the assignment where such collaboration is authorized. Failure to abide by this guideline will invoke an F (failure grade) in the course or on the assignment, at the discretion of the instructor, based on the severity of the infraction.
Scholastic Dishonesty:

THE STUDENT IS HEREBY WARNED THAT ANY/ALL ACTS OF SCHOLASTIC DISHONESTY WILL RESULT IN AN "F" GRADE FOR ALL ASSIGNMENTS IN THIS COURSE. As a definition, "scholastic dishonesty" will include any or all of the following acts:

- Unauthorized collaborations — you are explicitly forbidden from working together.
- Using work of others — you are explicitly forbidden from using the work of others — "others" is defined as students in this course, as well as any other person. You are specifically required to perform your own work.

Work Requirements: (layout/format/etc.)

- You must show ALL work — as appropriate, YOU MUST:
  - WORK: Show all details in calculations (no skipped steps) — all analysis relations must be shown.
  - UNITS: Show all units in all calculations.

- Work layout: (as appropriate for a given problem)
  - NEATNESS: You will be graded on the neatness of your work.
  - LABELS: All work, trends, and features on every plot MUST be appropriately labeled — no exceptions.
    - Work: All work must be fully labeled and documented — equations, relations, calculations, etc.
    - Trends: This includes the slope, intercept, and the information used to construct a given trend.
    - Features: Any description of features/points of interest on a given trend (times, pressures, etc.).
  - LINES: Use appropriate drafting care in construction of lines, trends, arrows, etc.
  - SKETCHING: Take great care in any sketches you create/use in your work.

- Plots/Plotting: (as required)
  - SYMBOLS: Use symbols for "data" (if "data" are presented — e.g., discrete data points from a table).
  - LINES: Use lines to represent models.
  - COLORS: Use black for all axes and gridlines. Use primary colors (red, green, blue), avoid pastel colors.
  - etc: Please do NOT use a border or "frame" around your plots.

Work Standard:

Simply put, the expectation of the instructors is that "perfection is the standard" — in other words, your work will be judged against a perfect standard. If your submission is not your very best work, then do not submit it. You have an OBLIGATION to submit only your very best work.

Student Obligation:

You must prepare your work as instructed above, or you will be assessed SEVERE grading penalties.

e-mail Protocols:

In order to manage your correspondence, we require that you use the following protocol.

Subject Line: [YYYYMMDD] (YOURLASTNAME) Subject
           (date) (your last name) (Subject of your e-mail)

Body:

Dr. AKKUTLU or Dr. LEE or Dr. BLASINGAME:

I would like to enquire about the following:
* Question 1 ... (be clear and concise)
* Question 2 ... (be clear and concise)
* Question 3 ... (be clear and concise)

I thank you for your assistance.

YourFirstName YOURLASTNAME
(contact information)
E: (TAMU)
E: (personal)
T: (a phone contact) (We will NEVER call you without first sending an e-mail or text)

Comments:

- DO NOT FORWARD/REPLY TO EMAILS FROM ECAMPUS — SEND A NEW NOTE.
- The subject line is used to file e-mail (this is why this specific subject line is required).
- Every effort will be made to answer every e-mail, but PLEASE consult the syllabus for "administrative" issues.
- Questions by e-mail are preferred — e.g., issues/errors/etc. and/or help with issues relevant to the course.
- Courier New 10pt Bold font is required.
Course Objectives:

The students will:

**Module 1:**
- Be able to understand the role that unconventional resources play in regional and global energy spectra.
- Be able to understand oil/gas storage in the unconventional resources and perform volumetric calculations.
- Be able to understand oil and gas transport at the pore scale during production from unconventional resources.
- Be able to develop theoretical methods to predict oil and gas production from an unconventional reservoir.
- Be able to identify flow regimes, which may occur during production from hydraulically fractured wells.
- Be able to develop the analytical solution for the case of formation linear flow.

**Module 2:**
- Be able to classify resources using the PRMS classification system.
- Be able to categorize reserves using PRMS and SEC guidelines and regulations.
- Be able to estimate reserves by forecasting with Arps and other empirical decline models.
- Be able to state and explain a workflow for constructing a typical well production profile (i.e., a type well/type curve).
- Be able to state and explain how to determine optimal well spacing in unconventional (low permeability) resources.

**Module 3:**
- Be able to describe the reservoir and production metrics, which can be evaluated using well performance data.
- Be able to apply "conventional" concepts in geology, petrophysics, and phase behavior to unconventional reservoirs.
- Be able to apply RTA/PTA/DCA methodologies to well performance data obtained from unconventional reservoirs:
- Be familiar with the following special topics: liquid-loading, artificial lift, field development, multiwell performance.
- Be able to create a correlation of completion, production, and reservoir metrics for an unconventional case history.

Lecture Topics:

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module 1:</strong></td>
<td></td>
</tr>
<tr>
<td>Akkutlu</td>
<td>Geological and Geochemical Considerations for Unconventional Resources</td>
</tr>
<tr>
<td>Akkutlu</td>
<td>Multi-scale Pore Structure Development, Porosity, Pore Size Distribution</td>
</tr>
<tr>
<td>Akkutlu</td>
<td>Volumetric Methods of Calculating Oil/Gas In-place in Unconventional Formations</td>
</tr>
<tr>
<td>Akkutlu</td>
<td>Measurement and Modeling of Permeability for Unconventional Formations</td>
</tr>
<tr>
<td>Akkutlu</td>
<td>Pressure Transients During Production from Hydraulically-Fractured Unconventional Wells</td>
</tr>
<tr>
<td>Akkutlu</td>
<td>Simulation-Based History-Matching of Unconventional Well Production and Forecasting</td>
</tr>
<tr>
<td><strong>Module 2:</strong></td>
<td></td>
</tr>
<tr>
<td>Lee</td>
<td>PRMS resources classification</td>
</tr>
<tr>
<td>Lee</td>
<td>SEC reserves regulations</td>
</tr>
<tr>
<td>Lee</td>
<td>Estimating reserves using Arps decline models</td>
</tr>
<tr>
<td>Lee</td>
<td>Estimating reserves using traditional type wells</td>
</tr>
<tr>
<td>Lee</td>
<td>Interference and well spacing</td>
</tr>
<tr>
<td>Lee</td>
<td>Estimating reserves using RTA flow models</td>
</tr>
<tr>
<td><strong>Module 3:</strong></td>
<td></td>
</tr>
<tr>
<td>Blasingame</td>
<td>What Can we Learn from Well Performance Data?</td>
</tr>
<tr>
<td>Blasingame</td>
<td>Geology, (traditional) Petrophysics, and (bulk) Phase Behavior</td>
</tr>
<tr>
<td>Blasingame</td>
<td>PTA/RTA/DCA for Unconventionals</td>
</tr>
<tr>
<td>Blasingame</td>
<td>Special Topics — Well Performance of Unconventionals</td>
</tr>
<tr>
<td>Blasingame</td>
<td>Correlation of Completion, Production, and Reservoir Metrics</td>
</tr>
<tr>
<td>Blasingame</td>
<td>“What’s Next” for Unconventionals</td>
</tr>
</tbody>
</table>

Course Closure:

- There is no comprehensive final examination for this course.
- (exam schedule) [https://www.tamiu.edu/Registrar/finalexamschedule.shtml](https://www.tamiu.edu/Registrar/finalexamschedule.shtml)
- (grades - graduates) 10 December Thursday, 6 p.m. (18:00), Grades due for all degree candidates.
- (academic calendar) [https://Registrar.tamu.edu/Catalogs-Policies-Procedure/Academic-Calendar](https://Registrar.tamu.edu/Catalogs-Policies-Procedure/Academic-Calendar)
- (grades - all) 14 December Monday, 12 p.m. (noon), Grades due for all non-graduating students).
Americans with Disabilities Act (ADA) Statement:
Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit http://disability.tamu.edu. Disabilities may include, but are not limited to, attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible. (Last updated and approved by Faculty Senate on 11/11/2019)

"An Aggie does not lie, cheat or steal, or tolerate those who do."

Definitions of Academic Misconduct:
1. CHEATING: Intentionally using or attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
2. FABRICATION: Making up data or results, and recording or reporting them; submitting fabricated documents.
3. FALSIFICATION: Manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
4. MULTIPLE SUBMISSION: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from the instructor of the class for which the student submits the work.
5. PLAGIARISM: The appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
6. COMPLICITY: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.
7. ABUSE AND MISUSE OF ACCESS AND UNAUTHORIZED ACCESS: Students may not abuse or misuse computer access or gain unauthorized access to information in any academic exercise. See Student Rule 22: http://student-rules.tamu.edu/
8. VIOLATION OF DEPARTMENTAL OR COLLEGE RULES: Students may not violate any announced departmental or college rule relating to academic matters.
9. UNIVERSITY RULES ON RESEARCH: Students involved in conducting research and/or scholarly activities at Texas A&M University must also adhere to standards set forth in University Rule 15.99.03.M1 - Responsible Conduct in Research and Scholarship. For additional information please see: https://aggiehonor.tamu.edu/Rules-and-Procedures/Rules/Honor-System-Rules

Academic Integrity Statement and Policy:
"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20). You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at https://aggiehonor.tamu.edu/.

Copyright Statement:
The materials used in this course are copyrighted. These materials include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless permission is expressly granted.

Plagiarism Statement:
As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, http://student-rules.tamu.edu, under the section "Scholastic Dishonesty."

University Writing Center:
The mission of the University Writing Center (UWC) is to help you develop and refine the communication skills vital to success in college and beyond. Currently, you can choose to work with a trained UWC peer consultant via web conference or email. You can schedule an appointment to discuss any kind of writing or speaking project, including research papers, lab reports, application essays, or creative writing. Our consultants can work with you at any stage of your process, whether you're deciding on a topic or reviewing your final draft. You can also get help with public speaking, presentations, and group projects. To schedule an appointment or to view our handouts, videos, or interactive learning modules, visit http://writingcenter.tamu.edu. Questions? Call 979-458-1455 or email uwc@tamu.edu.
Title IX and Statement on Limits to Confidentiality:
Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

1. The incident is reasonably believed to be discrimination or harassment.
2. The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

Statement on Mental Health and Wellness:
Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at https://suicidepreventionlifeline.org/.

COVID-19 Temporary Amendment to Minimum Syllabus Requirements:
The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

Campus Safety Measures:
To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

1. Self-monitoring—Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
2. Face Coverings—Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.
3. Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
4. Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
5. To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

Personal Illness and Quarantine:
Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.3.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.
Policies and Procedures:

Total = 100 percent

Basis for Grade:  
- A: > 90
- B: 89.99 to 80
- C: 79.99 to 70
- D: 69.99 to 60
- F: < 59.99

3. Other text materials:

2. Journal articles (to be made available in electronic formats)

1. Course materials for this semester are located at:

   Course and Reference Materials:

1. Lee, W.J. and Wattenbarger, R.A.: Gas Reservoir Engineering, SPE (1996). [Available at MSC Bookstore, can also be ordered directly from SPE (probably at reduced rates), you must be an SPE member — SPE +1.800.456.6863]

   Required Text:

   Petroleum Engineering 613 Instructor: Dr. Tom BLASINGAME TA: Alex VALDES-PEREZ

   Natural Gas Engineering Office: Richardson 821A Office: Richardson 821

   Texas A&M University/College of Engineering t-blasingame@tamu.edu arvaldesp1987@tamu.edu

   Mon/Wed 19:55-21:10 RICH 319 (this course will be mostly off-line, in-class lectures will only be held with notification by instructor)

   Required Text:

   1. Lee, W.J. and Wattenbarger, R.A.: Gas Reservoir Engineering, SPE (1996). [Available at MSC Bookstore, can also be ordered directly from SPE (probably at reduced rates), you must be an SPE member — SPE +1.800.456.6863]

   2. Journal articles (to be made available in electronic formats)

   3. Other text materials:

   - Kerr, R. N. and W. F. Black, Reservoir Engineering, SPE (1996). [Available at MSC Bookstore, can also be ordered directly from SPE (probably at reduced rates), you must be an SPE member — SPE +1.800.456.6863]

   Reading Portfolio ................................................................. [due: Monday 23 April 2018 by 5:00 p.m. (i.e., 16:59:59 US CST)] 15 percent
   Homework Portfolio ............................................................ [due: Monday 30 April 2018 by 5:00 p.m. (i.e., 16:59:59 US CST)] 60 percent
   Final Examination .............................................................. [due: Thursday 03 May 2018 by 8:00 p.m. (i.e., 19:59:59 US CST)] 25 percent
   Total = 100 percent

   Policies and Procedures:

   1. Class meetings may be irregular during the term — students will be notified in advance by the instructor for dates when the class will physically meet in the classroom. Students are expected to attend class every session when the instructor calls for a class meeting. Resident (not Distance Learning students) are REQUIRED to attend class every session (as called by the instructor). Distance Learning students are expected review lecture materials within 24 hours of the lecture being given. For sessions which are physically held in the classroom, attendance is not a casual requirement, penalties can and will be assigned for missing class.

   2. Policy on Grading
   - All work in this course is graded on the basis of answers only — any partial credit is at the discretion of the instructor.
   - All work requiring calculations shall be properly and completely documented for credit.
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   - Only in very rare cases will exams be considered for re-grading — partial credit (if any) is not subject to appeal.
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   4. The grade for a late assignment is zero. Homework will be considered late if it is not turned in at the start of class on the due date. If a student comes to class after homework has been turned in and after class has begun, the student's homework will be considered late and given a grade of zero. Late or not, all assignments must be turned in. A course grade of Incomplete will be given if any assignment is missing, and this grade will be changed only after all required work has been submitted.

   5. Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an examination or collaborating on an assignment where collaboration is not specifically authorized by the instructor will be removed from the class roster and given an F (failure grade) in the course.
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- Work Requirements: You must show ALL work — as appropriate, YOU MUST:
  - WORK: You must show all details in your calculations (no skipped steps), all portions of all analysis relations must be shown.
  - UNITS: You must show all units in all calculations.
  - TYPING: Students must provide work products which are TYPED, no handwritten work will be accepted.
  - SCANNING: If a document is scanned, a scanner of at least 30 dpi AND color is required.
  - PHOTOS: DO NOT SUBMIT PHOTOS for "scanning" documents (photos will not be accepted).

- Work Layout: (appropriate for a given problem)
  - NEATNESS: You will be graded on the neatness of your work.
  - LABELS: All work, trends, and features on every plot MUST be appropriately labeled — no exceptions.
    - Work: All work must be fully labeled and documented — equations, relations, calculations, etc.
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  - LINES: Use lines to represent models.
  - COLORS: Use black for all axes and gridlines. Use primary colors (red, green, blue), avoid pastel colors.
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    - etc.: Please do NOT use a border or "frame" around your plots.

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The expectation of the instructor (Blasingame) is that "perfection is the standard" — in other words, your work will be judged against a perfect standard. If your submission is not your very best work, then don't submit it. You must only submit only your very best work.

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e-mail Protocols

In order to manage your correspondence, I require that you use the following protocol.

Subject Line: [YYYYMMDD] [YOURLASTNAME] Subject (date) (your last name) (Subject of your e-mail)

Body:

Dr. BLASINGAME:

I would like to enquire about the following:
* Question 1 ... (be clear and concise)
* Question 2 ... (be clear and concise)
* Question 3 ... (be clear and concise)

I thank you for your assistance.

YourFirstName YOURLASTNAME
E: (TAMU)
E: (personal)
T: (a phone contact) (I will NEVER call you without first sending an e-mail or text)

Comments:

- DO NOT FORWARD/REPLY TO EMAILS FROM ECAMPUS — SEND A NEW NOTE.
- The subject line is used to file e-mail (this is why this specific subject line is required).
- Every effort will be made to answer every e-mail, but PLEASE avoid trivial enquiries (consult the syllabus for "administrative" issues).
- I am more than happy to address questions by e-mail — i.e., issues/errors/etc. and/or need help with something relevant to the course.
- Courier New 10pt Bold font is required.

Computational Tools:

In this course you are NOT required to work in a particular computational environment. However, you should be/must be proficient at whatever computational tool(s) you use for work in this course. Example products/computational environments include

- MS Excel or Visual Basic (VB) via MS Excel.
- MATLAB (http://www.mathworks.com/products/matlab/).
- Mathematica (https://www.wolfram.com/mathematica/).
- Programming Languages: C++, FORTRAN, Pascal, machine language, the Univac, an abacus, etc.

Please note that YOU are RESPONSIBLE for your computer-aided solutions. Depending on the assignment you may be asked for a copy of your source code and should provide relevant commentary/documentation in your source code sufficient for your work to be traced. You will also be asked for an outline/workflow for any/all computational solutions.
Course Description

Graduate Catalog: Flow of natural gas in reservoirs and in wellbores and gathering systems; deliverability testing; production forecasting and decline curves; flow measurement and compressor sizing.

Translation: From the reservoir through the sales line—we will try to study every aspect of natural gas systems. PVT properties, flow in porous media, flow in pipes and thermodynamic properties will be studied. We will use the Lee and Wattenbarger and the ERCB texts as guides — as well as numerous technical papers that go into much more depth of detail for a particular problem. We will focus on well testing, deliverability analysis, and decline curve analysis, as well as wellbore flow phenomena.

Prerequisites by Topic:

Differential and integral calculus, Ordinary and partial differential equations, Thermodynamics, Fluid dynamics and heat transfer, Reservoir fluid properties, and Reservoir petrophysics.

Instructor Responsibilities

The instructor is responsible for

● A learning environment where students of all skills levels are appropriately challenged.
● Showing respect and consideration to the students.
● Being prepared for class and keeping on schedule with the syllabus.
● Preparing exercises that follow the course objectives.
● Covering the material that will be tested on exams.

The instructor is not responsible for

● Work missed by absent students (unless a University-excused absence is provided to the instructor).
● Poor performance by inattentive or uninterested students. This is a fundamental course in Reservoir Engineering, one that you will use actively in your career as a reservoir or production engineer.
● Personal issues — if you have personal issues that impair your performance in this course, you are encouraged to discuss these problems with your instructor for possible remedies. However, the instructor is responsible for assigning your grade based solely on your performance and is not at liberty to allow personal appeals to influence your grade.

Student Responsibilities

The student is responsible for

● Class attendance. Students should attend all scheduled class meetings.
● Being prepared for class. In-class quizzes could be given. Always bring your books, course notes, and calculator to each class meeting.
● Being prepared for exams.
● Showing respect and consideration to his classmates and the instructor. Do not talk excessively with your neighbors during class. Do not take up class time for discussions with the instructor that should be held outside of class. Students who disrupt the class will be asked to leave.
Americans with Disabilities Act (ADA) Statement:
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu

Aggie Honor Code: (http://www.tamu.edu/aggiehonor/)
"An Aggie does not lie, cheat or steal, or tolerate those who do."

Definitions of Academic Misconduct:
- CHEATING: Intentionally using or attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
- FABRICATION: Making up data or results, and recording or reporting them; submitting fabricated documents.
- FALSIFICATION: Manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
- MULTIPLE SUBMISSION: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from the instructor of the class for which the student submits the work.
- PLAGIARISM: The appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
- COMPLICITY: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.
- ABUSE AND MISUSE OF ACCESS AND UNAUTHORIZED ACCESS: Students may not abuse or misuse computer access or gain unauthorized access to information in any academic exercise. See Student Rule 22: http://student-rules.tamu.edu/
- VIOLATION OF DEPARTMENTAL OR COLLEGE RULES: Students may not violate any announced departmental or college rule relating to academic matters.
- UNIVERSITY RULES ON RESEARCH: Students involved in conducting research and/or scholarly activities at Texas A&M University must also adhere to standards set forth in the University Rules.

For additional information please see:
http://student-rules.tamu.edu/.

Coursework Copyright Statement: (Texas A&M University Policy Statement)
The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy them, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."
Assignment Coversheet

This sheet (or the sheet provided for a given assignment) must be included with EACH work submission.

Required Academic Integrity Statement: (Texas A&M University Policy Statement)

Academic Integrity Statement

All syllabi shall contain a section that states the Aggie Honor Code and refers the student to the Honor Council Rules and Procedures on the web.

Aggie Honor Code

"An Aggie does not lie, cheat, or steal or tolerate those who do."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: www.tamu.edu/aggiehonor/

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

Aggie Code of Honor:

An Aggie does not lie, cheat, or steal or tolerate those who do.

Required Academic Integrity Statement:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

_______________________________ (Print your name)

_______________________________ (Your signature)
Petroleum Engineering 613 — Natural Gas Engineering
Course Description, Prerequisites by Topic, and Course Objectives
Spring 2018 (Spring Break: 12-16 March 2018)

Date | Topic | Reading | Instructor
--- | --- | --- | ---
January 15 | Mon | Martin Luther King Day — University Holiday |  
17 | Wed | Course Introduction/Review of Syllabus (Syllabus — Spring 2018) | Blasingame
| | Introduction: historical perspectives, concepts, data, etc. | ERCB Ch. 1, Katz Ch. 1-2,9 | Blasingame
22 | Mon | Properties of Natural Gases | ERCB App. A, LW Ch. 1, Katz Ch. 3-5,12 | Blasingame
24 | Wed | Properties of Natural Gases | ERCB App. A, LW Ch. 1, Katz Ch. 3-5,12 | Blasingame
29 | Mon | Gas Flow Measurement | LW Ch. 3, Katz Ch. 8 | Blasingame
31 | Wed | Gas Flow Measurement | LW Ch. 3, Katz Ch. 8 | Blasingame
February 05 | Mon | Gas Flow in Wellbores | ERCB App. B, LW Ch. 4, Katz Ch. 7 | Blasingame
07 | Wed | Gas Flow in Wellbores | ERCB App. B, LW Ch. 4, Katz Ch. 7 | Blasingame
12 | Mon | Fundamentals of Fluid Flow in Porous Media | ERCB Ch. 2, LW Ch. 5, Katz Ch. 10 | Blasingame
14 | Wed | Fundamentals of Fluid Flow in Porous Media | ERCB Ch. 2, LW Ch. 5, Katz Ch. 10 | Blasingame
19 | Mon | Pressure-Transient Testing of Gas Wells (Introduction) | ERCB Ch. 4-7, LW Ch. 6, Katz Ch. 10 | Blasingame
21 | Wed | Pressure-Transient Testing of Gas Wells (Diagonostics) | ERCB Ch. 4-7, LW Ch. 6, Katz Ch. 10 | Blasingame
26 | Mon | Pressure-Transient Testing of Gas Wells (Drawdown tests) | ERCB Ch. 4-7, LW Ch. 6, Katz Ch. 10 | Blasingame
28 | Wed | Pressure-Transient Testing of Gas Wells (Buildup tests) | ERCB Ch. 4-7, LW Ch. 6, Katz Ch. 10 | Blasingame
March 05 | Mon | IPR concepts for gas wells | ERCB Ch. 3, LW Ch. 4 | Blasingame
07 | Wed | IPR concepts for gas wells | ERCB Ch. 3, LW Ch. 4 | Blasingame
Spring Break: 12-16 March 2018
19 | Mon | Deliverability testing of gas wells (Introduction) | Hnd (Rawlins/Schellhardt), Katz Ch. 9,11 | Blasingame
21 | Wed | Deliverability testing of gas wells (simplified methods) | ERCB Ch. 3, LW Ch. 7, Katz Ch. 9,11 | Blasingame
26 | Mon | Deliverability testing of gas wells (advanced methods) | ERCB Ch. 3, LW Ch. 7, Katz Ch. 9,11 | Blasingame
28 | Wed | Deliverability testing of gas wells (advanced methods) | ERCB Ch. 3, LW Ch. 7, Katz Ch. 9,11 | Blasingame
30 | Fri | Reading Day (No Classes — Good Friday) |  
April 02 | Mon | Decline-Curve Analysis for Gas Wells (Introduction/Historical Considerations) | LW Ch. 9 | Blasingame
04 | Wed | Decline-Curve Analysis for Gas Wells (Advanced Decline Curve Analysis) | TBD | Blasingame
09 | Mon | Decline-Curve Analysis for Gas Wells (Fetkovich Decline Type Curve) | LW Ch. 9 | Blasingame
11 | Wed | Decline-Curve Analysis for Gas Wells (Carter Decline Type Curve) | LW Ch. 9 | Blasingame
16 | Mon | Gas Volumes and Material-Balance Calculations (Dry Gas) | LW Ch. 10 | Blasingame
18 | Wed | Gas Volumes and Material-Balance Calculations (Water Influx) | LW Ch. 10 | Blasingame
23 | Mon | Reading Portfolio submission is due. | [Monday 23 April 2018 [by 5:00 p.m. (i.e., 16:59:59 US CST)] |  
23 | Mon | Gas Volumes and Material-Balance Calculations (Geopressured) | LW Ch. 10 | Blasingame
25 | Wed | Gas Volumes and Material-Balance Calculations (Gas Condensate) | LW Ch. 10 | Blasingame
30 | Mon | Course Closure |  
May 03 | Thu | Final Examination is due. (for classes held MW 7:55-9:10 p.m.) | [Thursday 03 May 2018 [by 8:00 p.m. (i.e., 19:59:59 US CST)] |  
Primary Text:

Supplemental Texts:

Supplemental Reference Materials:
Course Objectives

Chapter 1 — Properties of Natural Gases

<table>
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<th>Section</th>
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<tbody>
<tr>
<td>1.1</td>
<td>Introduction</td>
<td>1</td>
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<tr>
<td></td>
<td>● Be able to describe the chapter contents.</td>
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<tr>
<td>1.2</td>
<td>Review of Definitions and Fundamental Principles</td>
<td>1</td>
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<tr>
<td></td>
<td>● Be familiar with and be able to use the concept of moles and mole fractions.</td>
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<td>● Be familiar with and be able to use the ideal gas law.</td>
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<td></td>
<td>● Be able to derive Eq. 1.4.</td>
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<td></td>
<td>● Be familiar with and be able to use the real gas law.</td>
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<td>● Be able to state the Principle of Corresponding States in relation to &quot;certain gas properties.&quot;</td>
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<td></td>
<td>● Be able to use the concepts of reduced and pseudoreduced variables (Principle of Corresponding States).</td>
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<tr>
<td>1.3</td>
<td>Properties of Natural Gases</td>
<td>2</td>
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<tr>
<td></td>
<td>● Be familiar with and be able to use Table 1.1.</td>
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<tr>
<td></td>
<td>● Be able to calculate the apparent molecular weight of a gas mixture.</td>
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<td>● Be able to define and compute the specific gravity of a gas.</td>
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<tr>
<td>1.4</td>
<td>Calculation of Pseudocritical Gas Properties</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>● Be able to use the Stewart, Burkhart, and Voo (or Stewart et al.) method for sweet and sour natural gases.</td>
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<td></td>
<td>● Be able to use the Sutton method using gas specific gravity.</td>
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<td>● Be able to use the Wichert and Aziz method to correct pseudocriticals for H2S and CO2 contamination.</td>
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<tr>
<td></td>
<td>● Be able to use the correct pseudocriticals for N2 and H2O contamination.</td>
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<tr>
<td></td>
<td>● Be able to use Eqs. 1.37 or 1.38 with 1.39a and 1.39b to estimate the specific gravity of a reservoir gas.</td>
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<td></td>
<td>● Be able to estimate the total gas flowrate using wellstream gas gravity and correlations (Example 1.9).</td>
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<td></td>
<td>● Be able to use the &quot;Systematic Procedure for Calculating Pseudocritical Gas Properties&quot; given on p. 15.</td>
<td></td>
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<tr>
<td>1.5</td>
<td>Dranchuk and Abou-Kassem Correlation for z Factor</td>
<td>16</td>
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<tr>
<td></td>
<td>● Be able to use the graphical solution for the Dranchuk and Abou-Kassem (DAK) correlation (Figs. 1.7 and 1.8).</td>
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<tr>
<td></td>
<td>● Be able to use the Dranchuk and Abou-Kassem (DAK) equation-of-state (EOS) (given on p. 274, Appendix A).</td>
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<tr>
<td>1.6</td>
<td>Gas Formation Volume Factor (FVF)</td>
<td>16</td>
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<tr>
<td></td>
<td>● Be able to derive the gas formation volume factor (Bg) from first principles.</td>
<td></td>
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<tr>
<td></td>
<td>● Be able to estimate the gas formation volume factor (Bg) given gas composition or gas specific gravity.</td>
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<tr>
<td>1.7</td>
<td>Gas Density</td>
<td>17</td>
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<tr>
<td></td>
<td>● Be able to derive the gas density (ρg) from first principles.</td>
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<tr>
<td></td>
<td>● Be able to estimate the gas density (ρg) given gas composition or gas specific gravity.</td>
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<tr>
<td>1.8</td>
<td>Gas Compressibility</td>
<td>17</td>
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<tr>
<td></td>
<td>● Be able to derive the gas compressibility (cg) and the reduced gas compressibility (cr) from first principles.</td>
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<tr>
<td></td>
<td>● Be able to estimate the gas compressibility (cg) given gas composition or gas specific gravity.</td>
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<tr>
<td>1.9</td>
<td>Gas Viscosity</td>
<td>18</td>
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<tr>
<td></td>
<td>● Be able to estimate the gas viscosity (μg) using the Lee, Gonzalez, Eakin (or Lee et al.) correlation.</td>
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<tr>
<td>1.10</td>
<td>Properties of Reservoir Oils</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>● For your own familiarity, not specifically covered in this course.</td>
<td></td>
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<tr>
<td>1.11</td>
<td>Properties of Reservoir Waters</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>● Be able to estimate the volume of solution gas which can be liberated from water.</td>
<td></td>
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<tr>
<td>1.12</td>
<td>Water Vapor Content of Gas</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>● Be able to estimate the water vapor content of a given gas sample.</td>
<td></td>
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<tr>
<td>1.13</td>
<td>Gas Hydrates</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>● Be able to describe the physical nature of a gas hydrate.</td>
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<td></td>
<td>● Be able to describe the conditions required for the formation of gas hydrates.</td>
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<tr>
<td>1.14</td>
<td>Pore Volume Compressibility Correlations</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>● Be familiar with the definition of pore volume compressibility (cρ = (1/ρ) [dρ/dp]l).</td>
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<td></td>
<td>● Be familiar with and be able to use the cρ correlations given by Eqs. 1.014-1.105.</td>
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<tr>
<td>1.15</td>
<td>Gas Turbulence Factor and Non-Darcy Flow Coefficient</td>
<td>32</td>
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<tr>
<td></td>
<td>● Be familiar with the non-Darcy flow formulation given by Eq. 1.106.</td>
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<td></td>
<td>● Be familiar with and be able to use the &quot;Jones&quot; correlation to estimate the β-non-Darcy flow parameter.</td>
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<tr>
<td>1.16</td>
<td>Summary</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>● Be familiar with and be able to perform the &quot;summary&quot; tasks as proposed by the authors.</td>
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<tr>
<td></td>
<td>● Be familiar with and be able to answer the &quot;Questions for Discussion&quot; as proposed by the authors.</td>
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## Course Objectives

### Chapter 3 — Gas Flow Measurement

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<tr>
<td>3.1</td>
<td>Introduction</td>
<td>43</td>
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<tr>
<td></td>
<td>- Be able to describe and state the reasons for gas flow measurement.</td>
<td></td>
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<tr>
<td></td>
<td>- Be familiar with the typical &quot;dynamic&quot; flow meters used for gas flow measurement.</td>
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<tr>
<td>3.2</td>
<td>Orifice Meters</td>
<td>43</td>
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<tr>
<td></td>
<td>- Be familiar with the governing equation for the orifice meter (Eq. 2.23).</td>
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<td>- Be familiar with and be able to derive Eq. 3.8.</td>
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<td></td>
<td>- Be able to explain the basis and terms in Eq. 3.9 (and 3.10).</td>
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<td>- Be able to compute the $C'$ factor (i.e., the orifice flow constant) for a given orifice meter installation.</td>
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<td>- Be able to reproduce Example 3.1 in complete detail (i.e., demonstrate the capability to estimate all terms)</td>
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<tr>
<td>3.3</td>
<td>Orifice Meter Installation</td>
<td>47</td>
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<tr>
<td></td>
<td>- Be familiar with and be able to explain Figs. 3.1 and 3.2.</td>
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<td></td>
<td>- Be familiar with the typical installation of an orifice meter system (location, dimensions, etc.).</td>
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<tr>
<td>3.4</td>
<td>Critical Flow Prover</td>
<td>53</td>
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<tr>
<td></td>
<td>- Be familiar with and able to explain the &quot;critical flow prover&quot; — its basis and its typical applications.</td>
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<td></td>
<td>- Be able to use Eq. 3.13 to compute the gas flowrate for a &quot;critical flow prover.&quot;</td>
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<tr>
<td>3.5</td>
<td>Choke Nipples</td>
<td>53</td>
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<td></td>
<td>- Be familiar with and able to explain the &quot;choke nipple.&quot;</td>
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<td></td>
<td>- Be able to use Eq. 3.13 to compute the gas flowrate for a &quot;choke nipple.&quot;</td>
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<tr>
<td>3.6</td>
<td>Pitot Tube</td>
<td>54</td>
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<tr>
<td></td>
<td>- Be able to explain the concept of estimating the gas flowrate using a &quot;pitot tube.&quot;</td>
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<tr>
<td></td>
<td>- Be able to explain the typical application of gas measurement using a &quot;pitot tube.&quot;</td>
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### Chapter 4 — Gas Flow in Wellbores

<table>
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<tr>
<td>4.1</td>
<td>Introduction</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>- Be able to explain (in simple terms) the methods for predicting the flowing and static pressures in gas wells</td>
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<td>- Be familiar with the limiting assumptions for each method used to predict bottomhole pressures.</td>
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<td>4.2</td>
<td>BHP Calculations for Dry Gas Wells</td>
<td>58</td>
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<tr>
<td></td>
<td>- Be able to explain the need for accurate flowing and static bottomhole pressures in reservoir engineering.</td>
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<td>- Be familiar with Eq. 2.26.</td>
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<td>- Be able to derive Eq. 4.8 for a STATIC gas column, and be able to state all relevant assumptions.</td>
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<td>- Be able to apply the &quot;Average Temperature and $z$-Factor Method&quot; for BHSP (and explain any limitations).</td>
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<td></td>
<td>- Be able to apply &quot;Poettmann's Method&quot; for BHSP (and explain any limitations).</td>
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<td></td>
<td>- Be able to apply the &quot;Cullender and Smith Method&quot; for BHSP (and explain any limitations).</td>
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<td>- Be able to derive Eq. 4.19 from Eq. 4.8 (this is the basis for the Cullender and Smith Method for BHSP's).</td>
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<td>- Be able to derive Eq. 4.25 (basis for all single-phase gas BHP calculations).</td>
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<td>- Be familiar with and be able to use Figs. 4.2 and 4.3.</td>
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<td></td>
<td>- Be able to apply the &quot;Average Temperature and $z$-Factor Method&quot; for BHP (and explain any limitations).</td>
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<td>- Be able to apply the &quot;Sukkar and Cornell Method&quot; for BHF (and explain any limitations).</td>
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<tr>
<td></td>
<td>- Be able to apply the &quot;Cullender and Smith Method&quot; for BHF (and explain any limitations).</td>
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<tr>
<td>4.3</td>
<td>Effect of Liquids on BHP Calculations</td>
<td>66</td>
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<tr>
<td></td>
<td>- Be able to explain (in simple terms) the influence of liquids on the calculation of BHF in gas wells.</td>
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<tr>
<td>4.4</td>
<td>Evaluating Gas-Well Production Performance</td>
<td>73</td>
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<td>- Be able to state the typical factors which affect the production performance of gas wells.</td>
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<td></td>
<td>- Be able to explain the concept of an inflow performance relation (or IPR) and the controlling factors for IPRs.</td>
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<td></td>
<td>- Be able to sketch a typical IPR curve for a gas well.</td>
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<td>- Be familiar with and be able to analyze data from a &quot;Four-Point Deliverability Test.&quot;</td>
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<td>- Be able to sketch a typical Four-Point Deliverability Test plot for a gas well.</td>
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<td>- Be able to explain the concept of a &quot;Tubing Performance Curve&quot; as illustrated in Figs. 4.18 and 4.19.</td>
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<td>- Be able to construct a &quot;Tubing Performance Curve&quot; for a dry gas well.</td>
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<tr>
<td>4.5</td>
<td>Forecasting Gas-Well Performance</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>- Be able to construct a production forecast for a dry gas well using an IPR and a tubing performance curve.</td>
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</tr>
<tr>
<td>4.6</td>
<td>Summary</td>
<td>77</td>
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<tr>
<td></td>
<td>- Be able to explain the uses of surface and calculated bottomhole pressures (static and flowing).</td>
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<tr>
<td></td>
<td>- Be able to explain the deficiencies of estimating bottomhole pressures based on the materials in this Chapter.</td>
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</table>
Course Objectives

Chapter 5 — Fundamentals of Fluid Flow in Porous Media

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<tr>
<th>Section</th>
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<tbody>
<tr>
<td>5.1</td>
<td>Introduction</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>● Be familiar with the differential equations most often used to model unsteady-state fluid flow in porous media.</td>
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<tr>
<td></td>
<td>● Be familiar with the relevant solutions to these differential equations for applications in reservoir engineering.</td>
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<tr>
<td>5.2</td>
<td>Ideal-Reservoir Model</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>● Be familiar with derivation of the gas flow diffusivity equations (Eq. 5.39, 5.47, and 5.59).</td>
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<td>● Be familiar with the effect of pressure-dependent gas properties (see Figs. 5.2-57, inclusive).</td>
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<td></td>
<td>● Be familiar with the &quot;liquid form&quot; of the &quot;dimensionless&quot; diffusivity equation (Eq. 5.119).</td>
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<td></td>
<td>● Be familiar with the &quot;gas forms&quot; of the &quot;dimensionless&quot; diffusivity equation (Eqs. 5.137 and 5.154).</td>
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<tr>
<td>5.3</td>
<td>Solutions to the Diffusivity Equation</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>● Be familiar with the following solutions to the diffusivity equation which are relevant to reservoir engineering:</td>
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<tr>
<td></td>
<td>— The solution for a bounded cylindrical reservoir,</td>
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<td></td>
<td>— The solution for an infinite-acting reservoir with a well treated as a line source with zero wellbore radius,</td>
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<tr>
<td></td>
<td>— The pseudosteady-state solution, and</td>
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<td></td>
<td>— The solution that includes wellbore storage for a well in an infinite-acting reservoir.</td>
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<td></td>
<td>● Be familiar with and be able to use Eqs. 5.161 (and/or 5.169) and 5.172.</td>
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<td></td>
<td>● Be familiar with the &quot;Exponential Integral&quot; (or Ei) function.</td>
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<td>● Be familiar the concept of a near-well damage (or skin) zone (see Fig. 5.8).</td>
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<td></td>
<td>● Be familiar the concept of a bounded circular (cylindrical) reservoir at &quot;pseudosteady-state&quot; flow conditions.</td>
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<td></td>
<td>● Be familiar with and be able to use Eqs. 5.173 and 5.178.</td>
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<td>● Be familiar with and be able to explain Figs. 5.9 and 5.10.</td>
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<td></td>
<td>● Be familiar with Eq. 5.187 for pseudosteady-state flow in a generalized reservoir geometry.</td>
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<td>● Be familiar with and be able to use Eq. 5.190 to predict the beginning of pseudosteady-state flow.</td>
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<td>● Be familiar with the concept of &quot;wellbore storage&quot; — and be able to explain Fig. 5.11.</td>
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<td></td>
<td>● Be able to derive the &quot;wellbore storage&quot; rate relations depicted by Figs. 5.12 (Eq. 5.197) and 5.13 (Eq. 5.205).</td>
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<tr>
<td>5.4</td>
<td>Radius of Investigation</td>
<td>99</td>
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<tr>
<td></td>
<td>● Be familiar with the concept of the &quot;radius of investigation&quot; for a transient radial flow system.</td>
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<td>● Be familiar and be able to use Eq. 5.220.</td>
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<tr>
<td>5.5</td>
<td>Horner's Approximation</td>
<td>103</td>
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<tr>
<td></td>
<td>● Be familiar with and be able to use the so-called &quot;Horner&quot; approximation for production time in a buildup test.</td>
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<td>● Be familiar with the guidelines on rates before shut-in.</td>
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<tr>
<td>5.6</td>
<td>van Everdingen-Hurst Solutions to the Diffusivity Equation</td>
<td>103</td>
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<tr>
<td></td>
<td>● Be familiar with and be able to apply the following reservoir models/conditions:</td>
<td></td>
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<tr>
<td></td>
<td>— Constant-Rate Production: No-Flow Outer Reservoir Boundaries.</td>
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<tr>
<td></td>
<td>— Constant-Rate Production: Constant-Pressure Outer Reservoir Boundaries.</td>
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<tr>
<td></td>
<td>— Production at Constant BHP</td>
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</tr>
<tr>
<td>5.7</td>
<td>Summary</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>● Be able to answer all of the elements for fluid flow in porous media as stated in the summary of this chapter.</td>
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<td></td>
<td>● Be able to address the &quot;Questions for Discussion&quot; section in this chapter.</td>
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## Course Objectives

### Chapter 6 — Pressure-Transient Testing of Gas Wells

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<td>Introduction</td>
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<tr>
<td></td>
<td>Be familiar with the underlying theory and practical applications of pressure-transient testing in gas wells.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Be familiar with and be able to apply &quot;conventional&quot; semi-log plots (infinite-acting radial flow system).</td>
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<tr>
<td>6.2</td>
<td>Types and Purposes of Pressure-Transient Tests</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Be familiar with pressure buildup, drawdown, and falloff types of well tests (single well).</td>
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<tr>
<td>6.3</td>
<td>Homogeneous Reservoir Model-Slightly Compressible Liquids</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Be familiar with the governing theory and be able to apply Eq. 6.2 (i.e., the log[t] formulation).</td>
<td>[PDD]</td>
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<tr>
<td></td>
<td>Be able to develop/apply Eqs. 6.3 and 6.5 to estimate the permeability and &quot;skin factor&quot; (respectively).</td>
<td>[PDD]</td>
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<tr>
<td></td>
<td>Be familiar with the governing theory and be able to apply Eq. 6.7 (i.e., the &quot;Horner Time&quot; formulation).</td>
<td>[PBU]</td>
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<tr>
<td></td>
<td>Be able to develop/apply Eqs. 6.8 and 6.10 to estimate the permeability and &quot;skin factor&quot; (respectively).</td>
<td>[PBU]</td>
</tr>
<tr>
<td>6.4</td>
<td>Complications In Actual Tests</td>
<td>112</td>
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<td></td>
<td>Be familiar with and be able to apply the &quot;radius of investigation&quot; concept (Eqs. 6.12 and 6.13).</td>
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<td></td>
<td>Be familiar with and be able to identify the &quot;Early,&quot; &quot;Middle,&quot; and &quot;Late&quot; time features in well tests.</td>
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<td></td>
<td>Be familiar with and be able to explain the influence of &quot;Wellbore Storage&quot; in well tests.</td>
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<td></td>
<td>Be able to sketch Figs. 6.8 and 6.9 (illustrating the influence of wellbore storage on surface and sandface rates).</td>
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<td></td>
<td>Be able to develop/apply Eq. 6.17 from the system described by Fig. 6.10 (two-zone (radial) damage model).</td>
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<td></td>
<td>Be familiar with and be able to use the skin factor in the &quot;effective wellbore radius.&quot;</td>
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<td></td>
<td>Be familiar with and be able to use the skin &quot;pressure drop&quot; relation (Eq. 6.20).</td>
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<tr>
<td>6.4</td>
<td>Fundamentals of Pressure-Transient Testing In Gas Wells</td>
<td>115</td>
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<tr>
<td></td>
<td>Be familiar with the conventional &quot;pseudopressure&quot; (Eq. 6.21) and &quot;pseudotime&quot; (Eq. 6.22) variables.</td>
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<td></td>
<td>Be familiar with the &quot;adjusted pressure&quot; (Eq. 6.25) and &quot;adjusted time&quot; (Eq. 6.26) variables.</td>
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<td></td>
<td>Be familiar with the &quot;adjusted pressure/adjusted time&quot; formulation for a pressure drawdown test (Eq. 6.27).</td>
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<td></td>
<td>Be familiar with the &quot;adjusted time&quot; formulations for producing time (Eq.6.28) and shut-in time (Eq. 6.29).</td>
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<td></td>
<td>Be familiar with the components of Table 6.1 (working equations for pressure transient analysis in gas wells).</td>
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<td></td>
<td>Be familiar with the &quot;pressure-squared&quot; relations for the analysis of gas well tests (primarily Eq. 6.34).</td>
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<td>6.7</td>
<td>Analysis of Gas-Well Flow Tests</td>
<td>117</td>
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<tr>
<td></td>
<td>Be familiar with the typical flow conditions which occur in a prescribed well test.</td>
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<td></td>
<td>Be familiar with and be able to analyze the data from a &quot;constant rate flow test.&quot;</td>
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<td></td>
<td>Be familiar with and be able to apply Eqs. 6.41 and 6.43 (permeability and &quot;skin factor&quot; (respectively)).</td>
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<td>Be able to derive and apply Eq. 6.49 for the analysis of data from a &quot;variable-rate&quot; flow test.</td>
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<td></td>
<td>Be familiar with and be able to apply Eqs. 6.50 and 6.51 (permeability and &quot;skin factor&quot; (variable-rate system)).</td>
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<td></td>
<td>Be able to state the two major limitations of the proposed variable-rate analysis method.</td>
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<td>Be able to analyze pressure transient test data where the rate changes &quot;smoothly&quot; (state any assumptions).</td>
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<tr>
<td>6.8</td>
<td>Summary</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>Be able to state all of the elements for pressure transient testing as indicated in the summary of this chapter.</td>
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<td></td>
<td>Be able to address the &quot;Questions for Discussion&quot; section in this chapter.</td>
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Chapter 7 — Deliverability Testing of Gas Wells

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<td>7.1</td>
<td>Introduction</td>
<td>168</td>
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<tr>
<td></td>
<td>• Be familiar with the most common types of &quot;deliverability&quot; tests, and the associated variables/parameters.</td>
<td></td>
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<tr>
<td>7.2</td>
<td>Types and Purposes of Deliverability Tests</td>
<td>168</td>
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<tr>
<td></td>
<td>• Be familiar with and be able to describe the absolute open-flow (AOF) potential.</td>
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<td>• Be familiar with and be able to describe the inflow performance relationship (IPR) or gas backpressure curve.</td>
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<td></td>
<td>• Be familiar with the use(s) of the inflow performance relationship (IPR) curve.</td>
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<td>• Be familiar with and be able to describe how to conduct a &quot;flow-after-flow&quot; test.</td>
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<td>• Be familiar with and be able to describe a &quot;single point&quot; test.</td>
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<td>• Be familiar with and be able to describe the isochronal and modified isochronal test approaches.</td>
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<tr>
<td>7.3</td>
<td>Theory of Deliverability Test Analysis</td>
<td>168</td>
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<td></td>
<td>• Be familiar with and be able to describe the Houpeurt theoretical gas-flow equations.</td>
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<td>• Be familiar with and be able to describe the Rawlins and Schellhardt empirical gas flow equations.</td>
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<td>• Be able to describe the conditions of applicability for both the theoretical and empirical gas flow equations.</td>
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<td>• Theoretical Deliverability Equations:</td>
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<td></td>
<td>— Be able to describe the origin and nature of Eq. 7.1.</td>
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<td>— Be able to describe the assumptions applied to Eq. 7.1 that lead to Eq. 7.2.</td>
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<td>— Be able to describe the assumptions used to derive Eq. 7.6, and cite specific behavior of the ( \mu_c )-product.</td>
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<td>— Be familiar with the definition of pseudopressure as given by Eq. 7.7.</td>
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<td>— Be able to describe the assumptions applied to Eq. 7.1 that lead to Eq. 7.8, and cite the limiting assumptions.</td>
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<td>— Be familiar with and be able to apply the deliverability relations given by Eqs. 7.9 and 7.10.</td>
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<td>— Be familiar with and be able to apply the Houpeurt relations given by Eqs. 7.11 - 7.15. ((p_e)) form</td>
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<td></td>
<td>— Be familiar with and be able to apply the Houpeurt relations given by Eqs. 7.18 - 7.22. ((p_e)) form</td>
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<td></td>
<td>• Empirical Deliverability Equations:</td>
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<td></td>
<td>— Be familiar with and be able to apply the Rawlins-Schellhardt deliverability equation, Eq. 7.23. ((p_e)) form</td>
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<td></td>
<td>— Be familiar with and be able to apply the pseudopressure form of the Rawlins-Schellhardt relation, Eq. 7.24.</td>
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<td></td>
<td>— Be familiar with Houpeurt's comments regarding Eqs. 7.23 and 7.24.</td>
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<td>7.4</td>
<td>Stabilization Time</td>
<td>171</td>
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<tr>
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<td>• Be familiar with the definition of &quot;stabilization time&quot; as it relates to deliverability testing.</td>
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<td></td>
<td>• Be familiar with the use of the &quot;radius of investigation&quot; concept to define the &quot;stabilization time.&quot;</td>
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<td></td>
<td>• Be familiar with the modification of the &quot;stabilization time&quot; concept for hydraulically fractured wells.</td>
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<td>7.5</td>
<td>Analysis of Deliverability Tests</td>
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<td></td>
<td>• Flow-After-Flow Tests</td>
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<td></td>
<td>— Be able to sketch a schematic plot of rate and pressure for a &quot;flow-after-flow&quot; test.</td>
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<td>— Be able to describe the sequence of flowrates for a &quot;flow-after-flow&quot; test.</td>
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<td></td>
<td>— Be able to analyze &quot;flow-after-flow&quot; test data using the Rawlins-Schellhardt deliverability equation Eq. 7.24.</td>
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<td></td>
<td>— Be able to analyze &quot;flow-after-flow&quot; test data using the Houpeurt deliverability equation Eq. 7.12.</td>
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<td>• Single-Point Tests</td>
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<td></td>
<td>— Be familiar with the major limitations of a &quot;single point&quot; test ((i.e., \text{prior knowledge of well performance})).</td>
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<td>— Be able to analyze &quot;single point&quot; test data using the Rawlins-Schellhardt deliverability relations.</td>
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<td></td>
<td>— Be able to analyze &quot;single point&quot; test data using the Houpeurt deliverability relations.</td>
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<tr>
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<td>• Isochronal Tests</td>
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<td></td>
<td>— Be able to sketch a schematic plot of rate and pressure for an &quot;isochronal&quot; test.</td>
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<td></td>
<td>— Be able to understand and use the concept of a &quot;stabilized&quot; rate point for an isochronal test.</td>
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<td></td>
<td>— Be able to analyze &quot;isochronal&quot; test data using the Rawlins-Schellhardt deliverability relations.</td>
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<td></td>
<td>— Be able to analyze &quot;isochronal&quot; test data using the Houpeurt deliverability relations.</td>
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<td>• Modified Isochronal Tests</td>
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<td>— Be able to sketch a schematic plot of rate and pressure for a &quot;modified isochronal&quot; test.</td>
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<td></td>
<td>— Be able to understand and use the concept of a &quot;stabilized&quot; rate point for a modified isochronal test.</td>
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<td></td>
<td>— Be able to analyze &quot;modified isochronal&quot; test data using the Rawlins-Schellhardt deliverability relations.</td>
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<tr>
<td></td>
<td>— Be able to analyze &quot;modified isochronal&quot; test data using the Houpeurt deliverability relations.</td>
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<tr>
<td>7.6</td>
<td>Summary</td>
<td>189</td>
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<tr>
<td></td>
<td>• Be able to address each of the points given in the Summary section for Deliverability Testing.</td>
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<tr>
<td></td>
<td>• Be able to address the &quot;Questions for Discussion&quot; proposed in the Summary section for Deliverability Testing.</td>
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Chapter 9 — Decline-Curve Analysis for Gas Wells

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<td>Introduction</td>
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<td></td>
<td>• Be familiar with the &quot;Arps&quot; family of relations (exponential, hyperbolic, and harmonic decline relations).</td>
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<td>9.2</td>
<td>Introduction to Decline-Curve Analysis</td>
<td>214</td>
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<td></td>
<td>• Be familiar with the advantages and disadvantages of &quot;decline curve analysis.&quot;</td>
<td></td>
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<tr>
<td></td>
<td>• Be familiar with and be able to apply an &quot;abandonment&quot; or &quot;economic limit&quot; to a decline curve analysis case.</td>
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</tr>
<tr>
<td>9.3</td>
<td>Conventional Analysis Techniques</td>
<td>214</td>
</tr>
<tr>
<td></td>
<td>• Be familiar with and be able to apply the Arps' &quot;hyperbolic&quot; decline relation (Eq. 9.1).</td>
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<td></td>
<td>• Be familiar with the &quot;four important and widely violated assumptions&quot; for decline curve analysis.</td>
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<td></td>
<td>• Be able to sketch the Arps exponential, hyperbolic, and harmonic decline relations in terms of rate and log(rate).</td>
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<td></td>
<td>• Exponential Decline.</td>
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<tr>
<td></td>
<td>— Be able to state the form of the exponential rate decline relation (Eq. 9.2). (i.e., Eq. 9.1 assuming $b = 0$)</td>
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<tr>
<td></td>
<td>— Be able to derive Eq. 9.5 and explain its practical implications.</td>
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<tr>
<td></td>
<td>— Be able to derive Eq. 9.10 and explain its practical implications.</td>
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<tr>
<td></td>
<td>• Harmonic Decline.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>— Be able to state the form of the harmonic rate decline relation (Eq. 9.11). (i.e., Eq. 9.1 assuming $b = 1$)</td>
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<tr>
<td></td>
<td>— Be able to derive Eq. 9.15 and 9.16 and explain their practical implications.</td>
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<tr>
<td></td>
<td>• Hyperbolic Decline.</td>
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<tr>
<td></td>
<td>— Be able to state the form of the hyperbolic rate decline relation (Eq. 9.1)</td>
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<tr>
<td></td>
<td>— Be able to derive Eq. 9.21 and explain its practical implications (if any).</td>
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<tr>
<td>9.4</td>
<td>Decline Type Curves</td>
<td>219</td>
</tr>
<tr>
<td></td>
<td>• Be able to describe the concept of a &quot;decline type curve&quot;.</td>
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<tr>
<td></td>
<td>• Be able to state what (properties) can be obtained from a decline type curve match.</td>
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<td></td>
<td>• Fetkovich Decline Type Curve:</td>
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<tr>
<td></td>
<td>— Be able to sketch the Fetkovich &quot;rate/time decline type curve&quot; (i.e., Fig. 9.10).</td>
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<td></td>
<td>— Be able to state the specific assumptions associated with the Fetkovich &quot;rate/time decline type curve.&quot;</td>
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<td></td>
<td>— Be able to explain the specific flow regimes seen on the Fetkovich decline type curve.</td>
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<td></td>
<td>— Be familiar with and be able to apply the dimensionless variables given by Eqs. 9.22-9.24.</td>
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<td></td>
<td>— Be able to state the procedure to apply the Fetkovich decline curve to a given set of flowrate data.</td>
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<td></td>
<td>— Be able to demonstrate the solution of Example 9.2 (you must be able to reproduce all details).</td>
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<td></td>
<td>• Carter Decline Type Curve:</td>
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<td></td>
<td>— Be able to sketch the Carter &quot;rate/time decline type curve&quot; (i.e., Fig. 9.11).</td>
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<td></td>
<td>— Be able to state the specific assumptions associated with the Carter &quot;rate/time decline type curve.&quot;</td>
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<tr>
<td></td>
<td>— Be able to explain the specific flow regimes seen on the Carter decline type curve.</td>
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<td></td>
<td>— Be familiar with and be able to apply the dimensionless variables given by Eqs. 9.37-9.39.</td>
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<td></td>
<td>— Be able to state the procedure to apply the Carter decline curve to a given set of flowrate data.</td>
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<td></td>
<td>— Be able to demonstrate the solution of Example 9.3 (you must be able to reproduce all details).</td>
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<td></td>
<td>• Limitations of Decline Type Curves</td>
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<td></td>
<td>— Be able to explain the strengths and limitations of using &quot;decline type curve&quot; analysis.</td>
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<tr>
<td></td>
<td>— Be familiar with the issues for &quot;decline type curve&quot; analysis if boundary-dominated flow is NOT achieved.</td>
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<tr>
<td></td>
<td>— Be familiar with the limitations of &quot;decline type curve&quot; analysis for multi-well reservoir systems.</td>
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<tr>
<td>9.5</td>
<td>Summary</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>• Be able to describe the basic aspects of decline curve analysis (e.g., assumptions, derivations, applications).</td>
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</tr>
<tr>
<td></td>
<td>• Be able to address the &quot;Questions for Discussion&quot; section in this chapter.</td>
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</tbody>
</table>
## Course Objectives

### Chapter 10 — Gas Volumes and Material-Balance Calculations

<table>
<thead>
<tr>
<th>Section</th>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>Introduction</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>• Be able to state the primary goal of material balance. <em>(to estimate the in-place fluid volumes and recovery factor)</em></td>
<td></td>
</tr>
<tr>
<td>10.2</td>
<td>Volumetric Methods</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>• Be able to state the assumptions and applications of &quot;volumetric methods&quot; for estimation of in-place fluids.</td>
<td></td>
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<tr>
<td></td>
<td>• Be able to estimate gas-in-place for a volumetric dry-gas reservoir.</td>
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<td></td>
<td>• Be able to estimate gas-in-place for a dry-gas reservoir with water influx.</td>
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<tr>
<td></td>
<td>• Be able to estimate gas-in-place for a volumetric gas condensate reservoir.</td>
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</tr>
<tr>
<td>10.3</td>
<td>Material Balance Methods</td>
<td>234</td>
</tr>
<tr>
<td></td>
<td>• Be familiar with the history of material balance methods as applied in reservoir engineering.</td>
<td></td>
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<tr>
<td></td>
<td>• Be able to describe the process of performing a general material balance <em>(e.g., data, relations, plots, etc.)</em>.</td>
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<tr>
<td></td>
<td>• Be able to explain the dominant variable in material balance <em>(e.g., drive mechanism, reservoir pressure, etc.)</em>.</td>
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<tr>
<td></td>
<td>• Be able to sketch Fig. 10.5 in full detail.</td>
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<td></td>
<td>• Volumetric Dry-Gas Reservoirs:</td>
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<tr>
<td></td>
<td>— Be able to state the relevant assumptions for the material balance of a volumetric dry-gas reservoir.</td>
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<tr>
<td></td>
<td>— Be able to state the material balance for a volumetric dry-gas reservoir <em>(Eq. 10.29)</em>.</td>
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<td></td>
<td>— Be able to apply the material balance for a volumetric dry-gas reservoir.</td>
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<tr>
<td></td>
<td>• Dry-Gas Reservoirs With Water Influx:</td>
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<tr>
<td></td>
<td>— Be able to state the relevant assumptions for the material balance of a dry-gas reservoir with water influx.</td>
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<tr>
<td></td>
<td>— Be able to state the material balance for a dry-gas reservoir with water influx <em>(Eq. 10.32)</em>.</td>
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<tr>
<td></td>
<td>— Be able to apply the material balance for a dry-gas reservoir with water influx.</td>
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</tr>
<tr>
<td></td>
<td>— Be familiar with and be able to apply the van Everdingen-Hurst method for water influx estimation.</td>
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<tr>
<td></td>
<td>— Be familiar with and be able to apply the Carter-Tracy method for water influx estimation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>— Be familiar with and be able to apply the Fetkovich method for water influx estimation.</td>
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<tr>
<td></td>
<td>• Volumetric Geopressed Gas Reservoirs:</td>
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<tr>
<td></td>
<td>— Be able to state the relevant assumptions for the material balance of a volumetric geo-pressed gas reservoir.</td>
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</tr>
<tr>
<td></td>
<td>— Be able to state the material balance for a volumetric geo-pressed gas reservoir <em>(Eq. 10.90)</em>.</td>
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<tr>
<td></td>
<td>— Be able to apply the material balance for a volumetric geo-pressed gas reservoir.</td>
<td></td>
</tr>
<tr>
<td>10.4</td>
<td>Summary</td>
<td>251</td>
</tr>
<tr>
<td></td>
<td>• Be able to state and apply all of the material balance methods addressed in this chapter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Be able to address the &quot;Questions for Discussion&quot; section in this chapter.</td>
<td></td>
</tr>
</tbody>
</table>
Petroleum Engineering 613 — Natural Gas Engineering

Reading Portfolio

Due: Monday 23 April 2018 [by 5:00 p.m. (i.e., 16:59:59 US CST)]

Assignment Coversheet

[This sheet (or the sheet provided for a given assignment) must be included with EACH work submission]

Required Academic Integrity Statement: (Texas A&M University Policy Statement)

Academic Integrity Statement

All syllabi shall contain a section that states the Aggie Honor Code and refers the student to the Honor Council Rules and Procedures on the web.

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Required Academic Integrity Statement:

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____________________________________ (Print your name)

____________________________________ (Your signature)
Orientation — Reading Portfolio:
You are to use the Course Objectives/Study Guide included in this syllabus to create a "Reading Portfolio" — where this Reading Portfolio will simply be the "answers" to the points raised in each element of the Course Objectives/Study Guide. The student should extract the Course Objectives/Study Guide portion of the syllabus into a separate MS Word document, then simply add 2-3 "bullets" of answers per "Course Objective." The purpose of the Reading Portfolio is to ensure that the student reviews and comprehends each of the course objectives. It is strongly recommended that the student complete the Reading Portfolio in the first few weeks of the semester, prior to commencing work on the "Homework Portfolio" assigned in the next section of this syllabus.

Submission — Reading Portfolio:
- **Due date:** Monday 23 April 2018 [by 5:00 p.m. (i.e., 16:59:59 US CST)]
- **Submission:** Submit as a SINGLE .pdf file named P613_18A_YOURLASTNAME_ReadPort.pdf
- **Recipient:** Send to t-blasingame@tamu.edu (use TAMU "FILEX" system for very large files)

**Example Structure — Reading Portfolio:**
(… at least 2 (two) bullet points are required for each course objective)

**Chapter 1 — Properties of Natural Gases**

<table>
<thead>
<tr>
<th>Section</th>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Be able to describe the chapter contents.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This chapter presents methods for estimating reservoir fluid properties required for gas-reservoir-engineering calculations.</td>
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<tr>
<td></td>
<td>This chapter provides correlations for estimating properties of natural gases, and liquid hydrocarbons and formation waters.</td>
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<tr>
<td></td>
<td>Additional correlations are provided for estimating porosity volume compressibility and the non-Darcy flow coefficient.</td>
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</tr>
<tr>
<td>1.2</td>
<td>Review of Definitions and Fundamental Principles</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Be familiar with and be able to use the concept of moles and mole fractions.</td>
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<tr>
<td></td>
<td>Various definitions for molar quantities are given in this section.</td>
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<tr>
<td></td>
<td>Example units are pound-mole (lbm-mol), gram-mole, kilogram-mole, etc. (e.g., 1 lbm-mol of methane weighs 16.043 lbm).</td>
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<tr>
<td></td>
<td>The mole fraction of a mixture component is the # of pound-moles of the component/total # of moles in that mixture.</td>
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<tr>
<td></td>
<td>Be familiar with and be able to use the ideal gas law.</td>
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<tr>
<td></td>
<td>The defining properties of an ideal gas include the following:</td>
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<tr>
<td></td>
<td>1. The volume of the gas molecules is insignificant compared with the total volume enclosing the gas.</td>
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<td></td>
<td>2. No attractive or repulsive forces exist among the molecules or between the molecules and the container walls.</td>
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<td></td>
<td>3. All molecule collisions are perfectly elastic; i.e., there is no loss of internal energy upon collision.</td>
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<tr>
<td></td>
<td>The defining properties of an ideal gas include the following:</td>
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<tr>
<td></td>
<td>An equation of state (EOS) for a gas describes the relationship between the volume and the pressure and temperature.</td>
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<tr>
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<td>The ideal-gas EOS is developed using Boyle's law (mass at constant pressure) and Charles' law (volume/temperature ratio).</td>
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<tr>
<td></td>
<td>The ideal-gas EOS is given by: ( pV = nRT ).</td>
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</tbody>
</table>

**Additional Guidance — Reading Portfolio:**
- **Keep it Simple:**
  - Please keep it simple and limit the LENGTH of a given bullet to a single line. (easier to read, and keeps it simple)
  - Symbols and abbreviations are acceptable as shorthand to keep the length of a given bullet to a single line.
  - Please work in complete sentences.
- **Equations:**
  - You are NOT required to type-out a given equation(s).
  - You are permitted to simply reference equations in your bullet responses (e.g., "Eq. 4.xx").
- **Last Words:**
  - Please work in a consistent and coherent manner, please follow the example provided above.
  - 2 bullets is the minimum requirement, please try to provide 3-4 bullets per course objective.

**Reminder Guidance — Reading Portfolio:**
You must submit a SINGLE .pdf file to t-blasingame@tamu.edu by Mon 23 Apr 2018.
- You must type your Reading Portfolio. (no hand-written work is allowed)
- You are to provide at least 2 (two) bullet points for your "answers" for each course objective.
- You are required to work in MS Word or another publication quality word processing software (i.e., do NOT use MS Excel).
- The standard of submission must be near "publication quality," poor/fair quality work submissions will NOT be accepted.
- Your submission file must be named P613_18A_YOURLASTNAME_ReadPort.pdf.
Petroleum Engineering 613 — Natural Gas Engineering

Homework Portfolio Assignment

Due: Monday 30 April 2018 [by 5:00 p.m. (i.e., 16:59:59 US CST)]

Assignment Coversheet

[This sheet (or the sheet provided for a given assignment) must be included with EACH work submission]

Required Academic Integrity Statement: (Texas A&M University Policy Statement)

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_______________________________ (Print your name)

_______________________________ (Your signature)
Homework Portfolio Assignment

The purpose of a “work” portfolio is to ensure that the student has developed competent skills in the course objectives. The portfolio MUST be submitted, and will be assigned a numeric grade (0 to 100) at the discretion of the instructor. As the portfolio consists of “book” problems taken from the primary course text (i.e., the Lee and Wattenbarger text), the expectation is that each student will work each problem completely and independently (i.e., each student will create their own solution work). Students are permitted to communicate and collaborate — HOWEVER, students are not permitted to submit shared or copied work.

Since these are all “book” problems, the assessment of the instructor (or his designate) is final and is not open to negotiation or resubmission.

Assignment — Homework Portfolio:

- **Experiment**: Submit a SINGLE .pdf file named P613_18A_YOURLASTNAME_HomePort.pdf
- **Recipient**: Send to t-blasingame@tamu.edu (use TAMU "FILEX" system for very large files)
- **Due date**: Monday 30 April 2018 [by 5:00 p.m. (i.e., 16:59:59 US CST)]
- **Submission**: Submit as a SINGLE .pdf file named P613_18A_YOURLASTNAME_HomePort.pdf

### Chapter 1 — Properties of Natural Gases

**LW Exercise 1.1** — Calculate the gas flow rate through an orifice meter.


**LW Exercise 1.3** — Estimating Pseudocritical Properties for a Sour Gas With Sutton’s Correlations.

**LW Exercise 1.4** — Correcting Pseudocritical Properties for H2S and CO2 Contamination.

**LW Exercise 1.5** — Estimating Water Compressibility.

**LW Exercise 1.6** — Estimating Water Compressibility.

**LW Exercise 1.7** — Calculation of Water Vapor Content.

### Chapter 3 — Gas Flow in Wellbores

**LW Exercise 3.1** — Calculate the gas flow rate through an orifice meter.

**LW Exercise 3.2** — Critical Flow Prover Calculation

**LW Exercise 3.3** — Calulate the gas flow rate through an orifice meter.

**LW Exercise 3.4** — Describe each orifice factor and discuss why they are needed.

**LW Exercise 3.5** — Which orifice factors are commonly neglected? Why?

**LW Exercise 3.6** — Derive Eq. 3.7 from Eq. 3.6.

**LW Exercise 3.7** — Derive Eq. 3.8 from Eq. 3.7.

### Chapter 4 — Gas Flow in Wellbores

**LW Exercise 4.1** — Calculating BHSP With the Average Temperature and z-Factor Method.

**LW Exercise 4.2** — Calculating BHSP With the Cullender and Smith Method.

**LW Exercise 4.3** — Calculating BHSP With the Cullender and Smith Method.

**LW Exercise 4.4** — Calculating BHFP With the Average Temperature and z-Factor Method.

**LW Exercise 4.5** — Calculating BHFP With the Cullender and Smith Method.

**LW Exercise 4.6** — Calculating Gas-Well Inflow Performance.

**LW Exercise 4.7** — Calculating Tubing Performance Curve and Natural Flow Point for a Gas Well.

**LW Exercise 4.8** — Forecasting Flow Rates, Abandonment, and Reserves.

**Extra Problem Derive Eq. 4.25 in complete detail — give all assumptions and show all terms.**

### Chapter 5 — Fundamentals of Fluid Flow in Porous Media

**LW Exercise 5.1** — Calculating Pressures Beyond the Wellbore With the Ei-Function Solution

**LW Exercise 5.2** — Analysis of a Well PI Test

**LW Exercise 5.3** — Flow Analysis for Generalized Reservoir Geometries.

### Chapter 6 — Pressure-Transient Testing of Gas Wells

**LW Exercise 6.1** — Analysis of a Variable-Rate Gas Flow Test

**LW Exercise 6.2** — Analysis of a Gas-Well Pressure-Buildup Test (Constant-Rate Prod. Before Shut-In).

**LW Exercise 6.3** — Analysis of a Modern Isochronal Test with a Stabilized Flow Point.

### Chapter 7 — Deliverability Testing of Gas Wells

**LW Exercise 7.1** — Analysis of a Flow-After-Flow Test.

**LW Exercise 7.2** — Analysis of Isochronal Tests.

**LW Exercise 7.3** — Analysis of a Modified Isochronal Test with a Stabilized Flow Point.

### Chapter 8 — Decline-Curve Analysis for Gas Wells


**LW Exercise 8.2** — Decline-Curve Analysis With the Fetkovich Type Curves.

### Chapter 9 — Gas Volumes and Material-Balance Calculations

**LW Exercise 9.1** — Estimating Water Influx With the van Everdingen-Hurst Method.

**LW Exercise 9.2** — Est. Water Influx With the Carter-Tracy Method.

**LW Exercise 9.3** — Est. Water Influx With the Fethovich Method.


### Guidance on Homework Portfolio Assignment:

- You must submit a SINGLE .pdf file to t-blasingame@tamu.edu by Mon 30 Apr 2018.
- You must type your Homework Portfolio. (No handwritten work is allowed)
- Your work may include output from computer programs such as MS Excel, but this work must be clearly shown and documented.
- It is suggested that you create a “work file” in MS Word or MS PowerPoint to capture your work, then create a .pdf from this file.
- The standard of submission must be near “publication quality,” poor/fair quality work submissions will NOT be accepted.
- Your submission file must be named P613_18A_YOURLASTNAME_HomePort.pdf.
Petroleum Engineering 613 — Natural Gas Engineering

Final Examination

Due: Thu 03 May 2018 [by 8:00 p.m. (i.e., 19:59:59 US CST)]

Assignment Coversheet

[This sheet (or the sheet provided for a given assignment) must be included with EACH work submission]

Required Academic Integrity Statement: (Texas A&M University Policy Statement)

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__________________________________________ (Print your name)

__________________________________________ (Your signature)
Orientation — Final Exam:
The final examination for this course will consist of selected problems from the Lee and Wattenbarger text. The following guidelines/points of reference are provided to orient the student in their work:

- This assignment is the equivalent of a final exam:
  - Any collaboration will be treated as an act of scholastic dishonesty and will result in a failure grade for this project.
  - Any work that is not fully documented will be given no credit.
  - All work must be complete.
  - You must type your final examination, no handwritten work is permitted.

- Conduct/process:
  - You are encouraged to develop a "work" or "scratch" version, then refine into a version suitable for submission.

- Grading:
  - This material is equivalent of a final exam — grading will be fair, but not overly generous.
  - You must show all work — omissions, a lack of detail, and/or poorly formed work will be assessed as incorrect.

- Final Reminder:
  - This is the equivalent of a final exam — submit your VERY BEST work.
  - You are specifically forbidden from any collaboration — no communication/collaboration of any type is permitted.

Submission — Final Exam:
- Due date: Thursday 03 May 2018 [by 8:00 p.m. (i.e., 19:59:59 US CST)]
- Submission: Submit as a SINGLE .pdf file named P613_18A_YOURLASTNAME_FinalExam.pdf
- Recipient: Send to t-blasingame@tamu.edu (use TAMU "FILEX" system for very large files)

Assignment — Final Exam:
(10 problems total)

Chapter 1 — Properties of Natural Gases
- LW Exercise 1.2 — Calculation of gas properties. (you are to complete all of the tasks in this problem)

Chapter 2 — Decline-Curve Analysis for Gas Wells
- LW Exercise 2.1 — Use conventional decline curve analysis to predict rate behavior.
- LW Exercise 2.2 — Use the Fetkovich decline type curve to estimate permeability, skin factor, and predict future production.
- LW Exercise 2.3 — Obtain the stabilized AOF for this well using the Rawlins-Schellhardt and the Houpeurt analysis techniques.

Chapter 3 — Gas Flow Measurement
- LW Exercise 3.1 — Obtain the stabilized AOF for this well using the Rawlins-Schellhardt and the Houpeurt analysis techniques.

Chapter 4 — Gas Flow in Wellbores
- LW Exercise 4.4 — Calculate the average T and z factors as instructed.

Chapter 5 — Fundamentals of Fluid Flow in Porous Media
- LW Exercise 5.3 — Reservoir pressure profiles.

Chapter 6 — Pressure-Transient Testing of Gas Wells
- LW Exercise 6.1 — Analysis of a pressure drawdown test sequence.
- LW Exercise 6.2 — Analysis of a pressure buildup test sequence.

Chapter 7 — Deliverability Testing of Gas Wells
- LW Exercise 7.1 — Obtain the stabilized AOF for this well using the Rawlins-Schellhardt and the Houpeurt analysis techniques.

Chapter 8 — Fundamentals of Fluid Flow in Porous Media
- LW Exercise 8.1 — Use conventional decline curve analysis to predict rate behavior.
- LW Exercise 8.2 — Use the Fetkovich decline type curve to estimate permeability, skin factor, and predict future production.

Chapter 9 — Decline-Curve Analysis for Gas Wells
- LW Exercise 9.6 — Use conventional decline curve analysis to predict rate behavior.
- LW Exercise 9.7 — Use the Fetkovich decline type curve to estimate permeability, skin factor, and predict future production.

Chapter 10 — Gas Volumes and Material-Balance Calculations
- LW Exercise 10.8 — Original gas in place material-balance for geopressed and normally pressured reservoirs.

Guidance on Final Examination: You must submit a SINGLE .pdf file to t-blasingame@tamu.edu by 8:00 p.m. on Thu 03 May 2018.

- You must type your final examination. (no hand-written work is allowed)
- Your work may include output from computer programs such as MS Excel, but this work must be clearly shown and documented.
- It is suggested that you create a "work file" in MS Word or MS PowerPoint to capture your work, then create a .pdf from this file.
- The standard of submission must be near "publication quality," poor/fair quality work submissions will NOT be accepted.
- Your submission file must be named P613_18A_YOURLASTNAME_FinalExam.pdf.
"Reminder" Guidance — Reading Portfolio: You must submit a SINGLE .pdf file to t-blasingame@tamu.edu by Mon 23 Apr 2018.

- You must type your Reading Portfolio. (no hand-written work is allowed)
- You are to provide at least 2 (two) bullet points for your "answers" for each course objective.
- You are required to work in MS Word or another publication quality word processing software (i.e., do NOT use MS Excel).
- The standard of submission must be near "publication quality," poor/fair quality work submissions will NOT be accepted.
- Your submission file must be named P613_18A_YOURLASTNAME_ReadPort.pdf.

"Reminder" Guidance — Final Examination: You must submit a SINGLE .pdf file to t-blasingame@tamu.edu by 8:00 p.m. on Thu 03 May 2018.

- You must type your final examination. (no hand-written work is allowed)
- Your work may include output from computer programs such as MS Excel, but this work must be clearly shown and documented.
- It is suggested that you create a "work file" in MS Word or MS PowerPoint to capture your work, then create a .pdf from this file.
- The standard of submission must be near "publication quality," poor/fair quality work submissions will NOT be accepted.
- Your submission file must be named P613_18A_YOURLASTNAME_Final_Exam.pdf.

Additional Guidance — Homework Portfolio: (this guidance also applies to the Final Examination)

- Work Structure for Equations/Calculations:
  - State the equation being used (use MS Equation Editor 3 (preferred) or the standard MS Equation tool or MathType)
  - Provide a definition/statement of variables and the values of those variables (including units)
  - State the equation with all values and units.
  - State the answer including units.
- Structure for Plots:
  - LABELS: All work, trends, and features on every plot MUST be appropriately labeled — no exceptions.
  - Work: All work must be fully labeled and documented — equations, relations, calculations, etc.
  - Trends: This includes the slope, intercept, and the information used to construct a given trend.
  - Features: Any description of features/points of interest on a given trend (times, pressures, etc.).
- LINES: Use appropriate drafting care in construction of lines, trends, arrows, etc.
- SKETCHING: Take great care in any sketches you create/use in your work.
- SYMBOLS: Use symbols for "data" (if "data" are presented — e.g., reference solutions given as discrete data points).
- LINES: Use lines to represent models.
- COLORS: Use black for all axes and gridlines. Use primary colors (red, green, blue), AVOID pastel colors.
- EQUATIONS: If a line or model is presented on a given plot, you must present the equation, the variables, and the units.
- etc.: Please do NOT use a border or "frame" around your plots.
PETE 614 Course Syllabus, Spring 2021

Course Information

**Course Number:** PETE 614  
**Course Title:** Master’s Student Paper Contest  
**Sections:** 600  
**Time:**  
Saturday, January 30, 2021. Your attendance and participation are **required** for a satisfactory grade.  
**Location:**  
ZOOM  
**Credit Hours:** 0, Lecture 0 hr/wk, Lab 0hr/wk, participation 6 hrs on competition day

Instructor Details

**Instructor:** Dr. Duane McVay  
**Office:** RICH 407B  
**Phone:** (979) 862-8466  
**E-Mail:** mcvay@tamu.edu  
**Office Hours:** To be held by Alternate Instructor

**Alternate Instructor:** Ms. Gia Alexander  
**Office:** RICH 916G  
**Via ZOOM:** https://tamu.zoom.us/my/sarmah  
**E-Mail:** Gia.Alexander@tamu.edu  
**Phone:** (979) 847-8855  
**Office Hours:** Mondays and Wednesdays, 3:00-4:00 and by appointment.

Course Description

“Presentation of a technical petroleum engineering topic judged by petroleum professionals at the master’s graduate level department student paper contest.”

Course Prerequisites

MSc Graduate Classification

Course Objectives/Topics Covered

Specific objectives for your coursework in PETE 435 include the following:

1. Write, prepare, and deliver an effective visual presentation video based on your research on a relevant engineering problem in the petroleum industry.
2. Prepare to answer questions from an audience with directness and clarity.
3. Analyze and give constructive feedback on other oral presentation videos.

Textbook and/or Resource Materials

The following required course materials are provided in Canvas:


**SPE Student Paper Contest Judging Rubric for Graduate Students**

**SPE Student Paper Contest Rules**

**Course Completion and Grading Policy**

This course is graded on a **satisfactory/unsatisfactory** basis. You must complete **ALL** of the items below to earn a satisfactory grade in this course. The assignments and points possible are as follows:

1. **Delivery** of Your Presentation at the Student Paper Contest: 100 points
2. **Your All-Day Participation** at the Student Paper Contest: 100 points
3. Completion and Submittal of **Feedback Form**: 100 points
4. Upload of your **final slide deck** to TurnItIn after the competition: 100 points

**Special Alert**: If the judges at the Student Paper Contest deem your performance unsatisfactory because of time, content, or delivery, you will need to repeat the presentation to me and other faculty members to pass this course. Lack of effort on your part will result in an unsatisfactory grade.

**Learning Resources**

**Workshops**

We will have several voluntary virtual workshops prior to the competition. Please watch your official university email for times and ZOOM links.

**The University Writing Center**

The mission of the University Writing Center (UWC) is to help you develop and refine the communication skills vital to success in college and beyond. Currently, you can choose to work with a trained UWC peer consultant via web conference or email. You can schedule an appointment to discuss any kind of writing or speaking project, including research papers, lab reports, application essays, or creative writing. Our consultants can work with you at any stage of your process, whether you’re deciding on a topic or reviewing your final draft. You can also get help with public speaking, presentations, and group projects. To schedule an appointment or to view our handouts, videos, or interactive learning modules, visit [writingcenter.tamu.edu](http://writingcenter.tamu.edu). Questions? Call 979-458-1455 or email [uwc@tamu.edu](mailto:uwc@tamu.edu).
Class Civility and Communication Policies

Civility

Throughout our preparation and the upcoming competition, we will behave like the engineering professionals we are in accordance with our Aggie value of having a Community of Respect on our campus. We will remember that ours is a global industry, and we will respect cultural differences. If you disrupt class, I will log you out for the day and ask you to login and explain your behavior to me during office hours.

Communication

This course is dedicated to teaching you to communicate professionally. As such, you should approach correspondence with me and others in the course in a professional manner. All emails to me should include the course and section number in the subject line.

Social Media Policy

Please respect the following boundaries:

1. I will not be LinkedIn Contacts with you until after you have completed at least one course with me.
2. I will not be Facebook Friends with you as long as you are still in university.

University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

On your third unexcused/undocumented absence, you will have missed the equivalent of three weeks of class, and I will send your advisor an Excessive Absences report through Howdy.

You may attend the other section of this course if needed. For example, if you feel ill on Monday, you may log in on the Wednesday link instead. Conversely, if you know you have an interview on Wednesday afternoon, you may log into the Monday section. So that you get the correct credit for your Weekly Activity, please email me ahead of time whenever you need to swap logins.
Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor (Student Rule 7, Section 7.4.1).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual
harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

COVID-19 Temporary Amendment to Minimum Syllabus Requirements

Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):
• Self-monitoring—Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.

• Face Coverings—Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.

• Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

• Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.

• To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

Personal Illness and Quarantine

Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.

Operational Details for Fall 2020 Courses

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.

College and Department Policies

Please note that successful completion of this course is a requirement toward your Bachelor of Science in Petroleum Engineering at Texas A&M University as included on your degree plan.
Course Schedule

You will log into ZOOM by 8:25 on Saturday, January 30, 2021. In addition to giving your own presentation, you are expected to remain logged in to observe and give feedback to your peers.
PETE 615 Course Syllabus, Spring 2021

Course Information

Course Number: PETE 615  
Course Title: Doctoral Student Paper Contest  
Sections: 600  
Time:  
Saturday, January 30, 2021. Your attendance and participation are required for a satisfactory grade.  
Location:  
ZOOM  
Credit Hours: 0, Lecture 0 hr/wk, Lab 0hr/wk, participation 6 hrs on competition day

Instructor Details

Instructor: Dr. Duane McVay  
Office: RICH 407B  
Phone: (979) 862-8466  
E-Mail: mcvay@tamu.edu  
Office Hours: To be held by Alternate Instructor  

Alternate Instructor: Ms. Gia Alexander  
Office: RICH 916G  
Via ZOOM: https://tamu.zoom.us/my/sarmah  
E-Mail: Gia.Alexander@tamu.edu  
Phone: (979) 847-8855  
Office Hours: Mondays and Wednesdays, 3:00-4:00 and by appointment.

Course Description

“Presentation of a technical petroleum engineering topic judged by petroleum professionals at the PhD graduate level department student paper contest.”

Course Prerequisites

PhD Graduate Classification

Course Objectives/Topics Covered

Specific objectives for your coursework in PETE 435 include the following:

1. Write, prepare, and deliver an effective visual presentation video based on your research on a relevant engineering problem in the petroleum industry.
2. Prepare to answer questions from an audience with directness and clarity.
3. Analyze and give constructive feedback on other oral presentation videos.

Textbook and/or Resource Materials

The following required course materials are provided in Canvas:
Course Completion and Grading Policy

This course is graded on a satisfactory/unsatisfactory basis. You must complete ALL of the items below to earn a satisfactory grade in this course. The assignments and points possible are as follows:

1. **Delivery** of Your Presentation at the Student Paper Contest: 100 points
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**Special Alert**: If the judges at the Student Paper Contest deem your performance unsatisfactory because of time, content, or delivery, you will need to repeat the presentation to me and other faculty members to pass this course. Lack of effort on your part will result in an unsatisfactory grade.

Learning Resources

**Workshops**

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• To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

**Personal Illness and Quarantine**

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**Operational Details for Fall 2020 Courses**

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.

**College and Department Policies**

Please note that successful completion of this course is a requirement toward your Bachelor of Science in Petroleum Engineering at Texas A&M University as included on your degree plan.
Course Schedule

You will log into ZOOM by 8:25 on Saturday, January 30, 2021. In addition to giving your own presentation, you are expected to remain logged in to observe and give feedback to your peers.
Engineering Near-Critical Reservoirs
PETE 616
Spring 2020

Syllabus and Administrative Procedures

Instructor:
Dr. Maria A. Barrufet
Teaching Assistant: TBD

e-mail: barrufet@tamu.edu

Contact Information: 979.845.0314
Office: Rooms 407C Richardson Building
Office Hours: Tuesday and Thursday (2:30 – 3:30 PM) or by appointment

Course Description:

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<tbody>
<tr>
<td>Identification of reservoir fluid type; calculation of original gas in place, original oil in place, reserves and future performance of retrograde gas and volatile oil reservoirs.</td>
</tr>
<tr>
<td>Prerequisites: PETE 323, PETE 400, PETE 401.</td>
</tr>
</tbody>
</table>

ACCESSING AND DOWNLOADING MATERIALS FROM LIBRARY (live tutorial for on-campus and distance-learning students)

Publisher
Fundamentals of Reservoir Engineering by L.P. Dake, Elsevier.

Module 1: Overall Scope – Reservoir and Fluid Characterization
Module 2: Material Balance Equation and Introduction to Simulation

Module 3: Reservoir Simulation for Near Critical Fluids – Special Compositional Needs

Module 4: Compositional Gravitational Gradients - Condensate Banking – Well Deliverability Production Strategies

Module 5: Building a Fluid Model – Calibration of EOS
Use of PVTi – Processing Data and Generating a Fluid Model for ECLIPSE 300. Calibration of EOS parameters to constant composition expansion (CCE), Swelling tests, and/or constant volume depletion data (CVD). Tuning to viscosity data.

Module 6: Compositional Reservoir Simulator – Processing Input and Output Files
Local Grid Refining. Relative Permeabilities as function of IFT.
Simulation and evaluation of depletion and gas cycling strategies: Volatile and Gas Condensate, examples. Production Controls: Scheduling/Restart Files. (Static Reservoir Model Provided).

➤ Extended and lumped compositional description
➤ Black oil and compositional model
➤ Evaluation of relative permeability models (Corey and IFT dependent)
➤ Local grid refining options (analysis of condensate banking, deliverability)
➤ Horizontal and vertical wells

### Performance Evaluation

<table>
<thead>
<tr>
<th>Activity</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation – Discussions in Bulletin Board – Team work</td>
<td>10%</td>
</tr>
<tr>
<td>Paper Reviews and Simulation Assignments</td>
<td>30%</td>
</tr>
<tr>
<td>Final Independent Project</td>
<td></td>
</tr>
<tr>
<td>(selections provided during the course, paper and presentation)</td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td>30%</td>
</tr>
<tr>
<td>Presentation</td>
<td>30%</td>
</tr>
</tbody>
</table>

Class notes downloadable from E-Campus. Selected SPE and other electronically provided papers/chapters, resources.

**GUIDELINES FOR PAPER REVIEW**

It should take no more than one page to summarize a typical paper. Some papers may require more; use your own judgment. Learn to be concise and to state briefly the essential ideas communicated.

**USUAL ORGANIZATION OF A REVIEW (adapted from Dr. John Lee)**

- Authors, title. Use the SPE standard reference style. (You can find it in the SPE Guide to Publications, which is on the web at http://www.spe.org)
- Problem. Briefly, describe the problem the authors are trying to solve.
- Solution. Describe the solution the authors propose. Did they propose a specific method to recover additional oil, do they discuss data required, limitations, do they analyze performance? What is it?
- Value. Describe the value of the authors’ solution to the petroleum industry.
- Conclusions. Describe the conclusions the authors reached as a result of their analysis
- Approach. Describe what the authors did to validate their proposed solution.
- Limitations. List the limitations of the work. Is it applicable to only a certain type of reservoir or field?
- Application. How would you apply the knowledge provided in this paper?
• Critique. What questions did the authors leave unanswered? What could the authors have
done to make the paper better?

OBJECTIVES FOR REVIEWING PAPERS IN THIS CLASS

• To learn how to learn from papers (harder than textbooks, but more important in the long run)
• To learn how to identify the really important ideas in papers
• To learn how to summarize ideas concisely
• To learn how engineers with vastly different points of view think and how they approach problems and their solutions

Academic Integrity Syllabus Statement

“An Aggie does not lie, cheat, or steal or tolerate those who do.”

All syllabi shall contain a section that states the Aggie Honor Code and refers the student
to the Honor Council Rules and Procedures on the web
http://www.tamu.edu/aggiehonor

All assignments and examinations will require the student to sign the following

“On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work.”

________________________
Signature of Student

Americans with Disabilities Act (ADA) Policy Statement

The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy statement was forwarded to the Faculty Senate for information.

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe that you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.
Course Description

This course deals with the engineering science of bringing petroleum fluids from beneath the earth’s surface to the production facilities. As such, it involves applying the principles of fluid mechanics and heat transfer to petroleum production systems.

Reservoir flow, properties of petroleum fluids, and other associated items related to petroleum production is discussed in an introductory lecture. The basics of single and two-phase flow in the wellbore (pipe) is then covered. More detailed discussion of multiphase flow is presented in the following weeks. Discussion of wellbore heat transfer – which affects flow assurance – is an integral part of the course. Wellbore heat transfer is discussed in the three weeks after multiphase flow modeling.

Various types of production logging – whereby operating engineers gather information related to amount and composition of their production from various zones – is described in the next four weeks. The course then presents the theory and practice of major artificial lift mechanisms – including electrical submersible pumps, rod pumps, gas-lift, plunger lift, etc.

Learning Outcomes or Course Objectives

The goal of this course is to develop understanding and skills to model fluid flow and heat transfer in various components of multiphase production systems. We will present advanced techniques for modeling well deliverability and multiphase flow in wellbores and pipelines. Special emphasis is given to the components of multiphase production downstream of the sandface, including flow assurance, performance monitoring by downhole sensors, and problem diagnosis by production logging. Well performance improvement by artificial lift will be addressed.

Instructor Information

Name: Dr. A. Rashid Hasan  Office: Rich 501E
Phone Number: 979-847-8564  email: rhasan@tamu.edu
Office Hours: Monday 3:00 – 5:00 pm; Tuesday 3:00 – 5:00 pm

Textbook and/or Resource Material

- Hill, A. D.: Production Logging – Theoretical and Interpretive Elements. SPE Monograph Series, 14, 1990. **Recommended.**
- Other Materials: SPE technical papers in related subjects

Grading Policies

Homework: 15%. Midterm: 40% Final Exam: 20% (in class) Project: 25%

First midterm will have an in-class (30% of the exam) and a take-home (70% of the exam) component.
### Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Hours</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Introduction:</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Basic Petroleum Production Engineering,</td>
<td></td>
<td>Jan 15-17</td>
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<tr>
<td></td>
<td>o Overview of Single-phase flow principles</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>o 2-Phase Flow: Concepts, Definitions, Method of analysis</td>
<td></td>
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<tr>
<td></td>
<td>o Homogeneous and separated flow models.</td>
<td></td>
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<tr>
<td></td>
<td>o Multiphase flow models in vertical conduits</td>
<td></td>
<td>Jan 22-24</td>
</tr>
<tr>
<td>3-5</td>
<td>Multiphase flow in Inclined/Other systems:</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Flow in deviated wells.</td>
<td></td>
<td>Jan 29-31</td>
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<tr>
<td></td>
<td>o Flow in horizontal pipes.</td>
<td></td>
<td>Feb 05-07</td>
</tr>
<tr>
<td></td>
<td>o Nonconventional systems</td>
<td></td>
<td>Feb 12</td>
</tr>
<tr>
<td>6-8</td>
<td>Wellbore heat transport:</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Basic Heat Transfer, Formation temperature distribution.</td>
<td></td>
<td>Feb 14</td>
</tr>
<tr>
<td></td>
<td>o Energy balance, fluid temperature in single conduits.</td>
<td></td>
<td>Feb 19-21</td>
</tr>
<tr>
<td></td>
<td>o Fluid temperature in gas-lift (multiple conduits)</td>
<td></td>
<td>Feb 26</td>
</tr>
<tr>
<td></td>
<td>o Rate estimation from temperature</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Team Names and Project Abstract (1st Draft) due</strong></td>
<td></td>
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<tr>
<td></td>
<td><strong>In-class 1-hour 1st Midterm</strong></td>
<td></td>
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<tr>
<td></td>
<td><strong>First Midterm Take-home given</strong></td>
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<tr>
<td></td>
<td><strong>Due</strong></td>
<td></td>
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<tr>
<td>9-12</td>
<td>Production Logging:</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Introduction to Production Logging.</td>
<td></td>
<td>Mar 19</td>
</tr>
<tr>
<td></td>
<td>o Temperature Logging.</td>
<td></td>
<td>Mar 21-26</td>
</tr>
<tr>
<td></td>
<td>o Tracer Logging.</td>
<td></td>
<td>Mar 28</td>
</tr>
<tr>
<td></td>
<td>o Spinner Logging and Other Logs.</td>
<td></td>
<td>Apr 02-04</td>
</tr>
<tr>
<td>13-15</td>
<td>Artificial Lift:</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Pump Lift:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>o Rod Pump; ESP; Plunger Lift; Progressive Cavity Pump; Jet Pump.</td>
<td></td>
<td>Apr 9-11</td>
</tr>
<tr>
<td></td>
<td>o Gas Lift:</td>
<td></td>
<td>Apr 16-20</td>
</tr>
<tr>
<td></td>
<td>o Initial Unloading, Gas Lift Design.</td>
<td></td>
<td>Apr 23</td>
</tr>
<tr>
<td></td>
<td><strong>Final exam (in class)</strong></td>
<td>April 25</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Project Due</strong></td>
<td>May 02</td>
<td></td>
</tr>
</tbody>
</table>

**Americans with Disabilities Act (ADA)**

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**Academic Integrity**

"An Aggie does not lie, cheat, or steal, or tolerate those who do."

For additional information please visit: [http://aggiehonor.tamu.edu](http://aggiehonor.tamu.edu)
Goals of PETE 620:

In simple terms, the goal of PETE 620 (Fluid Flow in Petroleum Reservoirs) is to take the student from "sand grains to the classic solutions used in reservoir engineering." The path begins with a review of mathematics because many of us need to re-familiarize ourselves with algebra, calculus, differential equations, numerical methods, special functions, and other related topics/subjects. This review is intended to address most of the skills/topics which will be required in the course.

We then proceed to study the (mostly) empirical aspects of geology and petrophysics (rock properties), and then on to the fundamental building blocks of reservoir engineering: permeability, capillary pressure, relative permeability, and the electrical properties of reservoir rocks. After this we work through the "flow relations" (steady-state Darcy and non-Darcy flow), then Material Balance (needed for conservation of mass), pseudosteady-state flow, and finally the "diffusion" (or diffusivity) equations. At this point it is worth noting that we will have addressed the "fundamental" aspects of these building blocks — the assumptions, the limitations, and the need for advances in concepts for flow in porous media; and perhaps most importantly, the inherent non-linearities that exist for the "flow equations" used in Petroleum Reservoir Engineering.

In the last (and most important) portion of the course we consider the classic reservoir solutions for radial and linear flow, flow in fractured wells, flow in naturally-fractured (or dual porosity) systems, and the definition and use of convolution in reservoir engineering applications.

Assignments for PETE 620:

The assignments in this course vary from fundamental developments to solutions which could be used in reservoir engineering practice. Students are expected to demonstrate mastery of all fundamental concepts covered in the course. In addition, the instructor wishes to provide students with concepts, problems, and/or applications which will be useful for research.

The tentative assignment topics for the Fall 2020 are given as follows:

- (Math) Laplace Transforms
- (Math) Special Functions
- Correlation of Petrophysical Data
- Capillary Pressure/Relative Permeability
- Material Balance (liquid or gas)
- Pseudosteady-State Flow (liquid or gas)
- Linear Flow Solutions
- Radial Flow Solutions
- Solutions for Fractured Wells
- Dual Porosity Reservoirs
- Convolution/Deconvolution
- Wellbore Storage

Philosophy about Life:

- Most Appropriate Quote:
  Opportunity is missed by most people because it is dressed in overalls and looks like work... (hard work is the only path...)
  Thomas A. Edison, American Inventor (1847-1931)

- Important Rules for Life:
  — Never own anything that eats while you sleep...
  — Never own anything that needs repainting...
  — Never own anything that you can't drive a nail in...
  — Always work harder than those you work for...
  — If you must herd cats, then be a rat...
  — Never say no, and there's no limit to where you can go...

Brief Bio: Thomas A. Blasingame, Ph.D., P.E.

- Professor, Department of Petroleum Engineering at Texas A&M University in College Station Texas
- Holds a joint appointment in the Department of Geology and Geophysics at Texas A&M University
- Holder of the Robert L. Whiting Professorship in Petroleum Engineering
- B.S., M.S., and Ph.D. degrees in Petroleum Engineering from Texas A&M University.
- Teaching/Research activities:
  — Petrophysics
  — Reservoir engineering
  — Analysis/interpretation of well performance
  — Exploitation of unconventional reservoirs
  — Technical mathematics.
- Technical Contributions:
  — Pressure transient test analysis
  — Analysis of production data
  — Reservoir management
  — Diagnostic characterization of reservoir performance
  — General reservoir engineering

- Student counts to date (Aug 2020): 72 M.S. (thesis), 35 M.Eng. (report, non-thesis), and 16 Ph.D. students.

Guidance:

- Orientation — This is graduate school, the (only) person you are competing against is in the mirror.
- Work Quality — My highest commandment is that you submit your best work; and ONLY your best work.
- Focus — This is an essential course in reservoir engineering, results are used throughout the discipline.
- Timeliness — This material is very "dense" — do not underestimate your workload and timing.
- Course Materials — The material will teach itself, but you must put your energy and enthusiasm into the course.
- Connections — I am here to help; I will answer any/all relevant correspondence within 24 hours (unless I am totally offline).
Petroleum Engineering 620 — Fluid Flow in Petroleum Reservoirs
Syllabus and Administrative Procedures
Fall 2020

Instructor Information:

Petroleum Engineering 620
Instructor: Dr. Tom BLASINGAME
Texas A&M University
Richardson 821A
Richardson 821A
Fall 2020 (version: 20201023)

Required Texts/Resources: (a. Book must be purchased. b. Out of Print/Public Domain.)

Optional Texts/Resources: (Try local bookstores or online vendors, or the TAMU library.)

Course and Reference Materials:
The course materials for this course are located at:
https://blasingame.engr.tamu.edu/?start=pete%2Fblasingame.engr.tamu.edu%2FP620_20C%2F

Basis for Grade: [Grade Cutoffs (Percentages) → A: > 90  B: 89.99 to 80  C: 79.99 to 70  D: 69.99 to 60  F: < 59.99]

Assignments:
(Due: 14 Sep 2020) Graphical Behavior of Special Functions ................................................................. 15 percent
(Due: 21 Sep 2020) Construction and Demonstration of Your Own Laplace Transform Inversion Algorithm .................................................. 15 percent
(Due: 05 Oct 2020) Derivation of a k-p, Permeability Relation — Modified Parcull k, Models and the Bentsen p, Model .... 15 percent
(Due: 26 Oct 2020) Derivation of Pseudosteady-State Flow Solutions .................................................. 10 percent
(Due: 09 Nov 2020) Derivation of the "Rectangular-Hyperbola" Build-Up Method .................................................. 15 percent
(Due: 16 Nov 2020) Derivation of an Approximate Solution — Fractured Well with a Finite-Conductivity Vertical Fracture 15 percent
(Due: 02 Dec 2020) Approximations for Modelling Wellbore Storage Behavior .................................................. 15 percent

Total = 100 percent

Policies and Procedures:
1. Students are expected to attend class every session. Resident (not Distance Learning students) are REQUIRED to attend class every session. Distance Learning students are expected review lecture materials within 24 hours of the lecture being given. This is not a casual requirement, penalties can and will be assigned for missing class.
2. Policy on Grading
   a. All work in this course is graded based on answers only — any partial credit is at the discretion of the instructor.
   b. All work requiring calculations shall be properly and completely documented for credit.
   c. All grading shall be done by the instructor, or under his direction and supervision, and the decision of the instructor is final.
3. Policy on Regrading
   a. Only in very rare cases will assignments/exams be considered for re-grading — partial credit (if any) is not subject to appeal.
   b. Work which, while possibly correct, but cannot be followed, will be considered incorrect.
   c. Grades assigned to homework problems will not be considered for regrading.
   d. If regrading is necessary, the student is to submit a letter to the instructor explaining the situation that requires consideration for regrading, the material to be regraded must be attached to this letter. The letter and attached material must be received within one week from the date returned by the instructor.
4. The grade for a late assignment is zero. Homework will be considered late if it is not turned in at the start of class on the due date. If a student comes to class after homework has been turned in and after class has begun, the student's homework will be considered late and given a grade of zero. Late or not, all assignments must be turned in. A course grade of Incomplete will be given if any assignment is missing, and this grade will be changed only after all required work has been submitted.
5. Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an examination or collaborating on an assignment where collaboration is not specifically authorized by the instructor will be removed from the class roster and given an F (failure grade) in the course.
Work Requirements: (layout/format/etc.)

- You must show ALL work — as appropriate, YOU MUST:
  - WORK: You must show all details in your calculations (no skipped steps) — all portions of all analysis relations must be shown.
  - UNITS: You must show all units in all calculations.

- Work layout: (as appropriate for a given problem)
  - NEATNESS: You will be graded on the neatness of your work.
  - LABELS: All work, trends, and features on every plot MUST be appropriately labeled — no exceptions.
    - Work: All work must be fully labeled and documented — equations, relations, calculations, etc.
    - Trends: This includes the slope, intercept, and the information used to construct a given trend.
    - Features: Any description of features/points of interest on a given trend (times, pressures, etc.).
  - LINES: Use appropriate drafting care in construction of lines, trends, arrows, etc.
    - SKETCHING: Take great care in any sketches you create/use in your work.

- Plots/Plotting: (as required)
  - SYMBOLS: Use symbols for "data" (if "data" are presented — e.g., reference solutions given as discrete data points).
  - LINES: Use lines to represent models.
  - COLORS: Use black for all axes and gridlines. Use primary colors (red, green, blue), avoid pastel colors.
    - etc.: Please do NOT use a border or "frame" around your plots.

- Typing: ALL WORK SUBMITTED IN THIS COURSE MUST BE TYPED. NO HANDWRITTEN WORK IS PERMITTED.

- Scanning: >300 dpi COLOR scan from a printer/scanner — DO NOT SUBMIT PHOTOS (photos will not be accepted).

Scholastic Dishonesty:

THE STUDENT IS HEREBY WARNED THAT ANY/ALL ACTS OF SCHOLASTIC DISHONESTY WILL RESULT IN AN "F" GRADE FOR ALL ASSIGNMENTS IN THIS COURSE. As a definition, "scholastic dishonesty" will include any or all of the following acts:

- Unauthorized collaborations — you are explicitly forbidden from working together.
- Using work of others — you are explicitly forbidden from using the work of others — "others" is defined as students in this course, as well as any other person. You are specifically required to perform your own work.

Work Standard:

Simply put, the expectation of the instructor (Blasingame) is that "perfection is the standard" — in other words, your work will be judged against a perfect standard. If your submission is not your very best work, then don't submit it. You have an OBLIGATION to submit only your very best work.

Student Obligation:

You must prepare your work as instructed above, or you will be assessed SEVERE grading penalties.

e-mail Protocols

In order to manage your correspondence, I require that you use the following protocol.

- Subject Line: [YYYYMMDD] (YOUR LASTNAME) Subject (date) (your last name) (Subject of your e-mail)

  Body:

  Dr. BLASINGAME:

  I would like to enquire about the following:
  * Question 1 ... (be clear and concise)
  * Question 2 ... (be clear and concise)
  * Question 3 ... (be clear and concise)

  I thank you for your assistance.

  YourFirstName YOURLASTNAME
  (contact information)
  E: (TAMU)
  E: (personal)
  T: (a phone contact) (I will NEVER call you without first sending an e-mail or text)

Comments:

- DO NOT FORWARD/REPLY TO EMAILS FROM ECAMPUS — SEND A NEW NOTE.
- The subject line is used to file e-mail (therefore, this specific subject line is required).
- Every effort will be made to answer every e-mail, but PLEASE avoid trivial enquiries (consult the syllabus for "administrative" issues).
- I am more than happy to address questions by e-mail — i.e., issues/errors/etc. and/or need help with something relevant to the course.
- Courier New 10pt Bold font is required.

Computational Tools:

In this course you are NOT required to work in a particular computational environment. However, you should be/must be proficient at whatever computational tool(s) you use for work in this course. Example products/computational environments include

- Visual Basic (VB) via MS Excel.
- MATLAB (http://www.mathworks.com/products/matlab/).
- Mathematica (https://www.wolfram.com/mathematica/).
- C++, FORTRAN, Pascal, machine language, the Univac, an abacus, etc.

Please note that YOU are RESPONSIBLE for your computer-aided solutions. Depending on the assignment you may be asked for a copy of your source code and should provide relevant commentary/documentation in your source code sufficient for your work to be traced. As an exception, you are NOT to submit MATLAB, Mathematica, Maple, Theorist, etc. work for symbolic manipulations (i.e., derivations).
Course Description:

Graduate Catalog: Analysis of fluid flow in bounded and unbounded reservoirs, wellbore storage, phase redistribution, finite and infinite conductivity vertical fractures, dual-porosity systems.

Translation: Development of skills required to derive "classic" problems in reservoir engineering and well testing from the fundamental principles of mathematics and physics. Emphasis is placed on a mastery of fundamental calculus, analytical and numerical solutions of 1st and 2nd order ordinary and partial differential equations, as well as extensions to non-linear partial differential equations that arise for the flow of fluids in porous media.

Course Outline/Topics:

Advanced Mathematics Relevant to Problems in Engineering: (used throughout assignments)
- Approximation of Functions
  - Taylor Series Expansions and Chebyshev Economizations
  - Numerical Differentiation and Integration of Analytic Functions and Applications
  - Least Squares
- First-Order Ordinary Differential Equations
- Second-Order Ordinary Differential Equations
- The Laplace Transform
  - Fundamentals of the Laplace Transform
  - Properties of the Laplace Transform
  - Applications of the Laplace Transform to Solve Linear Ordinary Differential Equations
  - Numerical Laplace Transform and Inversion
- Special Functions

Petrophysical Properties:
- Porosity and Permeability Concepts
- Correlation of Petrophysical Data
- Concept of Permeability — Darcy's Law
- Capillary Pressure
- Relative Permeability
- Electrical Properties of Reservoir Rocks

Fundamentals of Flow in Porous Media:
- Steady-State Flow Concepts: Laminar Flow
- Steady-State Flow Concepts: Non-Laminar Flow
- Material Balance Concepts
- Pseudosteady-State Flow in a Circular Reservoir
- Development of the Diffusivity Equation for Liquid Flow
- Development of the Diffusivity Equations for Gas Flow
- Development of the Diffusivity Equation for Multiphase Flow

Classical Reservoir Flow Solutions:
- Dimensionless Variables and the Dimensionless Radial Flow Diffusivity Equation
- Solutions of the Radial Flow Diffusivity Equation — Infinite-Acting Reservoir Case
- Laplace Transform (Radial Flow) Solutions — Bounded Circular Reservoir Cases
- Real Domain (Radial Flow) Solutions — Bounded Circular Reservoir Cases
- Linear Flow Solutions: Infinite and Finite-Acting Reservoir Cases
- Solutions for a Fractured Well — High Fracture Conductivity Cases
- Dual Porosity Reservoirs — Pseudosteady-State Interporosity Flow Behavior
- Direct Solution of the Gas Diffusivity Equation Using Laplace Transform Methods
- Convolution and Concepts and Applications in Wellbore Storage Distortion

Advanced Reservoir Flow Solutions: (Possible Coverage)
- Multilayered Reservoir Solutions
- Dual Permeability Reservoir Solutions
- Horizontal Well Solutions
- Radial Composite Reservoir Solutions
- Models for Flow Impediment (Skin Factor)

Applications/Extensions of Reservoir Flow Solutions: (Possible Coverage)
- Oil and Gas Well Flow Solutions for Analysis, Interpretation, and Prediction of Well Performance
- Low Permeability/Heterogeneous Reservoir Behavior
- Macro-Level Thermodynamics (coupling PVT behavior with Reservoir Flow Solutions)
- External Drive Mechanisms (Water Influx/Water Drive, Well Interference, etc.)
- Hydraulic Fracturing/Solutions for Fractured Well Behavior
- Analytical/numerical Solutions of Various Reservoir Flow Problems
- Applied Reservoir Engineering Solutions — Material Balance, Flow Solutions, etc.
## Course Schedule:

<table>
<thead>
<tr>
<th>Month</th>
<th>Date</th>
<th>Day</th>
<th>Topic</th>
<th>Lecture or Potential Assignment Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug</td>
<td>19</td>
<td>W</td>
<td>Course Introduction</td>
<td>Syllabus</td>
</tr>
<tr>
<td>Aug</td>
<td>26</td>
<td>W</td>
<td>Approximation of Functions</td>
<td>Lec_02_Mod1_ML_02_Fcn_Approx.pdf</td>
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<tr>
<td>Aug</td>
<td>31</td>
<td>M</td>
<td>1st Order Ordinary Differential Equations</td>
<td>Lec_03_Mod1_ML_03_1st_Order_ode.pdf</td>
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<td>Sep</td>
<td>02</td>
<td>W</td>
<td>2nd Order Ordinary Differential Equations</td>
<td>Lec_04_Mod1_ML_04_2nd_Order_ode.pdf</td>
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<td>Sep</td>
<td>07</td>
<td>M</td>
<td>The Laplace Transform</td>
<td>Lec_05_Mod1_ML_05_LaplaceTrans.pdf</td>
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<tr>
<td>Sep</td>
<td>09</td>
<td>W</td>
<td>Introduction to Special Functions</td>
<td>Lec_06_Mod1_ML_06_SpecialFcns.pdf</td>
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<tr>
<td>Sep</td>
<td>14</td>
<td>M</td>
<td>Porosity and Permeability Concepts</td>
<td>Lec_07_Mod2_PtrPhy_01_PorPerm.pdf</td>
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<tr>
<td>Sep</td>
<td>16</td>
<td>W</td>
<td>Correlation of Petrophysical Data</td>
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<td>Lec_27_Mod4_ResFlw_08_WellboreStrg.pdf</td>
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**Nov 26** Th **Thanksgiving Holiday (no class)**

Dec 02 W Any/all remaining assignments due. (https://www.tamu.edu/registrar/finalexamschedule.shtml)

Dec 10 R Final grades due *GRADUATING* students. (10 December Thursday, 6 p.m. (18:00)) (https://registrar.tamu.edu/Catalogs,-Policies-Procedures/Academic-Calendar)

Dec 14 M Final grades for *ALL* students Fall 2020 term (14 December Monday, 12 p.m. (noon)) (https://registrar.tamu.edu/Catalogs,-Policies-Procedures/Academic-Calendar)

## Comments:
1. All class sessions will also be recorded and put on the instructor’s website (and the eCampus system as well if possible).
2. Friday class sessions will also be used from time-to-time (substitute lecture dates, math recitations, etc.).
3. This lecture schedule is tentative and is subject to change (as a legal disclaimer).
Assignment Coversheet

Required Academic Integrity Statement: (Texas A&M University Policy Statement)
Academic Integrity Statement

All syllabi shall contain a section that states the Aggie Honor Code and refers the student to the Honor Council Rules and Procedures on the web.

Aggie Honor Code
"An Aggie does not lie, cheat, or steal or tolerate those who do."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: www.tamu.edu/aggiehonor/

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

Aggie Code of Honor:
An Aggie does not lie, cheat, or steal or tolerate those who do.

Required Academic Integrity Statement:
"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

__________________________________________ (Print your name)
__________________________________________ (Your signature)
1. (Due: 14 Sep 2020) Graphical Behavior of Special Functions

Given: Resources on Special Functions given in the course notes.

Required: To recreate the plots shown in the course notes for

- Exponential Integral: $Ei(x)$ and $E_1(x) = -Ei(-x)$
- Gamma and Incomplete Gamma Functions: $\Gamma(x)$, and $\gamma(a,x)$, and $\Gamma(a,x)$
- Error and Complementary Error Functions: $erf(x)$ and $erfc(x)$
- Bessel Functions: $J_0(x)$, $J_1(x)$, $Y_0(x)$, and $Y_1(x)$
- Modified Bessel Functions: $I_0(x)$, $I_1(x)$, $K_0(x)$, and $K_1(x)$, as well as the integrals of $I_0(x)$ and $K_0(x)$.

Notes:
- You may use any computational tool (e.g., Excel, Python, FORTRAN), but your plots must be publication quality (as in the notes).

References:
M.R. Spiegel, (1971) Advanced Mathematics for Engineers and Scientists, Schaum’s Series. [This is the 1st edition, the 1971 text.]

2. (Due: 21 Sep 2020) Construction and Demonstration of Your Own Laplace Transform Inversion Algorithm

Given: Using the references below and the course notes, you are to construct and demonstrate your own Laplace transform inversion algorithm. You are to demonstrate your algorithm on the following cases:

2a. $f(s) = \frac{\Gamma(s+1)}{s} \rightarrow f(t) = \frac{t^r e^t}{r!}$
2b. $f(s) = K_0(\sqrt{s})/s \rightarrow f(t) = \frac{e^{-1/4 t}}{\sqrt{\pi t}}$
2c. $f(s) = \frac{e^{-\sqrt{s}}}{\sqrt{s}} \rightarrow f(t) = \frac{e^{-1/4 t}}{\sqrt{\pi t}}$

Required:
- You are to provide clearly derived and fully detailed development/derivation of your Laplace transform inversion algorithm.
- You are to provide graphical presentations of the exact solution (given) and the results of your Laplace transform inversion algorithm.

References:

Submission Guidance for Each Problem: Submit a SINGLE .pdf file to t-blasingame@tamu.edu by 16:59:59 US CST on the assignment date.
- All work in this course must be typed, no handwritten work is permitted.
- It is suggested that you create a "work file" in MS Word or MS PowerPoint to capture your work, then create a .pdf from that file.
- The standard of submission must be near "publication quality," poor/fair quality work submissions will NOT be accepted.
- Your submission file must be named: P620_20C_Prob_#_YOURLASTNAME.pdf.
- Students ARE permitted to communicate but ARE NOT permitted to collaborate —any sharing/copying will result in a zero (0) score.
- Students ARE NOT permitted to submit symbolic/numeric software work (e.g., Mathematica, Theorist, Maple, MATLAB) for derivations.
Given: You are given the "Modified Purcell" $k_r$ models:

\[
\begin{align*}
    k_{rw} &= k_{rw}^0 (S_w^*)^\alpha \\
    k_{rn} &= k_{rn}^0 (1-S_w^*)^\beta \\
    S_r^* &= S_w - S_{wi}(1 - \sum_{i=2}^{oo} \beta_i \alpha_i)
\end{align*}
\]

You are to create/propose "your own" (original) $p_c$ model(s) — i.e., $p_c(S_w^*)$. You cannot use the "Brooks and Corey" model as "your own" model. As guidance, the following points should be considered:

- You are encouraged to develop a model that has $\leq 4$ parameters.
- If possible, your model should consider the following constraints: (again, do NOT use the Brooks-Corey model)
  - $p_i \to \infty$ as $S_w \to S_{wi}$
  - $p_r \to p_o$ as $S_w \to 1$
- You should note that you will need to take the integral of $1/(p_c(S_w^*))^2$ with respect to $S_w^*$ in your model considerations.

You are also given

Data: This is a "water-oil" system — WATER is the WETTING phase.

<table>
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<tr>
<th>Point</th>
<th>$S_w$ (p-data) (fraction)</th>
<th>$p_i$ (psia)</th>
<th>$S_w$ (k-data) (fraction)</th>
<th>$k_{rw}$ (fraction)</th>
<th>$k_{rn}$ (fraction)</th>
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Required: (Reminder: data are plotted as symbols, model(s) are plotted as lines)

3.1 You are to create/propose "your own" (original) $p_c$ model(s) [i.e., $p_c(S_w^*)$].

3.2 You are to fit "your own" (original) $p_c$-model(s) [i.e., $p_c(S_w^*)$] to the data given above: Report ALL $p_c$-model coefficients.

3.2.1. Plot $p_i$ vs. $S_w^*$
3.2.2. Plot log[$p_i$] vs. log[$S_w^*$]
3.2.3. Plot $1/(p_i)^2$ vs. $S_w^*$
3.2.4. Plot log[$1/(p_i)^2$] vs. log[$S_w^*$]

3.3 You are to fit the "Brooks and Corey" $p_c$-model [i.e., $p_c(S_w^*)$] to the data given above. (Add these $p_c$-model curves to the plots in 3.2)

3.4 Using the "Modified Purcell" $k_r$-relationships (Eqs. 3.1-3.3), you are to substitute your $p_c$-model(s) to yield $k_r(S_w)$ models.

3.5 You are to fit "your own" (original) $k_r(S_w)$-model(s): Report ALL $k_r$-model coefficients. ($k_r^{oo}$, $k_r^{oo}$, and recall that $\alpha = 2$ and $\beta = 2$)

3.5.1. Plot $k_r$ vs. $S_w$
3.5.2. Plot log[$k_r$] vs. $S_w$

Note: You are NOT required to assume $\alpha = 2$ and/or $\beta = 2$ — but you can if you wish to do so.

3.6 You are to fit the "Brooks and Corey" $k_r$-models using the data given above. (Add these $k_r$ model curves to the plots in 3.5)
5. (Due: 09 Nov 2020) Validation of the "Rectangular-Hyperbola" Build-Up Method

Given: The "Rectangular-Hyperbola" pressure build-up relation is given as:
\[ p_{uS} = \frac{a}{b + t} \] .......................... (5.1)

Governing Equations:
\[ \bar{p}_{i,0}(r_0, t_0) = \frac{1}{u} \bar{K}_i (\sqrt{u} r_0) + \frac{2}{\pi} E_1 \left( \frac{r_0}{4D} \right) + \frac{2}{\pi} E_1 \left( \frac{r_0}{2D} \right) + \frac{1}{4} \exp \left[ -\frac{r_0^2}{4D} \right] + s \] ........... [full solution, Laplace domain] (5.2)

\[ p_{u,0}^c(t_0, r_0) = \frac{2\pi r_0}{r_0^2} \] ................................................. [dimensionless average reservoir pressure] (5.4)

\[ p_{u,0}^s (\Delta t) = p_{u,0} (t_0 + \Delta t) - p_{u,a} (t_0) - p_{u,b} (t_0) \] ............................................. [dimensionless "buildup" pressure] (5.5)

5.1 Drawdown Solutions — you are to present all trends on a single log-log plot:
5.1.1. Plot \( \log[p_{u,0}(t_0)] \) vs. \( \log[t_0] \) using Eq. 5.2 (use the Stehfest algorithm to invert Eq. 5.2).
5.1.2. Plot \( \log[t_0] dp_{u,0}(t_0)/dt_0 \) vs. \( \log[t_0] \) using Eq. 5.2 (use the Stehfest algorithm to invert Eq. 5.2 to compute \( dp_{u,0}(t_0)/dt_0 \)).
5.1.3. Plot \( \log[p_{u,0}(t_0)] \) vs. \( \log[t_0] \) using Eq. 5.3.
5.1.4. Plot \( \log[t_0] dp_{u,0}(t_0)/dt_0 \) vs. \( \log[t_0] \). (the explicit derivative of Eq. 5.3 is given in the course notes)

5.2 Buildup Solutions — you are to present all trends on a single log-log plot:
5.2.1. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using Eq. 5.5, (with Eqs. 5.2 and 5.4) (use the Stehfest algorithm to invert Eq. 5.2).
5.2.2. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using Eq. 5.5, based on Eqs. 5.3 and 5.4.
5.2.3. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using \( p_{u,0}^c (t_0 + \Delta t) - p_{u,0} (t_0) - p_{u,a} (t_0) \) (use the Stehfest algorithm to invert Eq. 5.2).
5.2.4. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using \( p_{u,0}^s (\Delta t) -(2/\pi) \exp[-4 \pi^2 \Delta t_0^2] \).
5.2.5. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using \( p_{u,0}^s (\Delta t) = C (1 + B \Delta t_0^2) \). (B and C are constants you determine)

5.3 Provide a 2-3 paragraph summary of your observations … be specific to the nature of the solutions and the ability (or inability) of the Rectangular Hyperbola Method (RHM) to match the analytical and approximate solutions.

References:

5. (Due: 09 Nov 2020) Validation of the "Rectangular-Hyperbola" Build-Up Method

Given: The "Rectangular-Hyperbola" pressure build-up relation is given as:
\[ p_{uS} = \frac{a}{b + t} \] .......................... (5.1)

Governing Equations:
\[ \bar{p}_{i,0}(r_0, t_0) = \frac{1}{u} \bar{K}_i (\sqrt{u} r_0) + \frac{2}{\pi} E_1 \left( \frac{r_0}{4D} \right) + \frac{2}{\pi} E_1 \left( \frac{r_0}{2D} \right) + \frac{1}{4} \exp \left[ -\frac{r_0^2}{4D} \right] + s \] ........... [full solution, Laplace domain] (5.2)

\[ p_{u,0}^c(t_0, r_0) = \frac{2\pi r_0}{r_0^2} \] ................................................. [dimensionless average reservoir pressure] (5.4)

\[ p_{u,0}^s (\Delta t) = p_{u,0} (t_0 + \Delta t) - p_{u,a} (t_0) - p_{u,b} (t_0) \] ............................................. [dimensionless "buildup" pressure] (5.5)

5.1 Drawdown Solutions — you are to present all trends on a single log-log plot:
5.1.1. Plot \( \log[p_{u,0}(t_0)] \) vs. \( \log[t_0] \) using Eq. 5.2 (use the Stehfest algorithm to invert Eq. 5.2).
5.1.2. Plot \( \log[t_0] dp_{u,0}(t_0)/dt_0 \) vs. \( \log[t_0] \) using Eq. 5.2 (use the Stehfest algorithm to invert Eq. 5.2 to compute \( dp_{u,0}(t_0)/dt_0 \)).
5.1.3. Plot \( \log[p_{u,0}(t_0)] \) vs. \( \log[t_0] \) using Eq. 5.3.
5.1.4. Plot \( \log[t_0] dp_{u,0}(t_0)/dt_0 \) vs. \( \log[t_0] \). (the explicit derivative of Eq. 5.3 is given in the course notes)

5.2 Buildup Solutions — you are to present all trends on a single log-log plot:
5.2.1. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using Eq. 5.5, (with Eqs. 5.2 and 5.4) (use the Stehfest algorithm to invert Eq. 5.2).
5.2.2. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using Eq. 5.5, based on Eqs. 5.3 and 5.4.
5.2.3. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using \( p_{u,0}^c (t_0 + \Delta t) - p_{u,0} (t_0) - p_{u,a} (t_0) \) (use the Stehfest algorithm to invert Eq. 5.2).
5.2.4. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using \( p_{u,0}^s (\Delta t) -(2/\pi) \exp[-4 \pi^2 \Delta t_0^2] \).
5.2.5. Plot \( \log[p_{u,0}(\Delta t)] \) vs. \( \log[\Delta t] \) using \( p_{u,0}^s (\Delta t) = C (1 + B \Delta t_0^2) \). (B and C are constants you determine)

5.3 Provide a 2-3 paragraph summary of your observations … be specific to the nature of the solutions and the ability (or inability) of the Rectangular Hyperbola Method (RHM) to match the analytical and approximate solutions.

References:
6. (Due: 16 Nov 2020) Derivation of an Approximate Solution — Fractured Well with a Finite-Conductivity Vertical Fracture


Required:
- Prepare a critical review of the "Blasingame-Poe" de-superposition solution. (3-4 paragraphs minimum — strengths, weaknesses, etc.).
- Generate \( p_{D}(t_d) \) and \( p_{S}(t_d) \) using the "Blasingame-Poe" solution and compare to the cases shown in Table 1 in the Cinco et al reference.

Notes:
- \( p_{D}(t_d) \) for the data in Table 1 in Cinco, et al reference will have to be computed numerically (the instructor will provide).
- In full disclosure, variants of this problem have been assigned in the past, but the expectation in this case is for you to critically review and assess the validity of the "Blasingame-Poe" approximate solution — but more importantly, to suggest improvements/alternatives.

References:

7. (Due: 02 Dec 2020) Approximations for Modelling Wellbore Storage Behavior

Given: Two explicit, yet approximate models for the case of wellbore storage are to be considered — the "van Everdingen" model (assumes an exponential decay of rates in the wellbore) and the "Blasingame" approach which considers the cases of several approximations of the wellbore storage solution in the Laplace domain, inverted directly to the real domain (because of the form of the approximations).

Required:
- Derive \( p_{D}(t_d) \) and \( p_{S}(t_d) \) using the "van Everdingen" wellbore storage model (Eq. 6 is the \( p_{D}(t_d) \) result).
- Derive \( p_{D}(t_d) \) and \( p_{S}(t_d) \) using the "constant \( p_d(t_0) \)" and "linear \( p_d(t_0) \)" "Blasingame" models (Eqs. B-7 and C-5, respectively).
- Using the "Blasingame" approach, derive \( p_{D}(t_d) \) and \( p_{S}(t_d) \) using the "cumulative-exponential" model: \( p_{D}(t_0) = a (1 - \exp[-ct_D]) \).
- Plot \( p_{D}(t_d) \) and \( p_{S}(t_d) \) for each model vs. the standard solution for: \( C_0 = 1 \times 10^2, 1 \times 10^3, 1 \times 10^4, 1 \times 10^5, s = 20 \) (Table 8 Agarwal, et al).

Notes:
- In full disclosure, variants of this problem have been assigned in the past, this assignment has several different requirements.

References:
Americans with Disabilities Act (ADA) Statement:

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit http://disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible. (Last updated and approved by Faculty Senate on 11/11/2019)


"An Aggie does not lie, cheat or steal, or tolerate those who do."

Definitions of Academic Misconduct:

1. CHEATING: Intentionally using or attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
2. FABRICATION: Making up data or results, and recording or reporting them; submitting fabricated documents.
3. FALSIFICATION: Manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
4. MULTIPLE SUBMISSION: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from the instructor of the class for which the student submits the work.
5. PLAGIARISM: The appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
6. COMPLICITY: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.
7. ABUSE AND MISUSE OF ACCESS AND UNAUTHORIZED ACCESS: Students may not abuse or misuse computer access or gain unauthorized access to information in any academic exercise. See Student Rule 22: http://student-rules.tamu.edu/
8. VIOLATION OF DEPARTMENTAL OR COLLEGE RULES: Students may not violate any announced departmental or college rule relating to academic matters.
9. UNIVERSITY RULES ON RESEARCH: Students involved in conducting research and/or scholarly activities at Texas A&M University must also adhere to standards set forth in University Rule 15.99.03.M1 - Responsible Conduct in Research and Scholarship. For additional information please see:


Academic Integrity Statement and Policy:

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20). You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at https://aggiehonor.tamu.edu/.

Copyright Statement:

The materials used in this course are copyrighted. These materials include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless permission is expressly granted.

Plagiarism Statement:

As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, http://student-rules.tamu.edu, under the section "Scholastic Dishonesty."

University Writing Center:

The mission of the University Writing Center (UWC) is to help you develop and refine the communication skills vital to success in college and beyond. Currently, you can choose to work with a trained UWC peer consultant via web conference or email. You can schedule an appointment to discuss any kind of writing or speaking project, including research papers, lab reports, application essays, or creative writing. Our consultants can work with you at any stage of your process, whether you're deciding on a topic or reviewing your final draft. You can also get help with public speaking, presentations, and group projects. To schedule an appointment or to view our handouts, videos, or interactive learning modules, visit http://writingcenter.tamu.edu/. Questions? Call 979-458-1455 or email uwc@tamu.edu.
**Title IX and Statement on Limits to Confidentiality:**

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking. With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS). Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

**Statement on Mental Health and Wellness:**

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at https://suicidepreventionlifeline.org/.

**COVID-19 Temporary Amendment to Minimum Syllabus Requirements:**

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

**Campus Safety Measures:**

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
- **Face Coverings**—Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.
- **Physical Distancing**—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- **Classroom Ingress/Egress**—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course line has concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- **Personal Illness and Quarantine:**

Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.
Learning Objectives

The student should be able to demonstrate mastery of objectives in the following areas:

- **Module 1 — Advanced Mathematics Relevant to Problems in Engineering**
- **Module 2 — Petrophysical Properties**
- **Module 3 — Fundamentals of Flow in Porous Media**
- **Module 4 — Reservoir Flow Solutions**
- **Module 5 — Applications/Extensions of Reservoir Flow Solutions**

Considering these modular topics, we have the following catalog of course objectives:

**Module 1: Advanced Mathematics Relevant to Problems in Engineering**

- **Fundamental Topics in Mathematics:**
  - Work fundamental problems in algebra and trigonometry, including partial fractions and the factoring of equations.
  - Perform elementary and advanced calculus: analytical integration and differentiation of elementary functions (polynomials, exponentials, and logarithms), trigonometric functions (sin, cos, tan, sinh, cosh, tanh, and combinations), and special functions (Error, Gamma, Exponential Integral, and Bessel functions).
  - Derive the Taylor series expansions and Chebyshev economizations for a given function.
  - Derive and apply formulas for the numerical differentiation and integration of a function using Taylor series expansions. Specifically, be able to derive the forward, backward, and central "finite-difference" relations for differentiation, as well as the "Trapezoidal" and "Simpson's" Rules for integration.
  - Apply the Gaussian and Laguerre quadrature formulas for numerical integration.

- **Numerical Differentiation and Integration of Analytic Functions:**
  - Be able to recognize, develop, and apply the Taylor series (finite-difference) formulas for numerical differentiation of an analytic function.
    - The $O(\Delta x)^4$ derivatives are expressed as:
      - **First Derivative, $f'(x)$:**
        \[
        f'(x) = \frac{1}{12\Delta x} \left( f(x - 2\Delta x) - 8f(x - \Delta x) + 8f(x + \Delta x) - f(x + 2\Delta x) \right) + O(\Delta x)^4
        \]
      - **Second Derivative, $f''(x)$:**
        \[
        f''(x) = \frac{1}{12(\Delta x)^2} \left( (-f(x - 2\Delta x) + 16f(x - \Delta x) - 30f(x) + 16f(x + \Delta x) - f(x + 2\Delta x)) \right) + O(\Delta x)^4
        \]
      - **Third Derivative, $f'''(x)$:**
        \[
        f'''(x) = \frac{1}{8(\Delta x)^3} \left( f(x - 3\Delta x) - 8f(x - 2\Delta x) + 13f(x - \Delta x) - 13f(x + \Delta x) + 8f(x + 2\Delta x) 
        
        - f(x + 3\Delta x) \right) + O(\Delta x)^4
        \]
      - **Fourth Derivative, $f''''(x)$:**
        \[
        f''''(x) = \frac{1}{6(\Delta x)^4} \left( (-f(x - 3\Delta x) + 12f(x - 2\Delta x) - 39f(x - \Delta x) 
        
        + 56f(x) - 39f(x + \Delta x) + 12f(x + 2\Delta x) - f(x + 3\Delta x)) \right) + O(\Delta x)^4
        \]
Course Objectives (Continued)

Module 1: Advanced Mathematics Relevant to Problems in Engineering (continued)

- Be able to recognize and apply the following formulas and methodologies for numerical integration.
  - Trapezoidal rule: (with correction) (be able to develop — see Hornbeck):
    \[
    I(x) = \int_{x_0}^{x_n} f(x) dx \approx \frac{\Delta x}{2} \left[ f(x_0) + f(x_n) \right] + \Delta x \sum_{i=1}^{n-1} f(x_i) - \frac{\Delta x^2}{12} \left[ f''(x_n) - f'(x_0) \right]
    \]
    where \( \Delta x = \frac{x_n - x_0}{n} \)
  - Simpson's rule: (with correction) (be able to develop — see Hornbeck):
    \[
    I(x) = \int_{x_0}^{x_n} f(x) dx \approx \frac{\Delta x}{3} \left[ f(x_0) + f(x_n) + 4 \sum_{i=1 \text{ odd}}^{n-1} f(x_i) + 2 \sum_{i=2 \text{ even}}^{n-2} f(x_i) \right] - \frac{(\Delta x)^4}{180} (x_n - x_0) f^{IV}(\bar{x})
    \]
    where \( n \) must be even. Also \( \Delta x = \frac{x_n - x_0}{n} \) and \( \bar{x} = \frac{x_n + x_0}{2} \).
  - Gaussian quadrature: (weights and abscissas from Abramowitz and Stegun: *Handbook of Mathematical Functions*, Table 25.4, pgs. 916-919):
    \[
    \int_{x_0}^{x_n} f(x) dx \approx \frac{x_n - x_0}{2} \sum_{i=1}^{n} w_i f(z_i) \text{ where } z_i \left( \frac{x_n - x_0}{2} \right) x_i + \left( \frac{x_n + x_0}{2} \right)
    \]
  - Laguerre quadrature: (weights and abscissas from Abramowitz and Stegun: *Handbook of Mathematical Functions*, Table 25.9, pgs. 923):
    \[
    \int_{0}^{\infty} e^{-x} f(x) dx = \sum_{i=1}^{n} w_i f(x_i) \text{ or } \int_{0}^{\infty} g(x) dx = \sum_{i=1}^{n} w_i e^{x_i} g(x_i)
    \]

Solution of First and Second Order Ordinary Differential Equations:

- First Order Ordinary Differential Equations:
  - Classify the order of a differential equation (order of the highest derivative).
  - Verify a given solution of a differential equation via substitution of a given solution into the original differential equation.
  - Solve first order ordinary differential equations using the method of separation of variables (or separable equations).
  - Derive the method of integrating factors for a first order ordinary differential equation.
  - Apply the Euler and Runge-Kutta methods to numerically solve first order ordinary differential equations.

Solution of First Order Ordinary Differential Equations:

- Be able to derive the method of integrating factors for a first order ordinary differential equation.
- Be able to determine the solution of a first order ordinary differential equation using the method of integrating factors.

Second Order Ordinary Differential Equations:

- Develop the homogeneous (or complementary) solution of a 2nd order ordinary differential equation (ODE) using \( y = e^{mx} \) as a trial solution.
- Develop the particular solution of a 2nd order ordinary differential equation (ODE) using the method of undetermined coefficients.
Course Objectives (Continued)

Module 1: Advanced Mathematics Relevant to Problems in Engineering (continued)

- Application of the Runge-Kutta Method:
  - Be able to apply the Runge-Kutta methods to numerically solve 1st order ordinary differential equations given a general 1st order relation of the form:
    1. Given \( a_0 \frac{dy}{dt} + a_1 y = r(t) \), we must rearrange to yield the following form:
       \[
       \frac{dy}{dt} = \frac{1}{a_0} [r(t) - a_1 y]
       \]
    2. We also require the "initial" conditions: \( t_i \) and \( y_i = y(t_i) \), where \( t_i \) is usually set equal to zero (but does not have to be set to zero).
  - Be able to apply the Runge-Kutta methods to numerically solve 2nd order ordinary differential equations given a general 2nd order relation of the form:
    1. Given \( a_0 \frac{d^2 y}{dt^2} + a_1 \frac{dy}{dt} + a_2 y = r(t) \), we must rearrange to yield the following form:
       \[
       \frac{d^2 y}{dt^2} = \frac{1}{a_0} [r(t) - a_1 \frac{dy}{dt} - a_2 y] \]
       or \[
       \frac{d^2 y}{dt^2} = \frac{1}{a_0} [r(t) - a_1 y - a_2 \frac{dy}{dt}] \]
    2. For 2nd order equations, we again require "initial" conditions, but now we include a first derivative term. In this case we require: \( t_i, y_i = y(t_i) \), and \( v_i = v(t_i) \) where again, \( t_i \) is usually set equal to zero (but does not have to be set to zero).

- The Laplace Transform:
  - Fundamentals of the Laplace Transform:
    - Be able to state the definition of the Laplace transformation and its inverse.

  **Definition of the Laplace Transform:**
  \[
  \overline{f}(s) = L(f(t)) = \int_{0}^{\infty} e^{-st} f(t)dt \text{ or } \frac{1}{s} \int_{0}^{\infty} e^{-st} f(t)dt \text{ (using } x=st) \]

  **Definition of the Inverse Laplace Transform:** (Mellin Inversion Integral)
  \[
  f(t) = L^{-1}(f(s)) = \frac{1}{2\pi i} \int_{y-i\infty}^{y+i\infty} e^{st} \overline{f}(s)ds \]
  - Be able to prove that the Laplace transform is a linear operator.
  - Be able to derive the Laplace transforms given on page 98 of the Spiegel text.
  - Be familiar with, and be able to derive, the operational theorems for the Laplace transform as given on pages 101-102 of the Spiegel text.

  **Properties of the Laplace Transform:**
  - Be familiar with the "unit step" function shown below

The unit step function is given by:
- \( u(t-a) = 0 \) for \( t < a \)
- \( u(t-a) = 1 \) for \( t > a \)

And its Laplace transform is:
- \( \overline{f}(s) = \frac{1}{s} e^{-as} \)
Course Objectives (Continued)

Module 1: Advanced Mathematics Relevant to Problems in Engineering (continued)
— Be able to develop and apply the Laplace transform formulas for the discrete data functions shown below.

+ **Step Data Function:**
\[
\tilde{f}(s) = \frac{1}{s} \sum_{i=1}^{n} (f_i - f_{i-1}) e^{-st_i} \text{ where } (t_0 = 0 \text{ and } f_0 = 0)
\]

+ **Piecewise Linear Data Function:** (Roumboutsos and Stewart Method)
\[
\tilde{f}(u) = \frac{1}{s^2} m_1 (1 - e^{-st_1}) + \frac{1}{s^2} \sum_{i=2}^{n-1} m_i (e^{-st_i} - e^{-st_{i-1}}) + \frac{1}{s^2} m_n e^{-st_{n-1}}
\]
where the slope terms \(m_i\)'s are taken as backward differences given by
\[
m_i = \frac{f_i - f_{i-1}}{t_i - t_{i-1}}
\]

+ **Piecewise Log-Linear Data Function:** (Blasingame Method)
\[
\tilde{f}(s) = \frac{a_1}{s^1} \gamma(v_1, st_1) + \frac{a_2}{s^2} \gamma(v_2, st_2) - \frac{a_2}{s^2} \gamma(v_2, st_1)
\]
\[
+ \ldots + \frac{a_{n-1}}{s^{v_n-1}} \gamma(v_{n-1}, st_{n-1}) - \frac{a_{n-1}}{s^{v_n-1}} \gamma(v_{n-1}, st_{n-2}) + \frac{a_n}{s^{v_n}} \Gamma(v_n) - \frac{a_n}{s^{v_n}} \gamma(v_n, st_{n-1})
\]
The slope and intercept terms (\(a\)'s and \(v\)'s) are shown graphically in the attached notes. Also, \(\Gamma(x)\) is the Gamma function and \(\gamma(a, x)\) is the first incomplete Gamma function.

Applications of the Laplace Transform to Solve Linear Ordinary Differential Equations:
— Be able to develop the Laplace transform of a given differential equation and its initial condition(s). This requires the Laplace transform of each time-derivative, then substitution into the differential form, the result is an algebraic expression in terms of \(s\) and \(\tilde{f}(s)\).

+ **Laplace Transform of a Generic Time Dependent Derivative:**
\[
L\left(\frac{d^n}{dt^n} \ f(t)\right) = s^n \tilde{f}(s) - s^{n-1} f(t = 0) - s^{n-2} f'(t = 0) - \ldots - s f^{n-2} (t = 0) - f^{n-1} (t = 0)
\]
where \(c_0 = f(t = 0), c_1 = f'(t = 0), c_2 = f''(t = 0), \ldots c_{n-2} = f^{n-2} (t = 0), c_{n-1} = f^{n-1} (t = 0)\)

— Be able to resolve the algebra resulting from the Laplace transform of a given differential equation and its initial condition(s) into a closed and hopefully, invertible form.

— Be able to invert the closed form Laplace transform solution of a given differential equation using the fundamental properties of Laplace transforms, Laplace transform tables, partial fractions.

Numerical Laplace Transform and Inversion:
— Be able to use the Gauss-Laguerre integration formula for numerical Laplace transformation. The Laguerre quadrature weights, \(w_k\), and abscissas, \(x_k\), can be obtained from Abramowitz and Stegun.
\[
\tilde{f}(s) = \int_0^\infty e^{-st} f(t) dt \approx \frac{1}{s} \sum_{k=1}^{n} w_k f \left( \frac{xt}{s} \right)
\]
Course Objectives (Continued)

Module 1: Advanced Mathematics Relevant to Problems in Engineering (continued)

— Be familiar with the development of the Gaver formula for numerical Laplace transformation, and note its similarity to the Widder inversion formula given in the Cost (*AIAA Journal*) paper.

\[
\hat{f}(s) = \int_0^\infty e^{-st} f(t) dt \approx \frac{1}{s} \sum_{k=1}^{n} w_k f\left(\frac{x_k}{s}\right)
\]

— Be able to use the Gaver and Gaver-Stehfest numerical inversion algorithms for the inversion of Laplace transforms.

\[f_{\text{Gaver}}(t) = \frac{\ln(2)}{t} \sum_{k=0}^{n} \frac{(-1)^k}{(n-k)!} \left(\frac{\ln(2)}{t}\right)^{n+k}
\]

The Gaver-Stehfest formula for numerical Laplace transform inversion is

\[f_{\text{Gaver-Stehfest}}(t) = \frac{\ln(2)}{t} \sum_{i=1}^{n} V_i \frac{\ln(2)}{t}^{-i}
\]

and the Stehfest extrapolation coefficients are given

\[V_i = (-1)^{i/2} \sum_{k=1}^{i} \frac{k^{n/2} (2k)!}{n/2 (2k)! k!(k-1)!(i-k)!(2k-i)!}
\]

Introduction to Special Functions:

- Special Functions in Petroleum Engineering Applications
  — Be familiar with and be able to compute the following special functions which have applications in petroleum engineering:
  + Exponential Integral (\(Ei(x)\) and \(E_1(x)\) = \(-Ei(-x)\))
  + Gamma and Incomplete Gamma Functions (\(\Gamma(x)\), \(\gamma(a,x)\), \(\Gamma(a,x)\) and \(B(z,w)\))
  + Error and Complimentary Error Functions (\(erf(x)\) and \(erfc(x)\))
  + Bessel Functions: \(J_0(x), J_1(x), Y_0(x)\), and \(Y_1(x)\)
  + Modified Bessel Functions: \(I_0(x), I_1(x), K_0(x)\), and \(K_1(x)\), as well as the integrals of \(I_0(x)\) and \(K_0(x)\).

- Bessel Functions
  — Be familiar with the following Bessel functions:

  + Bessel Functions: \(J_\nu(x)\) and \(Y_\nu(x)\), where Bessel's differential equation is given as: (Abramowitz and Stegun; Chapter 9, Eq. 9.1.1)

\[
z^2 \frac{d^2 y}{dz^2} + z \frac{dy}{dz} + (z^2 - n^2)y = 0 \quad \text{and has the solution} \quad y = c_1 J_n(z) + c_2 Y_n(z)
\]

  + Modified Bessel Functions: \(I_\nu(x)\) and \(K_\nu(x)\), where Bessel's "modified" differential equation is given as: (Abramowitz and Stegun; Chapter 9, Eq. 9.6.1)

\[
z^2 \frac{d^2 y}{dz^2} + z \frac{dy}{dz} - (z^2 + n^2)y = 0 \quad \text{and has the solution} \quad y = c_1 I_n(z) + c_2 K_n(z)
\]

— Be able to use the Bessel functions in numerical problem solving efforts and theoretical developments; especially recurrence relations, integral definitions, and Laplace transforms.
Course Objectives (Continued)

Module 2: Petrophysical Properties

- Introduction to Porosity and Permeability Concepts:
  - Be able to recognize and classify rock types as clastics (sandstones) and carbonates (limestones, chalks, dolostones) along with the characteristics of porosity that these rocks exhibit.
  - Be able to distinguish between effective and total porosity, as well as be familiar with the meanings of primary (or depositional) porosity and secondary (or post-depositional) porosity.
  - Be familiar with factors which affect porosity. In particular, the shapes, arrangements, and distributions of grain particles and including the effect of cementation, vugs, and fractures on porosity.
  - Be familiar with the concept of permeability for porous rocks and be aware of the correlative relations for porosity and permeability.
  - Be familiar with "friction factor"-"Reynolds Number" plotting concept put forth by Cornell and Katz for flow through porous media. Be aware that this plotting concept validates Darcy's law empirically (the unit slope line on the left portion of the plot, lamina form).

- Development of a Semi-Empirical Concept of Permeability: Darcy’s Law:
  - Be able to develop a velocity/pressure gradient relation for modeling the flow of fluids in pipes (i.e., the Poiseuille equation).
    \[ v_{avg} = \frac{q}{A_x} = k_p \frac{1}{\mu} \frac{\Delta p}{\Delta x} \] where \( k_p = \frac{r^2}{8} \) is considered to be a "geometry" factor.
  - Be familiar with the general assumptions and limitations of the Poiseuille equation.
  - Be able to derive the "units" of a Darcy (1 Darcy = 9.86923x10^-9 cm^2).
  - Be able to derive the field units form of Darcy’s law.

- Introduction to Capillary Pressure and Relative Permeability:
  - Be familiar with the concept of "capillary pressure" for tubes as well as for porous media--and be able to derive the capillary pressure relation for fluid rise in a tube:
    \[ p_c = 2 \gamma_{ow} \cos(\theta) \frac{1}{r} \]
  - Be familiar with and be able to derive the permeability and relative permeability relations for porous media using the "bundle of capillary tubes" model as provided by Nakornthap and Evans. The permeability result is given by:
    \[ k = \phi^3 \frac{\gamma_{ow}^2}{2} \frac{1}{n} \int_0^{1/S_w} dS_w \]
  - Be familiar with the concept of "relative permeability" and the factors which should and should not affect this function. Also, be familiar with the laboratory techniques for measuring relative permeability.
Course Objectives (Continued)

Module 2: Petrophysical Properties (continued)

- Development of the Brooks-Corey-Burdine Equation for Permeability and the Development of a Type Curve Analysis Approach for Capillary Pressure Data:
  - Be able to derive the "field units" form of the Purcell-Burdine permeability equation ($k$ in md, $\gamma_{ow}$ in dyne/cm and, $p_c$ in psia). The Purcell-Burdine permeability equation as provided by Nakornthap and Evans is given in terms of absolute (i.e., metric) units. The "field units" result is given by:

$$k = 10.66\phi^3 \frac{\gamma_{ow}^2}{2} \frac{\beta}{n} \frac{1}{p_c^2} \int_0^1 dS_w^* \text{ where } \phi^* = \phi(1 - S_{wi})$$

  - Be familiar with and be able to derive the Brooks-Corey-Burdine equation for permeability based on the Purcell-Burdine permeability equation (as given above). This result is given by:

$$k = \phi^3 \frac{\beta}{n} \frac{1}{p_d^2} \left[ \frac{\lambda}{\lambda + 2} \right] \text{ or } k = 10.66\phi^3 \frac{\beta}{n} \frac{1}{p_d^2} \left[ \frac{\lambda}{\lambda + 2} \right] \text{ (field units)}$$

  - Be able to discuss the possible applications for the Brooks-Corey-Burdine permeability equation.

  - Be familiar with and be able to derive a type curve matching approach for capillary pressure data based on the Brooks-Corey model for capillary pressure and saturation given below.

$$p_D = (1 - S_{WD}) \frac{1}{\lambda} \text{ where } p_D = \frac{p_c}{p_d} \text{ and } S_{WD} = \frac{1 - S_w}{1 - S_{wi}} = 1 - S_w^*$$

- Electrical Properties of Reservoir Rocks:
  - Be familiar with the definition of the formation resistivity factor, $F$, as well as the effects of reservoir and fluid properties on this parameter.

  - Be familiar with and be able to use the Archie and Humble equations to estimate porosity given the formation resistivity factor, $F$.

  - Be familiar with the definition of the resistivity index, $I$, as well as the effects of reservoir and fluid properties on this parameter and also be familiar with the Archie result for water saturation, $S_w$.

  - Be familiar with the "shaly sand" models given by Waxman and Smits for relating the resistivity index with saturation and for relating formation factor with porosity.

- Development of a Type Curve Analysis Approach for Relative Permeability Data

  - Be familiar with and be able to derive the Burdine relative permeability equations (this derivation is provided in detail by Nakornthap and Evans). These relations are

$$k_{rw} = (S_w^*)^2 \int_0^{S_w^*} \frac{1}{p_c^2} dS_w^* \text{ and } k_{rn} = (1 - S_w^*)^2 \int_0^{1 - S_w^*} \frac{1}{p_c^2} dS_w^*$$

  - Be familiar with and be able to derive the Brooks-Corey-Burdine equations for relative permeability based on the combination of the Burdine relative permeability equations (shown above) and the Brooks and Corey capillary pressure model. These results are given by:

$$k_{rw} = k_{rw}^0 S_w^* (3 + 2/\lambda) \text{ and } k_{rn} = k_{rn}^0 (1 - S_w^*)^2 \left[ 1 - S_w^* (1 + 2/\lambda) \right]$$

where the Brooks and Corey capillary pressure model is given by $p_c = p_d S_w^* \frac{1}{\lambda}$
Course Objectives (Continued)

Module 2: Petrophysical Properties (continued)

- Be familiar with and be able to derive a type curve matching approach for relative permeability data based on the Brooks-Corey-Burdine relative permeability models. The "dimensionless" variables for this development are given below.
  - Dimensionless wetting phase relative permeability:
    \[ k_{rwD} = (1 - S_{wD})^{(3+2/\lambda)} \]
  - Dimensionless non-wetting phase relative permeability:
    \[ k_{rnD} = S_{wD}^2 [1-(1-S_{wD})^{(1+2/\lambda)}] \]
  - Dimensionless relative permeability ratio function:
    \[ \frac{k_{rnD}}{k_{rwD}} = \frac{S_{wD}^2}{(1-S_{wD})^2} [(1-S_{wD})^{-(1+2/\lambda)} - 1] \]
  - Dimensionless saturation functions:
    \[ S_{wD} = \frac{1-S_{w}^*}{1-S_{wi}^*} = 1 - S_w^* \quad \text{and} \quad S_{w}^* = \frac{S_w - S_{wi}}{1-S_{wi}} = 1 - S_{wD} \]

Module 3: Fundamentals of Flow in Porous Media

- **Steady-State Flow Concepts: Laminar Flow**
  - Derive the concept of permeability (Darcy's Law) using the analogy of the Poiseuille equation for the flow of fluids in capillaries. Be able to derive the "units" of a "Darcy" (1 Darcy = 9.86923x10^{-9} cm²), and be able to derive Darcy's Law in "field" and "SI" units.
  - Derive the single-phase, steady-state flow relations for the laminar flow of gases and compressible liquids using Darcy's Law — in terms of pressure, pressure-squared, and pseudopressure, as appropriate.
  - Derive the steady-state "skin factor" relations for radial flow.

- **Steady-State Flow Concepts: Non-Laminar Flow**
  - Demonstrate familiarity with the concept of "gas slippage" as defined by Klinkenberg.
  - Derive the single-phase, steady-state flow relations for the non-laminar flow of gases and compressible liquids using the Forchheimer equation (quadratic in velocity) — in terms of pressure, pressure-squared, and pseudopressure, as appropriate.

- **Material Balance Concepts:**
  - Be able to identify/apply material balance relations for gas and compressible liquid systems.
  - Be familiar with and be able to apply the "Havlena-Odeh" formulations of the oil and gas material balance equations.

- **Pseudosteady-State Flow Concepts:**
  - Demonstrate familiarity with and be able to derive the single-phase, pseudosteady-state flow relations for the laminar flow of compressible liquids in a radial flow system (given the radial diffusivity equation as a starting point).
  - Sketch the pressure distributions during steady-state and pseudosteady-state flow conditions in a radial system.
Module 3: Fundamentals of Flow in Porous Media (continued)

- Development of Diffusivity Equation: Pressure and Pseudopressure Forms, General and Radial Flow Geometries:
  - Be able to describe in words and in terms of mathematical expressions the mass continuity relation for flow through porous media.
  - Be able to develop the "diffusivity" equations for the flow of a slightly compressible liquid in porous media--"pressure" form, general flow geometry.
    - "Gradient-Squared" Case: General form for a slightly compressible liquid.
      \[ c(\nabla p)^2 + \nabla^2 p = \frac{\phi \mu c_t}{k} \frac{\partial p}{\partial t} \]
    - "Small and Constant Compressibility" Case: Base relation for all developments in reservoir engineering and well testing.
      \[ \nabla^2 p = \frac{\phi \mu c_t}{k} \frac{\partial p}{\partial t} \]
  - Be able to derive the pseudopressure/pseudotime forms of the diffusivity equation for cases where fluid density and viscosity are functions of pressure for a general flow geometry.
    - "Pseudopressure-Time" Form
      \[ \nabla^2 p_p = \frac{\phi \mu c_t}{k} \frac{\partial p_p}{\partial t} \]
    - "Pseudopressure-Pseudotime" Form
      \[ \nabla^2 p_p = \frac{\phi (\mu c_t)_n}{k} \frac{\partial p_p}{\partial t_a} \]
    - where the "pseudopressure" function, \( p_p \), is given by:
      \[ p_p = \left( \frac{\mu B}{k} \right)_n \int_{p_{base}}^{p} \frac{k}{\mu B} dp \quad \text{or} \quad p_p = (\mu B)_n \int_{p_{base}}^{p} \frac{1}{\mu B} dp \]
    - and the "pseudotime" function, \( t_a \), is given by:
      \[ t_a = (\mu c_t)_n \int_{0}^{t} \frac{1}{\mu(p)c_t(p)} dt \]

- Development of Diffusivity Equations for the Flow of a Real Gas: Pressure and Pressure-Squared and Pseudopressure Forms:
  - Be familiar with and be able to derive the single-phase diffusivity equations in terms of formation volume factors (\( B_o \) or \( B_g \)) for both the oil and gas cases. These results are given as:
    - Single-Phase Oil Equation:
      \[ \nabla \cdot \left[ \frac{k_o}{\mu_o B_o} \nabla \phi \right] = \frac{\partial (\phi B_o)}{\partial t} \]
    - Single-Phase Gas Equation:
      \[ \nabla \cdot \left[ \frac{k_g}{\mu_g B_g} \nabla \phi \right] = \frac{\partial (\phi B_g)}{\partial t} \]
  - Be able to develop the general form of the diffusivity equation for single-phase gas flow in terms of pressure (and \( p/z \)) — starting from the density formulation. These relations are given by:
    - Density Formulation:
      \[ \nabla \cdot \left[ \frac{\phi k}{\mu} \nabla p \right] = \frac{\partial (\phi p)}{\partial t} \]
    - General Form: Single-Phase Gas Equation:
      \[ \nabla \cdot \left[ \frac{\phi k}{\mu} \nabla p \right] = \frac{\partial \left( \frac{\phi k p}{k} \right)}{\partial t} \]
  - Be able to develop the diffusivity equation for single-phase gas flow in terms of the following: pseudopressure, pressure-squared, and pressure.
Course Objectives (Continued)

Module 3: Fundamentals of Flow in Porous Media (continued)

— "Pseudopressure" Formulation:

\[ \nabla^2 p_{pg} = \frac{\phi \mu c_t}{k} \frac{\partial p_{pg}}{\partial t} \]

where \( \frac{p_{pg}}{p} = \left( \frac{\mu z}{p} \right)_n \int_{p_{base}}^{p} \frac{p}{\mu z} dp \)

— "Pressure-Squared" Formulation:

\[ \nabla^2 (p^2) - \frac{\partial}{\partial p^2} \left[ \ln(\mu z) \right] (\nabla (p^2))^2 = \frac{\phi \mu c_t}{k} \frac{\partial p}{\partial t} \]

if \( \mu z \approx \) constant then \( \nabla^2 (p^2) = \frac{\phi \mu c_t}{k} \frac{\partial p}{\partial t} \)

— "Pressure" Formulation:

\[ \nabla^2 p - \frac{\partial}{\partial p} \left[ \ln(\mu z) \right] [\nabla p]^2 = \frac{\phi \mu c_t}{k} \frac{\partial p}{\partial t} \]

if \( \mu z \approx \) constant then \( \nabla^2 p = \frac{\phi \mu c_t}{k} \frac{\partial p}{\partial t} \)

Development of Diffusivity Equations for the Multiphase Flow:

- Be able to develop the continuity relations for the oil, gas, and water phases in terms of the fluid densities. Assume that the gas phase includes gas liberated from the oil and water phases.

Oil Continuity Equation:

\[ \nabla \bullet (\rho_o v_o) = \frac{\partial}{\partial t} (\phi \rho_o) \]

Water Continuity Equation:

\[ \nabla \bullet (\rho_w v_w) = -\frac{\partial}{\partial t} (\phi \rho_w) \]

Gas Continuity Equation:

\[ \nabla \bullet (\rho_g v_g)_{tot} = \nabla \bullet [p_g v_g + \frac{v_o}{B_o} R_{so} \rho_{gsc} + \frac{v_w}{B_w} R_{sw} \rho_{gsc}] = -\frac{\partial}{\partial t} (\phi \rho_g)_{tot} \]

- Be able to write Darcy's law velocity relations for each phase. The general form is given by:

\[ v_i = -\frac{k_i}{\mu_i} \nabla p_i \] where \( i = \) oil, gas, and water.

- Be able to develop the mass flux relations for the oil, gas, and water phases in terms of the fluid formation volume factors. Again, assume that the gas phase includes gas liberated from the oil and water phases.

Oil Flux Equation:

\[ \rho_o v_o = -\rho_{osc} \frac{k_o}{\mu_o B_o} \nabla p_o \]

Water Flux Equation:

\[ \rho_w v_w = -\rho_{wsc} \frac{k_w}{\mu_w B_w} \nabla p_w \]

Gas Flux Equation:

\[ (\rho_g v_g)_{tot} = -\rho_{gsc} \left[ \frac{k_g}{\mu_g B_g} \nabla p_g + R_{so} \frac{k_o}{\mu_o B_o} \nabla p_o + R_{sw} \frac{k_w}{\mu_w B_w} \nabla p_w \right] \]

- Be able to develop the mass relations for the oil, gas, and water phases in terms of the fluid formation volume factors. As before, assume that the gas phase includes gas liberated from the oil and water phases.

Oil Mass Equation:

\[ (\phi \rho_o) = \phi \rho_o s_o = \phi \rho_{osc} s_o \frac{B_o}{B_o} \]

Water Mass Equation:

\[ (\phi \rho_w) = \phi \rho_w s_w = \phi \rho_{wsc} s_w \frac{B_w}{B_w} \]
Course Objectives (Continued)

Module 3: Fundamentals of Flow in Porous Media (continued)

Gas Mass Equation:

\[ (\phi \rho_g)_{oil} = \phi \rho_g S_g + \phi S_o \frac{R_{so}}{B_o} \rho_{gsc} + \phi S_w \frac{R_{sw}}{B_w} \rho_{gsc} = \phi \rho_g [\frac{S_g}{B_g} + R_{so} \frac{S_o}{B_o} + R_{sw} \frac{S_w}{B_w}] \]

Assuming no capillary pressure forces \((\nabla P = \nabla p_o = \nabla P_g = \nabla p_w)\), be able to develop the generalized diffusivity relations for each phase. (Martin Eqs. 1-3)

"Oil" Equation:

\[ \nabla \cdot \left[ \frac{k_o}{\mu_o B_o} \nabla P_o \right] = \frac{\partial}{\partial t} (\phi \frac{S_o}{B_o}) \]

"Water" Equation:

\[ \nabla \cdot \left[ \frac{k_w}{\mu_w B_w} \nabla P_o \right] = \frac{\partial}{\partial t} (\phi \frac{S_w}{B_w}) \]

"Gas" Equation:

\[ \nabla \cdot \left[ \left( \frac{k_g}{\mu_g B_g} + R_{so} \frac{k_o}{\mu_o B_o} + R_{sw} \frac{k_w}{\mu_w B_w} \right) \nabla P \right] = \frac{\partial}{\partial t} \left[ \phi \left( \frac{S_g}{B_g} + R_{so} \frac{S_o}{B_o} + R_{sw} \frac{S_w}{B_w} \right) \right] \]

NEGLECTING the \( \nabla S_g \nabla P, \nabla S_w \nabla P, \) and \( \nabla P \nabla P = \nabla p^2 \) terms — be able to develop the diffusivity relations for each phase as shown by Martin (Eqs. 7-9)

"Oil" Equation:

\[ \frac{k_o}{\mu_o B_o} \nabla^2 P_o = \frac{\partial}{\partial t} (\phi \frac{S_o}{B_o}) \]

"Water" Equation:

\[ \frac{k_w}{\mu_w B_w} \nabla^2 P_w = \frac{\partial}{\partial t} (\phi \frac{S_w}{B_w}) \]

"Gas" Equation:

\[ \left( \frac{k_g}{\mu_g B_g} + R_{so} \frac{k_o}{\mu_o B_o} + R_{sw} \frac{k_w}{\mu_w B_w} \right) \nabla^2 P = \frac{\partial}{\partial t} \left[ \phi \left( \frac{S_g}{B_g} + R_{so} \frac{S_o}{B_o} + R_{sw} \frac{S_w}{B_w} \right) \right] \]

Development of Diffusivity Equations for the Multiphase Flow — Martin's Saturation Equations and the Concept of Total Compressibility:

Be familiar with and be able to derive the Martin relations for total compressibility and the associated saturation-pressure relations (Eqs. 10 and 11).

Oil Saturation Equation:

\[ \frac{dS_o}{dp} = \frac{S_o}{B_o} \frac{dB_o}{dp} + \frac{\lambda_o}{\lambda_t} c_t \]

Water Saturation Equation:

\[ \frac{dS_w}{dp} = \frac{S_w}{B_w} \frac{dB_o}{dp} + \frac{\lambda_w}{\lambda_t} c_t \]

Total Compressibility:

\[ c_t = \frac{S_o}{B_o} \frac{dB_o}{dp} + \frac{S_o B_g}{B_o} \frac{dR_{so}}{dp} - \frac{S_w}{B_w} \frac{dB_w}{dp} + \frac{S_w B_g}{B_w} \frac{dR_{sw}}{dp} - \frac{S_g}{B_g} \frac{dB_g}{dp} \]

or,

\[ c_t = \left[- \frac{1}{B_o} \frac{dB_o}{dp} + \frac{B_g}{B_o} \frac{dR_{so}}{dp} \right] S_o + \left[- \frac{1}{B_w} \frac{dB_w}{dp} + \frac{B_g}{B_w} \frac{dR_{sw}}{dp} \right] S_w + \left[- \frac{1}{B_g} \frac{dB_g}{dp} \right] S_g \]

or finally,

\[ c_t = c_o S_o + c_w S_w + c_g S_g \]

where,
Module 4: Reservoir Flow Solutions

\[
c_o = - \frac{1}{B_o} \frac{dB_o}{dp} + \frac{B_g}{B_o} \frac{dR_{so}}{dp}, \quad c_w = - \frac{1}{B_w} \frac{dB_w}{dp} + \frac{B_g}{B_w} \frac{dR_{sw}}{dp}, \quad \text{and} \quad c_g = - \frac{1}{B_g} \frac{dB_g}{dp}
\]

Total Pressure Equation:

\[
\nabla^2 p = \phi c_i \frac{\partial}{\partial t} \quad \text{where} \quad \lambda_i = \frac{k_o}{\mu_o} + \frac{k_g}{\mu_g} + \frac{k_w}{\mu_w}
\]

- Dimensionless Variables and the Dimensionless Radial Flow Diffusivity Equation:
  
  - Be able to develop the dimensionless form of the single-phase radial flow diffusivity equation as well as the appropriate dimensionless forms of the initial and boundary conditions, including the developments of dimensionless radius, pressure, and time.
  
  - The Dimensionless Diffusivity Equation:
    
    \[
    \frac{\partial^2 \tilde{p}_D}{\partial r_D^2} + \frac{1}{r_D} \frac{\partial \tilde{p}_D}{\partial r_D} = \frac{\partial \tilde{p}_D}{\partial t_D}
    \]
  
  - Dimensionless Initial and Boundary Conditions:
    
    + Dimensionless Initial Condition
      
      \[p_D(r_D, t_D \leq 0) = 0\] (uniform pressure in reservoir)
    
    + Dimensionless Inner Boundary Condition
      
      \[\left[ r_D \frac{\partial \tilde{p}_D}{\partial r_D} \right]_{r_D=1} = -1\] (constant rate at the well)
    
    + Dimensionless Outer Boundary Conditions
      
      a. "Infinite-Acting" Reservoir
      
      \[p_D(r_D \to \infty, t_D) = 0\]
    
      b. "No-Flow" Boundary
      
      \[\left[ r_D \frac{\partial \tilde{p}_D}{\partial r_D} \right]_{r_D=r_D} = 0\] (No flux across the reservoir boundary)
    
      c. Constant Pressure Boundary
      
      \[p_D(r_D, t_D = 0) = 0\] (Constant pressure at the reservoir boundary)
  
  - Be able to derive the conversion factors for dimensionless pressure and time, for both SI and "field" units.

- Solutions of the Radial Flow Diffusivity Equation Using the Laplace Transform:
  
  - Be able to recognize that the Laplace transform of the dimensionless form of the single-phase radial flow diffusivity equation is the modified Bessel differential equation. Also, be able to write the general solution for this transformed differential equation.

  Dimensionless Diffusivity Equation:

  \[
  \frac{\partial}{\partial r_D} \left[ r_D \frac{\partial \tilde{p}_D}{\partial r_D} \right] = \frac{\partial^2 \tilde{p}_D}{\partial r_D^2} + \frac{1}{r_D} \frac{\partial \tilde{p}_D}{\partial r_D} = \frac{\partial \tilde{p}_D}{\partial t_D}
  \]

  Laplace Transform of Diffusivity Equation:

  \[
  \frac{1}{r_D} \frac{d}{dr_D} \left[ r_D \frac{d \tilde{p}_D}{dr_D} \right] = \omega \tilde{p}_D
  \]
Course Objectives (Continued)

Module 4: Reservoir Flow Solutions (continued)

General Solution:
\[ \bar{p}_D(r_D, u) = A_0(u) + B_0(u) \]

Derivative of the General Solution:
\[ \frac{d\bar{p}_D}{dr_D} = A_1(u) - B_1(u) \]

- Be able to develop the particular solution (in Laplace domain) for the constant rate and constant pressure inner boundary conditions and the infinite-acting reservoir outer boundary condition. Also, be able to use the van Everdingen and Hurst result to convert the constant rate case to the constant wellbore pressure case.

  **Constant Rate Solution** (infinite-acting reservoir)

\[ \bar{p}_D(r_D, u) = \frac{1}{u} K_0(\sqrt{u} r_D) \approx \frac{1}{u} K_1(\sqrt{u} r_D) \]

Constant Rate-Constant Pressure Relation: (from van Everdingen and Hurst)

\[ \bar{q}_D(u) = \frac{1}{u^2} = \frac{1}{p_D(u)} \]

- Be able to develop the real domain (time) solution for the constant rate inner boundary condition and the infinite-acting reservoir outer boundary condition using both the Laplace transform and the Boltzmann transform approaches. Also be able to develop the "log-approximation" for this solution.

  **Boltzmann Transform of the Diffusivity Equation:**

\[ \frac{d^2 p_D}{d\epsilon_D^2} + \left[1 + \frac{1}{\epsilon_D} \frac{d p_D}{d\epsilon_D} \right] = 0 \quad \text{(infinite-acting reservoir case only)} \]

"Log Approximation" Solution for the Diffusivity Equation:

\[ p_D(r_D, u) \approx \frac{1}{u} K_0(\sqrt{u} r_D) \approx \frac{1}{2u} \ln\left[ \frac{4}{e^y \frac{1}{r_D^2}} \right] \quad (y=0.577216... \text{Euler's constant}) \]

- **Laplace Transform Solutions of the Radial Flow Diffusivity Equation for a Bounded Circular Reservoir:**

  - Be able to derive the particular solutions (in Laplace domain) for a well produced at a constant flow rate in a homogeneous reservoir for the following initial condition, subject to the following initial and outer boundary conditions:

    - Dimensionless Initial and Boundary Conditions:
      
      + Dimensionless Initial Condition
      
      \[ p_D(r_D, t_D \leq 0) = 0 \quad \text{(uniform pressure in reservoir)} \]
      
      + Dimensionless Inner Boundary Condition
      
      \[ [r_D \frac{\partial p_D}{\partial r_D}]_{r_D=1} = -1 \quad \text{(constant rate at the well)} \]
      
      + Dimensionless Outer Boundary Conditions
      
      a. Prescribed Flux at the Boundary
      
      \[ [r_D \frac{\partial p_D}{\partial r_D}]_{r_D=r_e D} = q_{Dext}(t_D) \]
Course Objectives (Continued)

Module 4: Reservoir Flow Solutions (continued)

b. Constant Pressure at the Boundary

\[ p_D(r_D = r_e, t_D) = 0 \]

— Particular Solutions in the Laplace Domain:

+ "Infinite-acting" reservoir behavior

\[ \mathcal{P}_D(r_D, u) = \frac{1}{u} \frac{K_0(\sqrt{u} r_D)}{\sqrt{u} K_1(\sqrt{u})} \]

Or the line source approximation

\[ \mathcal{P}_D(r_D, u) = \frac{1}{u} K_0(\sqrt{u} r_D) \quad (\text{where } \sqrt{u} K_1(\sqrt{u}) \to 1, \text{ for } \sqrt{u} \to 0) \]

+ Bounded circular reservoir — "no-flow" at the outer boundary (i.e., \( q_{D\text{ext}}(t_D) = 0 \))

\[ \mathcal{P}_D(r_D, u) = \frac{1}{u} \frac{K_0(\sqrt{u} r_D)l_0(\sqrt{u} r_{e_D}) + K_1(\sqrt{u} r_{e_D})l_0(\sqrt{u} r_D)}{\sqrt{u} K_1(\sqrt{u})l_0(\sqrt{u} r_{e_D})} \]

(1) \( \text{constant rate at the well} \)

+ Bounded circular reservoir — "constant-pressure" at the outer boundary

\[ \mathcal{P}_D(r_D, u) = \frac{1}{u} \frac{K_0(\sqrt{u} r_D)l_0(\sqrt{u} r_{e_D}) - K_0(\sqrt{u} r_{e_D})l_0(\sqrt{u} r_D)}{\sqrt{u} K_1(\sqrt{u})l_0(\sqrt{u} r_{e_D})} \]

(1) \( \text{constant rate at the well} \)

+ Bounded circular reservoir — "prescribed flux" at the outer boundary

\[ \mathcal{P}_D(r_D, u) = \frac{1}{u} \frac{K_0(\sqrt{u} r_D)l_0(\sqrt{u} r_{e_D}) + K_1(\sqrt{u} r_{e_D})l_0(\sqrt{u} r_D)}{\sqrt{u} K_1(\sqrt{u})l_0(\sqrt{u} r_{e_D})} \]

(1) \( \text{constant rate at the well} \)

+ Bounded circular reservoir — "no-flow" at the outer boundary

\[ \mathcal{P}_D(r_D, u) = \frac{1}{u} \frac{K_0(\sqrt{u} r_D)l_0(\sqrt{u} r_{e_D}) - K_0(\sqrt{u} r_{e_D})l_0(\sqrt{u} r_D)}{\sqrt{u} K_1(\sqrt{u})l_0(\sqrt{u} r_{e_D})} \]

\[ + \frac{1}{u} q_{D\text{ext}}(u) \left[ \frac{u}{\sqrt{u} r_{e_D}} \right] K_0(\sqrt{u} r_D)l_0(\sqrt{u} r_{e_D}) - \sqrt{u} K_1(\sqrt{u})l_0(\sqrt{u} r_{e_D}) \]

**Real Domain Solutions of the Radial Flow Diffusivity Equation for a Bounded Circular Reservoir:**

- Be able to derive the following particular solutions in the real domain from the appropriate Laplace transform solutions for an unfractured well produced at a constant flow rate in a homogeneous reservoir for the following outer boundary conditions:

  — "Infinite-acting" reservoir behavior (line source solution)

\[ p_D(t_D, r_D) = \frac{1}{2} E_1(\frac{r_D^2}{4t_D}) \]

or the so-called "log approximation"

\[ p_D(t_D, r_D) = \frac{1}{2} \ln(\frac{4}{\pi} \frac{t_D}{r_D^2}) \]

— Bounded circular reservoir — "no-flow" at the outer boundary

\[ p_D(t_D, r_D) = \frac{1}{2} E_1(\frac{r_D^2}{4t_D}) - \frac{1}{2} E_1(\frac{r_{e_D}^2}{4t_D}) + \frac{2t_D}{r_{e_D}^2} \exp(-\frac{r_{e_D}^2}{4t_D}) + \frac{t_D^2}{2r_{e_D}^2} - \frac{1}{4} \exp(-\frac{r_{e_D}^2}{4t_D}) \]

and its "well testing" derivative function, \( p_D' = \frac{d}{dt_D}[p_D(t_D, r_D)] \) is given by
Course Objectives (Continued)

Module 4: Reservoir Flow Solutions (continued)

\[ p'(t_D, r_D) = \frac{1}{2} \exp\left(-\frac{r_D^2}{4t_D}\right) + \frac{2t_D}{r_{eD}^2} \exp\left(-\frac{r_{eD}^2}{4t_D}\right) + \frac{1}{2t_D} \left( \frac{r_D^2}{4} - \frac{r_{eD}^2}{8} \right) \exp\left(-\frac{r_{eD}^2}{4t_D}\right) \]

— Bounded circular reservoir — "constant pressure" at the outer boundary

\[ p_D(t_D, r_D) = \frac{1}{2} E_1\left(\frac{r_D^2}{4t_D}\right) - \frac{1}{2} E_1\left(\frac{r_{eD}^2}{4t_D}\right) + \frac{1}{8t_D} (r_{eD}^2 - r_D^2) \exp\left(-\frac{r_{eD}^2}{4t_D}\right) \]

and its "well testing" derivative function, \( p_D' = d/dt_D[p_D(r_D, t_D)] \) is given by

\[ p'(t_D, r_D) = \frac{1}{2} \exp\left(-\frac{r_D^2}{4t_D}\right) - \frac{1}{2} \exp\left(-\frac{r_{eD}^2}{4t_D}\right) + \frac{1}{8t_D} (r_{eD}^2 - r_D^2)(r_{eD}^2 - r_D^2 - 1) \exp\left(-\frac{r_{eD}^2}{4t_D}\right) \]

● Solutions for the Behavior of a Fractured Well in a Bounded Circular Reservoir: Infinite and Finite-Acting Reservoir Cases:

■ Be familiar with the concept of a well with a uniform flux or infinite conductivity vertical fracture in a homogeneous reservoir. Note that the uniform flux condition implies that the rate of fluid entering the fracture is constant at any point along the fracture. On the other hand, for the infinite conductivity case, we assume that there is no pressure drop in the fracture as fluid flows from the fracture tip to the well.

■ Be able to derive the following real and Laplace domain (line source) solutions for a well with a uniform flux or infinite conductivity vertical fracture in a homogeneous reservoir.

— General Result: (cfracs subscript means Continuous Fracture Source)

\[ \bar{P}_{D,cfracs}(x_D \leq 1, y_D = 0, u) = \frac{1}{2} \int_{-1}^{1} \bar{P}_{D,cls}[(x_D - x_{wD}), u] dx_{wD} \]

where the cls subscript means Continuous Line Source

— "Infinite-acting" reservoir behavior (line source solution)

\[ \bar{P}_{D,cfracs,inf}(x_D \leq 1, y_D = 0, u) = \frac{1}{2u} \int_{-\infty}^{\infty} K_0(z)dz + \int_{-\infty}^{\infty} K_0(z)dz \]

— Bounded circular reservoir — "no-flow" at the outer boundary

\[ \bar{P}_{D,cfracs,nfb}(x_D \leq 1, y_D = 0, u) = \bar{P}_{D,cfracs,inf}(x_D \leq 1, y_D = 0, u) + \frac{1}{2u} \int_{-\infty}^{\infty} I_0(z)dz + \int_{-\infty}^{\infty} I_0(z)dz \]

— Bounded circular reservoir — "constant pressure" at the outer boundary

\[ \bar{P}_{D,cfracs,cpb}(x_D \leq 1, y_D = 0, u) = \bar{P}_{D,cfracs,inf}(x_D \leq 1, y_D = 0, u) - \frac{1}{2u} \int_{-\infty}^{\infty} I_0(z)dz + \int_{-\infty}^{\infty} I_0(z)dz \]
Appendix — Extended Description of Course Objectives

Fall 2020

Course Objectives (Continued)

Module 4: Reservoir Flow Solutions (continued)

- Dual Porosity Reservoirs — Warren and Root Approach — Pseudosteady-State Matrix Behavior:
  - Be familiar with the "fracture" and "matrix" models developed by Warren and Root.
  - Be able to develop the Laplace and real domain results given by Warren and Root for pseudosteady-state matrix flow. These relations are
    - Laplace domain results:
      \[ f(u) = \frac{\lambda + \alpha(1 - \alpha)u}{\lambda + (1 - \alpha)u} \]
    - Solutions in the Laplace domain:
      \[ \bar{p}_D(r_D, u) = \frac{1}{u} \frac{K_0\left(\sqrt{u}f(u)r_D\right)}{K_1\left(\sqrt{u}f(u)\right)} \approx \frac{1}{u} \frac{K_0\left(\sqrt{u}f(u)r_D\right)}{\frac{4}{e^2r_D^2} + 1} \]
    - Line source solution in the real domain:
      \[ p_D(t_D, r_D) = \frac{1}{2} \ln\left(\frac{4}{e^2r_D^2} + 1\right) - \frac{1}{2} E_1\left(-\frac{\lambda}{\alpha(1 - \alpha)} t_D\right) + \frac{1}{2} E_1\left(-\frac{\lambda}{(1 - \alpha)} t_D\right) + S \]
  - Be able to develop the Laplace and real domain results given by Warren and Root for pseudosteady-state matrix flow. These relations are
    \[ p'_D(t_D, r_D) = \frac{1}{2} + \frac{1}{2} \exp\left(-\frac{-\lambda}{\alpha(1 - \alpha)} t_D\right) - \frac{1}{2} \exp\left(-\frac{-\lambda}{(1 - \alpha)} t_D\right) \]

- Direct Solution of the Gas Diffusivity Equation Using Laplace Transform Methods:
  - Be familiar with the convolution form of a non-linear partial differential equation (with a non-linear right-hand-side term), as shown below.
    \[ \nabla^2 y = \beta(y) \frac{\partial^2}{\partial t^2} + \frac{\partial}{\partial t} \frac{\partial}{\partial t} \frac{1}{\tau(t - \tau)} d \tau \]
    Taking the Laplace transform of this relation gives
    \[ \nabla^2 \tilde{y}(u) = [u \tilde{y}(u) - y(t = 0)] g(u) \]
  - Be able to develop the generalized Laplace domain formulation of the non-linear radial gas diffusivity equation using the \( \beta(t) \) approach.
    - The real gas diffusivity equation (in radial coordinates) is given in dimensionless form by:
      \[ \frac{\partial^2 p_D}{\partial r^2} + \frac{1}{r_D} \frac{\partial p_D}{\partial r_D} = \frac{\mu c_i}{\mu c_{ii}} \frac{\partial \tilde{p}_D}{\partial t_D} \quad \beta(t_D) = \frac{\mu c_{ii}}{\mu c_{ii}} \]
      where
      \[ p_D = \frac{1}{141.2} \frac{k h}{q B \mu} (p_{pi} - p_p) \quad t_D = 0.0002637 \frac{k}{\phi \mu c_{ii}^2 r_w^2} \quad r_D = \frac{r}{r_w} \]
Course Objectives (Continued)

Module 4: Reservoir Flow Solutions (continued)

and the pseudopressure function is given by:

\[ p_p = \mu_B g_i \int_{p_{base}}^{p} \frac{dp}{\mu} = \frac{H_i z_i}{p_i} \int_{p_{base}}^{p} \frac{dp}{\mu} \]

— Substituting the convolution formulation into the right-hand-side of the real gas diffusivity equation gives

\[
\frac{1}{r_D} \frac{\partial}{\partial r_D} \left[ r_D \frac{\partial p_D}{\partial r_D} \right] = \frac{\partial^2 p_D}{\partial r^2} + \frac{1}{r_D} \frac{\partial p_D}{\partial r_D} = \int_0^{D} \frac{\partial p_D}{\partial \tau} g(t_D - \tau) d\tau
\]

\[
\frac{1}{r_D} \frac{d}{dr_D} \left[ r_D \frac{d\overline{p}_D(u)}{dr_D} \right] = \frac{d^2 \overline{p}_D(u)}{dr_D^2} + \frac{1}{r_D} \frac{d\overline{p}_D(u)}{dr_D} = u g(u) \overline{p}_D(u) \text{ (Laplace domain relation)}
\]

- Be familiar with and be able to develop the \( g(u) \) term. The \( g(t_D) \) term is defined by:

\[
\beta(t_D) \frac{\partial p_D}{\partial t_D} = \int_0^{D} \frac{\partial p_D}{\partial \tau} g(t_D - \tau) d\tau
\]

• Convolution:

- Be familiar with and be able to derive the convolution sums and integrals for the variable-rate and variable pressure drop cases.

  — Variable-Rate Case:

  \[ p_{wD}(t_D) = \sum_{j=1}^{n} (q_{Dj} - q_{Dj-1}) p_{D,cr}(t_D - t_{Dj-1}) \] (discrete rate changes)

  \[ p_{wD}(t_D) = \int_0^{D} q_D'(\tau)p_{D,cr}(t_D - \tau)d\tau \] (continuous rate changes)

  — Variable-Pressure Drop Case:

  \[ q_{ltD}(t_D) = \sum_{j=1}^{n} \left( \frac{p_i - p_{wf,j}}{p_i - p_f} \right) q_{Dcp}(t_D - t_{Dj-1}) \] (discrete rate changes)

- Be able to derive the general convolution identity in the Laplace domain from the integral form of the variable-rate convolution identity.

  \[ \overline{p}_{wD}(u) = \overline{q_D}(u) \overline{p}_{D,cr}(u) \]

- Be able to derive the real and Laplace domain identities for relating the constant pressure and constant rate cases: (from van Everdingen and Hurst)

  — Laplace domain result:

  \[ \overline{q}_{D,cp}(u) = \frac{1}{u^2} \frac{1}{\overline{p}_{D,cr}(u)} \]

  — Real domain result:

  \[
  \int_0^{D} q_{D,cp}(\tau)p_{D,cr}(t_D - \tau)d\tau = t_D \quad \text{or} \quad \int_0^{D} p_{D,cr}(\tau)q_{D,cp}(t_D - \tau)d\tau = t_D
  \]
Course Objectives (Continued)

Module 4: Reservoir Flow Solutions (continued)

- Concepts and Applications in Wellbore Storage Distortion:
  - Be familiar with and, based on physical principles, be able to derive the relations to model the phenomena of "wellbore storage." In particular, you should be able to derive the following:
    - General Rate Relation:
      \[ (q_{sf} - q)B = 24C_s \left( \frac{dp_{wf}}{dt} - \frac{dp_f}{dt} \right) \]
    - Pressure Relations (for small times/wellbore storage domination):
      \[ p_{wf} = p_i - \frac{qB}{24C_s}t \] (for small times, i.e., wellbore storage domination)
      or
      \[ p_{wD} = \frac{tD}{C_D} \] (for small times, i.e., wellbore storage domination)
    - Laplace Domain Identity:
      \[ \bar{p}_{wD}(u) = \frac{1}{\bar{p}_{sD}(u) + u^2C_D} \] (valid for all times)

Module 4: Reservoir Flow Solutions — Under Consideration

- Multilayered Reservoir Solutions
- Dual Permeability Reservoir Solutions
- Horizontal Well Solutions
- Radial Composite Reservoir Solutions
- Various Models for Flow Impediment (Skin Factor)

Module 5: Applications/Extensions of Reservoir Flow Solutions — Under Consideration

- Oil and Gas Well Flow Solutions for Analysis, Interpretation, and Prediction of Well Performance.
- Low Permeability/Heterogeneous Reservoir Behavior.
- Macro-Level Thermodynamics (coupling PVT behavior with Reservoir Flow Solutions).
- External Drive Mechanisms (Water Influx/Water Drive, Well Interference, etc.).
- Hydraulic Fracturing/Solutions for Fractured Well Behavior.
- Analytical/Numerical Solutions of Various Reservoir Flow Problems.
- Applied Reservoir Engineering Solutions — Material Balance, Flow Solutions, etc.
Catalog Course Description: Applications of the variables, models and decision criteria used in modern petroleum development; case approach used to study major projects such as offshore development and assisted recovery

Synopsis: This course covers selected strategies and analysis tools used in petroleum development programs from the diverse perspectives of public companies, private equity company, and state-controlled resources. Students will review the petroleum resource management system; literature regarding pricing, acquisitions, risk and uncertainty; and, case studies highlighting entity growth strategies, and portfolio management. Extensive use of Industry case studies forms the basis for lectures and projects.

Instructor: Priscilla G. McLeroy, P.E., Professor of Engineering Practice
979.845.2907
pgmcleroy@tamu.edu
Office – 501U Richardson Building
Office Hours – TR by appointment

Reference Texts:
Mian, M. A., Project Economics and Decision Analysis, Volumes I & II: Deterministic & Probabilistic Models 2nd Edition, PennWell (Tulsa) 2011. We will reference the books in some of the lectures, but the course lectures will not be directly from the books. Necessary reference materials will be posted on eCampus system.

Course Learning Objectives:
1. Describe how strategies are formulated from diverse petroleum development perspectives.
2. Demonstrate how to simulate petroleum portfolios from mindset of public companies, private equity company, and state-controlled resources.
3. Select and apply fit-for-purpose decision tools relative to strategic objective.
4. Demonstrate the trade-offs between growth, develop, and harvest strategies and how to leverage all within a petroleum portfolio.

Class Schedule: Tuesday and Thursday, 11:10 am-12:25 pm; RICH1009.

Course Requirements:
- Midterm Exam: 20%
- Homework and Participation: 40%
- Final Team Project: 40%
- Total: 100%

Typically homework is assigned every week with results submitted via eCampus prior to class online Discussion Posting. Homework discussions will be led online via eCampus Discussion Posts. Participation in the Discussion Post is mandatory for completing homework assignments.
There will be one online exam - Midterm. Each student will need to return the completed exam by 5 pm on the following Monday according to instructions provided with the exam.

Each team will do a final project. The project will be assigned at the time of the Midterm. Each team will present the project during the last week of class.

Additional Notes:
1. Teams are an integral part of successfully completing the course. Each individual will be evaluated by peers and Instructor as to their contribution to the team efforts and results. Teams will be virtual in that a Resident class member will join Distance Learning class members to makeup a 4-5 person team. Up to 5% of the final grade will be based on team participation (out of the 40% grade contribution for (“Homework and Participation”)
2. Course material and assignments will be posted on eCampus throughout the course to accommodate updates as we progress through the course; therefore, monitoring the site daily is required.
3. Homework is due before class begins on the due date, and should be submitted electronically via eCampus unless specified otherwise. Late homework will receive a grade of zero.
4. As part of homework assignments, you will be responsible for preparing reviews of all papers assigned. Please follow paper review guidelines, to be provided separately to you.
5. Examinations will be completed via eCampus within a 72 hour period. Exceptions should be brought to the Instructor’s attention a week in advance.

Topics Covered:
1. “Life Cycle” Project Economics
2. Petroleum Resource Management System, Reserves Assessment
3. Fiscal Regimes and Strategies
4. Company Drivers and Strategies
5. Capital Management Strategies
6. Portfolio Management Strategies – Tangible & Intangible (Technology)
7. Strategic Decision Processing
8. Acquisition and Development Strategies – Valuation Implications
9. Oil & Gas Law and Influence on Strategies

eCampus Account:
Course information including assignments, announcements, etc. will be posted regularly to the PETE 489/621 eCampus website. To set up your account for this course, please contact ITSHelp.tamu.edu. Secondary resources within the Department of Petroleum Engineering are Mary Lu Epps and Ted Seidel, 4th Floor, Richardson Building.

Before classes start your first assignment posted on eCampus will ask you to submit a brief description of your experience in the energy industry, who you work for, and contact information for the benefit of outside discussion between resident and DL students.
Academic Integrity Statement:
"An Aggie does not lie, cheat, or steal or tolerate those who do."

All students refer to the Honor Council Rules and Procedures on the web http://www.tamu.edu/aggiehonor < http://www.tamu.edu/aggiehonor>

Americans with Disabilities Act (ADA) Policy Statement:
The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy statement was forwarded to the Faculty Senate for information.

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe that you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Campus Carry
As a reminder, the legislative changes permitting concealed carry of handguns in buildings on campus became effective August 1, 2016. You can find more complete information at www.tamu.edu/statements/campus-carry.html
PETE 489/621 - Petroleum Development Strategy – Fall 2016 Schedule

Instructor: Priscilla G. McLeroy, P.E., pgmcleroy@tamu.edu
Prerequisites: basic petroleum project economics
Meets: 11:10 am-12:25 pm Tuesday & Thursday, RICH1009
Resources: posted lecture notes and reference materials

Synopsis - This course covers selected strategies and analysis tools used in petroleum development programs from the diverse perspectives of public companies, private equity company, and state-controlled resources. Students will review papers on the petroleum resource management system, pricing, acquisitions, risk and uncertainty, public company growth strategies, and portfolio management. Some lectures may be topics from industry guests.

<table>
<thead>
<tr>
<th>Lecture Series</th>
<th>Topics</th>
</tr>
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<tbody>
<tr>
<td>&quot;Life Cycle&quot; Upstream Project Building Blocks</td>
<td>(a) course introduction - syllabus, schedule, requirements; (b) life cycle economics - exploration to abandonment; (c) Petroleum Resource Management System &amp; reserves determination; (d) deterministic cash flow models – assumptions; (e) commercial analysis, CAPEX, OPEX, AFIT; (f) stochastic models - distributions of uncertainty; (g) stochastic cash flow conceptual modeling</td>
</tr>
<tr>
<td>Decline Curve Analyses</td>
<td>Conventional and Unconventional - review technical principles and comparisons</td>
</tr>
<tr>
<td>Capital at Work</td>
<td>Strategies for managing capital - cash flow, major projects, and debt</td>
</tr>
<tr>
<td>Fiscal Regimes – Upstream E&amp;P</td>
<td>(a) Drivers - State interests, NOC interests, IOC interests; (b) compensation structures; (c) fiscal systems of host countries</td>
</tr>
<tr>
<td>Public Company &amp; NOC Strategies</td>
<td>(a) Overview of drivers and forces influencing strategic planning; (b) Public company growth, development, harvest strategies; (c) NOC relative drivers</td>
</tr>
<tr>
<td>E&amp;P Portfolio Strategy</td>
<td>Portfolio management strategy – theory, stochastic budgeting, portfolio simulation under risk and uncertainty</td>
</tr>
<tr>
<td>E&amp;P Private Company Strategies</td>
<td>Private company relative drivers and business plan structures; – use of private equity, unique strategic considerations</td>
</tr>
<tr>
<td>E&amp;P Business Model Considerations</td>
<td>Models to structure, operate and exit E&amp;P assets – pooling/communitization, risk-based business structures, divestiture – for greenfield, brownfield, offshore, onshore assets</td>
</tr>
<tr>
<td>Acquisition, Development and Divestment Strategies</td>
<td>Overview of asset acquisition, development, and divestment process; evaluation and screening examples; due diligence traps and strategies to complete the deal</td>
</tr>
<tr>
<td>Best Practices to Remain Competitive</td>
<td>Team Projects – Target company evaluation of current Upstream strategies, performance, relative portfolio and Team’s recommended future strategies</td>
</tr>
</tbody>
</table>

PETE 489/621 Syllabus and Schedule – Fall
Petroleum Engineering 622 Exploration and Production Evaluation
Syllabus and Administrative Procedures
Fall 2017
Room 311 Richardson Building

Instructor: Priscilla G. McLeroy, P.E.
Contact Information: 979-845-2907;
Email: pgmcleroy@tamu.edu
Office: Room 501U Richardson Building
Office Hours: Generally open on Tuesdays/Thursdays; or, by appointment

Course Catalog Description: Exploration and Production Evaluation. (2-3). Credit 3. Selected topics in oil industry economic evaluation including offshore bidding, project ranking and selection, capital budgeting, long-term oil and gas field development projects and incremental analysis for assisted recovery and acceleration.

Text: None required
References:
We will reference the books in some of the lectures, but the course lectures will not be directly from the books. Other selected publications for reference materials will be posted on eCampus system.

Topics Covered: The focus will be on conceptual understanding, practical application and comprehending the strengths and weaknesses of the various exploration and production (E&P) projects, models and project management processes. The material learned in this course underlies successful commercialization of projects large and small – from the economics of asset (single well or field) development, to major project management decisions. The importance of the distinction between new and incremental projects will be made. Students will leave with the ability to structure projects in phases, understand critical path project decisions, carry out straightforward economic calculations, and identify impacts of risks and uncertainties during phases of oil & gas project development. After the course, the students will understand:

- Project identification of commercial opportunity via project economic justification
- E&P major project framing, planning, modeling, systems scheduling and project controls for varying scopes; e.g., deepwater offshore, unconventional onshore, mature onshore with environmental sensitivities
- Sources of E&P technical uncertainties and Industry business risks
- Integrated cost/benefit analysis in context and purpose of economic evaluation
- Deterministic Net Cash Flow (NCF) vs. stochastic valuations
- Understanding E&P value and investment metrics: Net Present Value, Returns, Investment Efficiency, Hurdle Rates
- Defining incremental vs acceleration projects
- Principles of risk reduction through options, diversification in E&P investments – not just that they work, but why they work
- E&P project organizations and teams
- E&P project development ties to Company business strategy
Class Schedule: TBD

Course Requirements:

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework and class participation</td>
<td>35%</td>
</tr>
<tr>
<td>Team Two-Staged Project</td>
<td>60%</td>
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<tr>
<td>Professionalism</td>
<td>5%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
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</tbody>
</table>

**Homework** involves critiques of assigned papers and/or online Discussion topics with results submitted via eCampus prior to assigned deadlines. Team assigned homeworks are graded with an overall team grade. In situations whereby one or more team members is not contributing as indicated by the majority of team members, a modified individual team member grade will be assessed and assigned. **Professionalism** involves contributions as team members (evaluated using two peer generated evaluations), individually to in-class discussions by Resident students, and online discussions by DL student submissions. **Team project** involves ability to integrate all topics covered in course into selected asset evaluation.

**Grading cutoffs (Percentages):**

- **A:** > 90
- **B:** 89.99 to 80
- **C:** 79.99 to 70
- **D:** 69.99 to 60
- **F:** < 59.99

**The General Plan for the Course**

The course is designed for one theory period per week plus one discussion period per week. On discussion days students will engage each other within respective Teams in reasoning about crucial questions regarding major trends and patterns related to the week’s theory by using assigned weekly Readings plus added primary and secondary sources the Team introduces (supporting interpreting the significance and meaning of the topic).

Integrated Teams (Resident and DL students and, depending on demographics of class, by disciplines represented) will be selected by the Instructor at the end of first week of semester. Each team will conduct a two-staged project. Summary project reports and presentations will be delivered during the midterm and final scheduled class period(s). Professionalism will be evaluated by peer evaluations of self and team members based on quality of contributions between presentation stages.

The Team project which constitutes the majority of the course grade will be a two-staged project: first stage being an interim case field summary and second stage being the final project report and presentation by teams.

Resident student attendance & DL student online Discussion contributions, familiarity with the required readings, and classroom questions or comments that are relevant and insightful are integral to the Professionalism evaluation. Differences in technical background or skill are not a criterion. In general, I evaluate classroom participation on the basis of the extent to which you contribute to a positive and effective learning environment (for yourself and others).

**Notes:**

1. Course material and assignments will be posted on eCampus throughout the course to accommodate updates as we progress through the course; therefore, monitoring the site daily is required.
2. Homework is due before class begins on the due date, and should be submitted electronically via eCampus unless specified otherwise. **Late homework will receive a grade of zero** (barring a university excused absence).
3. All course materials will be posted on eCampus. You will need to establish an eCampus account for this class and monitor the web site regularly. If you need help setting up your eCampus account, please contact [Mary Lu Walton Epps](mailto:mepps@tamu.edu) or in the 407 office suite:
   
   3116 TAMU | 407F&G Richardson Bldg | College Station, TX 77843-3116
   Ph: 979.458.4297 | fax: 979.862.7345 | mepps@tamu.edu |
   Ph: 979.862.1298 | fax: 979.862.1307 | ej5@tamu.edu |

4. [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07)
**Academic Integrity Statement**

"An Aggie does not lie, cheat, or steal or tolerate those who do."

All submitted course documents (assignments, including project material) shall include the following Aggie Honor Code with each Team members’ agreement as indicated by e-signature to the document:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

_____________________________________    ______________________________________
Team Member:    Team Member:

_____________________________________    ______________________________________
Team Member:    Team Member:

_____________________________________    ______________________________________
Team Member:    Team Member:

For further information, refer to the Honor Council Rules and Procedures on the web:

http://aggiehonor.tamu.edu

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**PETE 622 – E&P Evaluation**  
**Tentative Fall 2017 Schedule**

**Instructor:** Priscilla G. McLeroy, P.E.  
**pqmcleroy@tamu.edu**

**Prerequisites:** basic petroleum project economics

**Meets:** 11:10a-12:25p, RICH 311

**eCampus Resources:** posted lecture notes, assigned readings and reference materials

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**Synopsis** – This course covers selected topics effecting oil & gas industry economic evaluations. Diverse fields are evaluated from project perspectives including deepwater offshore, mature, greenfield, unconventional shale gas & oil, and environmentally restrictive and sensitive. Evaluations are considered relative to asset models, oil & gas project management processes, and valuation tools. Students will apply key concepts to fields assigned for course team projects.

<table>
<thead>
<tr>
<th>Lecture Series</th>
<th>Key Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week 1-Big Picture</strong></td>
<td>Introducing E&amp;P Evaluation - syllabus, schedule, requirements; E&amp;P project identification – what’s commercial vs. technically interesting?; E&amp;P data management</td>
</tr>
<tr>
<td><strong>Project Identification and Data management</strong></td>
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<tr>
<td><strong>Week 2-Big Picture E&amp;P Project Staging</strong></td>
<td>Framing the E&amp;P project, stage-gating, modeling, systems scheduling and project controls</td>
</tr>
<tr>
<td><strong>Weeks 3&amp;4-Fundamental Measures Analysis</strong></td>
<td>Evaluating reserves reporting within the Company and to outside regulators</td>
</tr>
<tr>
<td><strong>Project Foundations, 1P-2P-3P Reserves</strong></td>
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<tr>
<td><strong>Weeks 5&amp;6-Fundamental Measures Analysis</strong></td>
<td>E&amp;P accounting fundamentals - tangibles vs. intangibles; successful efforts vs. full-cost; accounting for drilling / exploration / development / production costs; accounting for sales revenues, impairment of assets, removal and restoration costs; financing and borrowing; analyzing Company and Analyst reports for valuation profiles</td>
</tr>
<tr>
<td><strong>E&amp;P Asset Accounting Breakdowns</strong></td>
<td></td>
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<tr>
<td><strong>Week 7-Fundamental Measures Analysis</strong></td>
<td>E&amp;P economic fundamentals revisited</td>
</tr>
<tr>
<td><strong>Review of Deterministic vs. Stochastic Analyses</strong></td>
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<tr>
<td><strong>Week 8-E&amp;P Project Yardsticks</strong></td>
<td>Understanding stakeholder value perspectives: Operator vs. Investor; changing perspectives and valuation yardsticks with project maturity</td>
</tr>
<tr>
<td><strong>Value Perspectives</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Week 9-Fundamental Measures Analysis</strong></td>
<td>Sourcing E&amp;P project uncertainties and Industry business risks; understanding Industry trends and drivers; business environment implications and signposts; normative vs. exploratory scenarios</td>
</tr>
<tr>
<td><strong>Structural E&amp;P Drivers, Scenarios</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Week 10-Decisions in Portfolio Management</strong></td>
<td>Reducing multiple project portfolio risks through options, diversification of E&amp;P investments, hedging; creating alternative business models / partnerships / joint ventures</td>
</tr>
<tr>
<td><strong>Optimization</strong></td>
<td></td>
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<tr>
<td><strong>Weeks 11&amp;12-Intangible E&amp;P Value Premiums</strong></td>
<td>Managing effective E&amp;P project teams; understanding team management differences within an Operating company vs. Service company</td>
</tr>
<tr>
<td><strong>Project Organizations &amp; Teams</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Weeks 13&amp;14-Intangible E&amp;P Value Additions</strong></td>
<td>Creating flexible E&amp;P project business plans to support Corporate Strategies</td>
</tr>
<tr>
<td><strong>E&amp;P Projects Linked with Corporate Strategy</strong></td>
<td></td>
</tr>
</tbody>
</table>
PETE 623 Course Syllabus-Spring 2016

Instructor: Dr. Berna Hascakir, Texas A&M University - Petroleum Engineering Department
Office: Richardson 401 N
Telephone: 979-845-6614
e-mail: hascakir@tamu.edu
Office Hours: TBD and anytime when my office door is wide open
TA: TBD
TA’s Office: TBD,
Office Hours: TBD

Catalog Description: Fundamentals and theory of water flooding; application of fractional flow theory; strategies and displacement performance calculations; wettability; relative permeability, and rock-water interaction. Class will meet T-Th 02:00-03:50 PM in RICH 208.

Instructional Objectives
Topics Covered:
1. Introduction
2. Natural Water Influx
3. Microscopic Efficiency of Immiscible Displacement
4. Macroscopic Displacement Efficiency of Linear Waterflood
5. Immiscible Displacement in Two Dimensions-Areal
6. Vertical Displacement in Linear and Areal Models
7. Waterflood Design
8. The Role of Reservoir Geology in the Design and Operation of Waterfloods

Contributions to Meeting the Curriculum Requirements of Criterion:

<table>
<thead>
<tr>
<th>Math and Science</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum Engineering</td>
<td>This course provides students with a fundamental background on waterflooding.</td>
</tr>
<tr>
<td>General Education</td>
<td>None</td>
</tr>
</tbody>
</table>

Course Learning Outcomes and Relationship to Program Outcomes:

<table>
<thead>
<tr>
<th>Course Learning Outcome: At the end of the course, students will be able to...</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the microscopic displacement processes occur during waterflooding.</td>
<td>11</td>
</tr>
<tr>
<td>Describe the relative permeability, wettability, capillary pressure, and interfacial tension concepts.</td>
<td>1,3,5</td>
</tr>
<tr>
<td>Determine and Analyze values of fractional flow.</td>
<td>5</td>
</tr>
<tr>
<td>Design a waterflood project.</td>
<td>2,3,5,11</td>
</tr>
</tbody>
</table>

Related Program Outcomes:

<table>
<thead>
<tr>
<th>No.</th>
<th>PETE graduates must have...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An ability to apply knowledge of mathematics, science, and engineering.</td>
</tr>
<tr>
<td>2</td>
<td>An ability to design and conduct experiments, as well as to analyze and interpret data.</td>
</tr>
<tr>
<td>3</td>
<td>An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.</td>
</tr>
<tr>
<td>5</td>
<td>An ability to identify, formulate, and solve engineering problems.</td>
</tr>
<tr>
<td>11</td>
<td>An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
</tr>
</tbody>
</table>
COURSE SCHEDULE - RICH 208

<table>
<thead>
<tr>
<th>Chapter: Reading</th>
<th>Topics</th>
<th>HW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Introduction-Natural Water Influx</td>
<td></td>
</tr>
<tr>
<td>Additional Notes</td>
<td>Natural Water Influx</td>
<td></td>
</tr>
<tr>
<td>Chapter 2-pp-5-52</td>
<td>Microscopic Efficiency of Immiscible Displacement</td>
<td>HW1</td>
</tr>
<tr>
<td>Chapter 2-pp-5-52</td>
<td>Microscopic Efficiency of Immiscible Displacement</td>
<td></td>
</tr>
<tr>
<td>Chapter 2-pp-5-52</td>
<td>Microscopic Efficiency of Immiscible Displacement</td>
<td>HW2</td>
</tr>
<tr>
<td>Chapter 2-pp-5-52</td>
<td>Microscopic Efficiency of Immiscible Displacement</td>
<td></td>
</tr>
<tr>
<td>Chapter 3-pp-53-110</td>
<td>Macroscopic Displacement Efficiency of a Linear Waterflood</td>
<td></td>
</tr>
<tr>
<td>Chapter 3-pp-53-110</td>
<td>Macroscopic Displacement Efficiency of a Linear Waterflood</td>
<td>HW3</td>
</tr>
<tr>
<td>Chapter 3-pp-53-110</td>
<td>Macroscopic Displacement Efficiency of a Linear Waterflood</td>
<td></td>
</tr>
<tr>
<td>Chapter 4-pp-111-138</td>
<td>Immiscible Displacement in Two Dimensions-Areal</td>
<td>HW4</td>
</tr>
<tr>
<td>Midterm</td>
<td>Presentation and/or Report Submission</td>
<td></td>
</tr>
<tr>
<td>Chapter 4-pp-111-138</td>
<td>Immiscible Displacement in Two Dimensions-Areal</td>
<td></td>
</tr>
<tr>
<td>Chapter 5-pp-139-188</td>
<td>Vertical Displacement in Linear and Areal Models</td>
<td>HW5</td>
</tr>
<tr>
<td>Chapter 5-pp-139-188</td>
<td>Vertical Displacement in Linear and Areal Models</td>
<td></td>
</tr>
<tr>
<td>Chapter 5-pp-139-188</td>
<td>Vertical Displacement in Linear and Areal Models</td>
<td></td>
</tr>
<tr>
<td>Chapter 6-pp-189-224</td>
<td>Waterflood Design</td>
<td>HW6</td>
</tr>
<tr>
<td>Chapter 6-pp-189-224</td>
<td>Waterflood Design</td>
<td></td>
</tr>
<tr>
<td>Chapter 7-pp-225-301</td>
<td>The Role of Reservoir Geology in the Design and Operation of Waterfloods</td>
<td></td>
</tr>
<tr>
<td>Review</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Exam</td>
<td>03:30-05:30 PM RICH 208</td>
<td></td>
</tr>
</tbody>
</table>

* Scheduled program and the exam dates may change.

COURSE POLICIES

**Prerequisites**: PETE 311; PETE 310; CHEM 107; CVEN 305; MEEN 315; MATH 308


**Attendance**: Texas A&M views class attendance as an individual student responsibility (http://student-rules.tamu.edu/rule07). Attendance is essential to complete the course successfully. Material presented in lecture and class discussion may expand upon points only briefly considered in the required text. Moreover, there will be pop quizzes presented as class activities during class hours, therefore, students are expected to attend class, to bring textbook, notes, homework problems and calculator all time. Attendance for Distance Learning (DL) students will be monitored through video watching records.

**Excused Absences**: Rules concerning excused absences may be found at http://student-rules.tamu.edu/rule07. Except for absences due to religious obligations, the student must notify her or his instructor in writing (acknowledged e-mail message is acceptable) prior to the date of absence if such notification is feasible. In cases where advance notification is not feasible (e.g. accident, or emergency) the student must provide notification by the end of the second working day after the absence. This notification should include an explanation of why notice could not be sent prior to the class. If the absence is excused, the instructor must either provide the student with an opportunity to make up any quiz, exam or other graded activities or provide a satisfactory alternative to be completed within 30 calendar days from the last day of the absence.

**Excused Absences for Religious Holy Days**: Texas House Bill (effective 9/1/03) states “An institution of higher education shall excuse a student from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student whose absence is excused under this subsection may not be penalized for that absence and shall be allowed to take an examination or complete an assignment from which the student is excused within a reasonable amount of time after the absence.”

**Makeup Policy**: Makeup exams will be given without question for excused absences as defined by University Regulations. If you miss an exam for any other reason, you may request a makeup, but the makeup exam may have a different format from that given in class, must be completed within one week of the original exam date, and there will be a 5% penalty. For pop quizzes (class activities) there will be no make-up, if you have an excuse, the average of the pop quizzes will be taken by excluding the pop quizzes you miss.
**Exams:** There will be two exams during the semester, one during class and one during the final exam period. Each exam will cover approximately three to four weeks of material presented in the class.

**Extra Credits:** There may be opportunities to earn extra credit during the semester. These activities will be announced in class. There are no make-ups or substitutions for extra-credit opportunities.

**Assignments:** Late assignments will normally be given a grade of zero. There will be homework assignments for each week or once in two weeks. Students are responsible to answer all homework problems.

**Grading Policy:** Your grading will be calculated according to the table given below. Letter grades will be assigned to the following guideline: A=90-100 (Excellent), B=80-89 (Good), C=70-79 (Satisfactory), D=60-69 (Passing), F=59 and below (Failing); I=Incomplete.

<table>
<thead>
<tr>
<th>Assignment</th>
<th>% of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. HW</td>
<td>24</td>
</tr>
<tr>
<td>2. Pop Quizzes/class activities</td>
<td>16</td>
</tr>
<tr>
<td>3. Midterm</td>
<td>30</td>
</tr>
<tr>
<td>8. Final Exam Comprehensive</td>
<td>30</td>
</tr>
</tbody>
</table>

**Assignment Details**
- There will be 6 homework assignment each will have 4% contribution to overall grade
- These assignments are random
- Presentation and/or report submission
- Written or a project (depends on the performance of the midterm exam)

**Student Conduct:** Academic Integrity Statement and Policy, Aggie Code of Honor “An Aggie does not lie, cheat, or steal or tolerate those who do.” Upon accepting admission to Texas A&M University, a student immediately accepts a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System. For more information: [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor). Each work that you turn in for this class MUST include your signature and the following statement. “On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work.”

**Classroom Behavior:** Texas A&M University supports the principle of freedom of expression for both instructors and students. The university respects the rights of the instructors to teach and the students to learn. Maintenance of these rights requires classroom conditions that do not impede their exercise. Classroom behavior that seriously interferes with either (1) instructor’s ability to conduct the class or (2) the ability of other students to profit from the instructional program will not be tolerated. An individual engaging in disruptive classroom behavior may be subject to disciplinary action. For additional information please visit [http://student-rules.tamu.edu/rule21](http://student-rules.tamu.edu/rule21).

**ADA Policy Statement:** (Texas A&M University Policy Statement) Americans with Disabilities Act (ADA) Policy Statement
The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy Statement was forwarded to the Faculty Senate for information.

**Coursework Copyright Statement:** (Texas A&M University Policy Statement)
The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy them, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writing, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section “Scholastic Dishonesty”.

**Prepared by:** Berna Hascakir, June, 02, 2015
Course Objectives: This course focuses on (1) the theory and code development of poromechanics problems, (2) their numerical stability, and (3) geomechanical responses driven by changes in flow (e.g., Mandel-Cryer effect, geological failure, hydraulic fracturing).

Prerequisite(s): PETE640 or PETE641 or PETE656 or PETE689-1, mathematic courses recommended.

Instructor: Dr. Jihoon Kim, Assistant Professor
501L Richardson, 862-1138, jihoon.kim@tamu.edu
Office hours: Tue. Thur. 2:00pm – 3:00pm

Class hours: TTR 12:45pm-2:00pm

References:

Lecture Topics Covered:
1. Introduction to coupled flow and geomechanics
2. Coupled flow and geomechanics: Thermoporomechanics
   a. Governing equations
   b. Constitutive relations
3. Numerical simulation in single phase flow
   a. Finite volume method
   b. Finite element method
   c. 1D & 2D flow
4. Numerical simulation in geomechanics
   a. Finite element methods
   b. 1D & 2D geomechanics
5. Coupling between flow and geomechanics
   a. Finite volume-finite element methods
   b. Finite element-finite element methods
   c. Solution strategies
6. Plasticity
   a. Failure models
   b. 1D plasticity, J2 plasticity, Drucker-Prager model
7. Hydraulic fracturing
   a. Literature review
   b. Analytical and numerical approaches
Method of Evaluation:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>40%</td>
</tr>
<tr>
<td>Exam 1</td>
<td>20%</td>
</tr>
<tr>
<td>Exam 2</td>
<td>40%</td>
</tr>
<tr>
<td>Participation &amp; Professionalism</td>
<td>Pass or Fail</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: In the special cases, Exam 2 might be able to be replaced by students’ ongoing research paper if they are related to geomechanics, depending on the quality and size of the paper.

Course Policies:

- **Attendance:** Attendance and active participation in class is expected. Students should read assigned reference material in advance and be prepared for class discussions. Please turn off and stow cell phones while class is in session.
- **Absences:** Work missed due to absences will be excused for only University-approved reasons in accordance with Texas A&M University Student Rules (see [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07)). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis. In accordance with recent changes to Rule 7, please be aware that in this class any “injury or illness that is serious enough for a student to be absent from class” will require “a medical confirmation note from his or her medical provider” even if the absence is for less than three days (see 7.1.6.2 Injury or illness less than three days).
- **Examinations Absences:** Make-up for major examinations will be given for university-excused absences only.
- **Academic Integrity:** “An Aggie does not lie, cheat, or steal, or tolerate those who do.” Collaboration on examinations and assignments is forbidden except when specifically authorized. See Policy on Academic Integrity. For additional information, visit [http://aggiehonor.tamu.edu](http://aggiehonor.tamu.edu).
- **ADA Policy Statement:** ADA Policy Statement: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu).

Helpful Links:

- Academic Calendar [http://admissions.tamu.edu/registrar/general/calendar.aspx](http://admissions.tamu.edu/registrar/general/calendar.aspx)
- Final Exam Schedule [http://admissions.tamu.edu/registrar/general/finalschedule.aspx](http://admissions.tamu.edu/registrar/general/finalschedule.aspx)
- On-Line Catalog [http://www.tamu.edu/admissions/catalogs/](http://www.tamu.edu/admissions/catalogs/)
# Tentative Course Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>DOW</th>
<th>Topics</th>
<th>HW (coding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/28/2018</td>
<td>Tue</td>
<td>Course Introduction</td>
<td></td>
</tr>
<tr>
<td>8/30/2018</td>
<td>Thu</td>
<td>Basic concepts, Governing equations</td>
<td></td>
</tr>
<tr>
<td>9/4/2018</td>
<td>Tue</td>
<td>Numerical discretization (Flow-FVM) 1D</td>
<td>Hw1: 1D FVM flow</td>
</tr>
<tr>
<td>9/6/2018</td>
<td>Thu</td>
<td>Numerical discretization (Flow-FVM) 2D</td>
<td></td>
</tr>
<tr>
<td>9/11/2018</td>
<td>Tue</td>
<td>Pore-volume coupling</td>
<td>Hw2: 2D FVM flow</td>
</tr>
<tr>
<td>9/13/2018</td>
<td>Thu</td>
<td>Thermodynamics of open continua</td>
<td></td>
</tr>
<tr>
<td>9/18/2018</td>
<td>Tue</td>
<td>Thermodynamics of open continua</td>
<td></td>
</tr>
<tr>
<td>9/20/2018</td>
<td>Thu</td>
<td>Thermodynamics of open continua</td>
<td></td>
</tr>
<tr>
<td>9/25/2018</td>
<td>Tue</td>
<td>No-class: SPE ATCE meeting</td>
<td></td>
</tr>
<tr>
<td>9/27/2018</td>
<td>Thu</td>
<td>Numerical discretization (flow-1D FEM)</td>
<td></td>
</tr>
<tr>
<td>10/2/2018</td>
<td>Tue</td>
<td>Numerical discretization (Geomechanics-1D FEM)</td>
<td>Hw3: 1D geomechanics</td>
</tr>
<tr>
<td>10/4/2018</td>
<td>Thu</td>
<td>Numerical discretization (Geomechanics-1D FEM)</td>
<td></td>
</tr>
<tr>
<td>10/9/2018</td>
<td>Tue</td>
<td>Coupled system (Residual form)</td>
<td></td>
</tr>
<tr>
<td>10/11/2018</td>
<td>Thu</td>
<td>Numerical discretization (Geomechanics-2D FEM)</td>
<td></td>
</tr>
<tr>
<td>10/16/2018</td>
<td>Tue</td>
<td>Exam 1 (Take-home exam)</td>
<td>Exam 1: Coupling in 1D</td>
</tr>
<tr>
<td>10/18/2018</td>
<td>Tue</td>
<td>Numerical discretization (Geomechanics-2D FEM)</td>
<td></td>
</tr>
<tr>
<td>10/23/2018</td>
<td>Tue</td>
<td>Numerical discretization (Geomechanics-2D FEM)</td>
<td>Hw4: 2D FEM geomechanics</td>
</tr>
<tr>
<td>10/25/2018</td>
<td>Thu</td>
<td>Solution strategies</td>
<td></td>
</tr>
<tr>
<td>10/30/2018</td>
<td>Tue</td>
<td>Stability in time</td>
<td>Hw 5: 1D sequential coupling</td>
</tr>
<tr>
<td>11/1/2018</td>
<td>Thu</td>
<td>Coupling in reservoir simulation</td>
<td></td>
</tr>
<tr>
<td>11/6/2018</td>
<td>Tue</td>
<td>Plasticity modeling</td>
<td></td>
</tr>
<tr>
<td>11/8/2018</td>
<td>Thu</td>
<td>Plasticity modeling</td>
<td>Hw 6: 1D returnmapping</td>
</tr>
<tr>
<td>11/13/2018</td>
<td>Tue</td>
<td>Plasticity modeling</td>
<td></td>
</tr>
<tr>
<td>11/15/2018</td>
<td>Thu</td>
<td>Plasticity modeling</td>
<td></td>
</tr>
<tr>
<td>11/20/2018</td>
<td>Tue</td>
<td>Poroelestaplasticity</td>
<td></td>
</tr>
<tr>
<td>11/22/2018</td>
<td>Thu</td>
<td>No-class: Thanksgiving days</td>
<td></td>
</tr>
<tr>
<td>11/27/2018</td>
<td>Tue</td>
<td>Simulation of hydraulic fracturing</td>
<td></td>
</tr>
<tr>
<td>11/29/2018</td>
<td>Thu</td>
<td>Simulation of hydraulic fracturing</td>
<td>Exam 2: Coupling in 2D</td>
</tr>
<tr>
<td>12/4/2018</td>
<td>Tue</td>
<td>Redefined day</td>
<td></td>
</tr>
</tbody>
</table>
PETE 625 – WELL CONTROL

Syllabus

Course Information

Course Number: PETE 625  
Course Title: Well Control  
Section: 600, 700  
Time: MW 2:55 pm – 4:10 pm  
Location: CHEM 111 and Online via Zoom  
Credit Hours: 3

Instructor Details

Instructor: Dr. JC Cunha  
Office: RICH 401 (office will be closed the entire Spring 2021; office hours will be provided by Zoom meeting only – see office hours below)  
Phone: 979-458-0721  
E-Mail: jc.cunha@tamu.edu  
Office Hours: By email request preferably every MW from 8 am to 10 am. If you need to talk to me, we can find another time mutually convenient. I will try to accommodate all requests. Please request your office time by email only.

Course Description

Theory of pressure control in drilling operations and during well kicks; abnormal pressure detection and fracture gradient determination; casing setting depth selection and advanced casing design; theory supplemented on well control simulation.

Course Prerequisites

PETE 661 or Approval of Advisor/Instructor.

Course Learning Outcomes

By the end of this course, students will be able to:

1. Understand the main causes of kicks and blowouts and how to avoid loss of well control.  
2. Understand how to recover well control using several accepted well control methods.  
3. Understand the methodology to determine abnormal pressure zones and formation fracture resistance.
4. Understand the difference on well control procedures for onshore and offshore drilling.
5. Have knowledge about well control equipment and its operation.
6. Perform casing seat selection while preparing a well plan.

Textbook and/or Resource Materials

- Well Control, by Jerome Schubert, PE, Texas A&M University.

- Fundamentals of Drilling Engineering
  Edited By: Robert F. Mitchell and Stefan Z. Miska
  2011
  SPE Textbook Series No. 12
  ISBN: 978-1-55563-207-6
  Society of Petroleum Engineers

How to access the content of the book “Fundamentals of Drilling Engineering”:
- Go to library.tamu.edu
- Type the name of the book on the search line (you may be asked to log in with your NetID and password).
- The eBook version of the book will show up in the results of the search.
- Click on “Connect to the full text of this electronic book”
- You will then have the option to download the book to your computer, for a maximum time of 21 days, or read it online (after 21 days you can download it again).

- Selected Technical papers

- Halliburton Cement Tables (Red Book), available on HAL website & installed on PETE computers. You can also download it to your computer or smartphone. Go to Halliburton.com and look for the eRedBook® Software link.

- Handouts available on a weekly basis on CANVAS.

Grading Policy

A (89-100) Excellent, 4 grade points per semester hour
B (79-88.9) Good, 3 grade points per semester hour
C (69-78.9) Satisfactory, 2 grade points per semester hour
D (59-68.9) No passing grade for graduate students
F (Below 59) Fail

Evaluation

Mid Term 1 (24 Feb): 20%
Mid Term 2 (31 Mar): 20%
Final (TBA): 25%
Assignments: 15%
Well Control Seminar, including technical reading, research and presentation (TBA): 20%

**Late Work Policy**

- Assignments will be accepted up to 24 hours late for a maximum of 80% of the full mark.

Late work means “submitting a deliverable after the established deadline”. Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy. (See Student Rule 7.)

**Course Schedule**

<table>
<thead>
<tr>
<th>Classroom Lectures: 15 weeks - 45 hours</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Well Control</td>
<td>3</td>
</tr>
<tr>
<td>Gas Migration and Fluid Hydrostatics</td>
<td>3</td>
</tr>
<tr>
<td>Pore Pressure Prediction</td>
<td>3</td>
</tr>
<tr>
<td>Formation Fracture Resistance</td>
<td>3</td>
</tr>
<tr>
<td>Well Control Equipment</td>
<td>3</td>
</tr>
<tr>
<td>Casing Seat Selection</td>
<td>3</td>
</tr>
<tr>
<td>Kick Causes and Detection</td>
<td>3</td>
</tr>
<tr>
<td>Kick Control Methods</td>
<td>6</td>
</tr>
<tr>
<td>Offshore and Subsea Well Control</td>
<td>3</td>
</tr>
<tr>
<td>Blowout Control</td>
<td>3</td>
</tr>
<tr>
<td>Seminar on Well Control</td>
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<td><strong>Total</strong></td>
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</tr>
</tbody>
</table>

**University Policies**

This section outlines the university level policies that must be included in each course syllabus. The TAMU Faculty Senate established the wording of these policies.

**Attendance Policy**

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.
Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

**Makeup Work Policy**

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

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Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor (Student Rule 7, Section 7.4.1).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

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Page 4 of 6
Title IX and Statement on Limits to Confidentiality

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With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

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COVID-19

Campus Safety Measures *(This is the same from Fall 2020 and will be updated once new directions are available)*
To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**

- **Face Coverings**—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the **Face Covering policy** and **Frequently Asked Questions (FAQ)** available on the **Provost website**.

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Offshore Drilling

(3-0). Credit 3

Course Description: Offshore drilling from fixed and floating drilling structures; directional drilling including horizontal drilling; theory of deviation monitoring and control.

Prerequisites: PETE 411 or 661; or approval of instructor.

Texts:
- Selected Technical Papers.

Basis for Grading:
- Homework 20%
- Quiz A 20%
- Quiz B 20%
- Project 20%
- FINAL 20%

Topics:
- Drilling a well from a floating vessel; station keeping 3
- Wellheads; casing program; blowout preventers 3
- The drilling riser; riser tensioning; drilling hydraulics 3
- Motion compensation; formation testing; shallow water flows 4
- Dual gradient drilling; subsea mudlift drilling 6
- Directional drilling; wellbore surveying techniques; 4
- Wellbore trajectory control 4
- The kick-off, drilling with mud motors and turbines 6
- The bottomhole assembly 4
- Horizontal drilling; torque and drag 3
- Hydrates and potential problems in deepwater drilling 2

Quizzes: (3 hours)
Total: 45 hours

Computer usage: Required for homework
Number and Name of Course: PETE 627 Well Completion and Workover
Hours: Monday/Wednesday, 9:30-10:45 AM, Richardson Room 1009

Description of Course:
This course covers well completion technology and its recent advances for production, injection, stimulation and well performance monitoring and control. It consists of four units, hardware and performance of well completion, completion for hydraulic fracturing, completion for acidizing, and optimization of well performance by intelligent completion.

Text Materials:
- Modern Completion technology for Oil and Gas Wells, Ding Zhu and Kenji Furui
- SPE papers

Course Daily Schedule:
1/13 Introduction, review of well performance
1/15 Review of IPR for horizontal wells
1/20 Review of skin concept and near-wellbore flow condition
1/22 Completion hardware and its functions
1/27 Perforation and skin factor for perforation
1/29 Perforation design and limited entry concept
2/3 Slotted liner and skin factor for slotted liner
2/5 No class (HFTC)
2/10 Completion impact on well performance in terms of skin
2/12 Completion for sand control, gravel pack, screens and prepacked completion
2/17 Tubing and liner selection for frictional pressure drop in pipe
2/19 Inflow control devices
2/24 Sliding sleeve valves and inflow control valves
2/26 Completion design for maximizing production efficiency
3/2 Summary of well completion for production
3/4 Midterm exam (30%)
3/9-3/15 No class (Spring Break)
3/16 Hydraulic fracturing review
3/18 Pumping pressure for breakdown and fracture propagation
3/23 Completion for fracturing and perforation for fracturing
3/25 Fractured well performance based on fracture design
3/30 No class (SPE workshop)
4/1 No class (SPE workshop)
4/6 Fluid selection, friction reducer and pumping pressure for slurry
4/8 Proppant selection and fracture conductivity
4/13 Acidizing review, wormhole theory
4/15 Completion for acid treatment, limited entry for acid distribution
4/20 Acid fracturing, jetting
4/22 Intelligent completion concept: monitoring and control
4/27 Downhole sensing, fiber optic technology
4/29 Final project: Optimization of completion design (30%)

Course Instructor/Supervisor:
Dr. D. Zhu
Office Hour: Monday 2-3
Office: Rm. 1011 Richardson Building
E-mail: dingzhu@tamu.edu
ADA Policy Statement: (Texas A&M University Policy Statement)

The Americans with Disabilities Act (ADA) Policy Statement

The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy statement was forwarded to the Faculty Senate for information.

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe that you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.

Coursework Copyright Statement: (Texas A&M University Policy Statement)

Suggested for Inclusion in Your First Day Handout or Syllabus

The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyright-protected, you do not have the right to copy them, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."
Course Information

Course Number: PETE 628  
Course Title: Horizontal Drilling  
Section: All Sections  
Time: Online only, asynchronous  
Location: Online only, asynchronous  
Credit Hours: 3

Instructor Details

Instructor: Sam Noynaert  
Office: RICH 501J  
Phone: 979-845-6164  
E-Mail: noynaert@tamu.edu  
Office Hours: By appointment. Email to setup in-office visit, Zoom/MS Teams or phone call

Course Description

Catalog Description: Directional drilling, bottomhole assemblies for achieving and maintaining control of inclination and direction; drilling fluids; torque and drag calculations; buckling of tubulars: transport of drilled solids.

Additional Description: This course covers horizontal well engineering design and operational practices. Lectures and exercises have a practical focus with the goal of providing skills and tools that can be immediately applied in the industry.

We discuss the concepts around directional drilling practices and tools, torque and drag, drilling hydraulics, hole cleaning and drilling fluid considerations. Some initial completion design and practices will be covered as well to help students understand the reasons for well construction choices.

Some exercises will consist of traditional problems calculated by hand or in spreadsheet format. However, most exercises will be completed using K&M Technology's ERA software. We use real-world data to work through the design AND execution of a horizontal well or wells.

Course Prerequisites

PETE 411 or approval of instructor (Instructor approval is usually given for those that an industry background or those who have taken basic drilling courses. To get instructor approval for registration, email me at noynaert@tamu.edu).

Special Course Designation

No Special Designations
Course Learning Outcomes

Upon completion of PETE 628, it is intended for the student to have fundamental knowledge of the following concepts as well as how to apply the following concepts in the real-world design and operational examples:
- Rig and equipment selection
- Wellbore hydraulics in horizontal/highly deviated wells
- Wellbore stability causes and solutions in horizontal/highly deviated wells
- Casing design/procedures specific to these wellpaths.
- Cementing design/procedures specific to these well paths.
- Torque and drag
- Geosteering
- Hole cleaning
- Well control in horizontal wells
- Drillstring design
- Directional drilling practices and tools

Textbook and/or Resource Materials

No required texts. Material will come from a variety of sources and will be provided by the instructor. Fundamentals of Drilling Engineering by Mitchell and Miska is a good general reference for some of the concepts we cover but you are not required to have that text.

Grading Policy

Grading Scale

- >89.5 = A
- 79.5 – 89.4 = B
- 69.5 – 79.4 = C
- 59.5 – 69.4 = D
- <59.5 = F

Update (8/26/2020) – Grade Weights by Assignment Type not included in initial Syllabus:

Exams (number TBD): 50%
HW and Lecture Quizzes: 30%
Project: 20%

Late Work Policy

- HW will be accepted up to 1 week late for 50% credit
- Exams must be completed by the deadline
- Projects must be completed by the deadline
- Quizzes will be accepted up to 1 week after they are initially posted. After one week, quizzes are not accepted.
# Course Schedule

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Topic</th>
<th>Assignment Due</th>
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<tr>
<td>1</td>
<td>8/25/2020</td>
<td>Syllabus/Course Introduction</td>
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<td>2</td>
<td>9/1/2020</td>
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<td>12/3/2020</td>
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<td>Final Exam</td>
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Updated August 16, 2020
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COVID-19 Temporary Amendment to Minimum Syllabus Requirements

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

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Operational Details for Fall 2020 Courses

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.

College and Department Policies

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.
Further Discussion on the Aggie Code of Honor
(An Aggie does not lie, cheat, or steal or tolerate those who do.)

For my policies on how I handle Honor Code violations, see the following notes:

My responsibility based on the Aggie Honor Code:
As a Texas A&M University faculty member, I must follow the Aggie Honor Code. This means that I will not tolerate those who cheat. In addition, as an instructor I must be fair. If I overlook cheating, it is not fair to those who DIDN’T cheat.
I know I can’t create a fool-proof system, but I will try to make the quantitative portion of this class as immune from OPPORTUNITIES to cheat as possible. If someone does cheat or assist in cheating, I will follow the procedure shown.

Departmental Reputation:
As a member of this department, I am charged with assisting in developing future petroleum engineers. Aggies have a reputation in the industry of being technically competent as well as ethical and honest in their business dealings. As a fellow Aggie, I feel very strongly about upholding and continuing this reputation.

Industry Application:
There will be many times in your career during which you will not have someone working with you who can provide technical assistance. In these instances, you will have to perform as an individual in order to make operational and business decisions for you and your company. If you are not able to perform as an individual now, how do you expect to perform under pressure with millions of dollars and possibly people’s actual lives on the line?

It may seem minor to sneak a look at someone’s exam, however if you are willing to do this, where does it stop? I for one do not want to see or hear of Aggies involved in unethical dealings.
Unfortunately, I have been involved in deals in which Aggies on the other side of the table were not ethical. I can personally say that the damage to Texas A&M University’s and our department’s reputation was shameful and irreparable from the viewpoint of the non-Aggies involved.

What constitutes dishonesty:
- Looking at another student’s exam
- Allowing another student to look at YOUR exam
- Using non-authorized aids or sources during a test (phones, texts, notes in calculator, etc)
- Collaborating on assigned work without instructor approval
- Plagiarism – just because you got it off of the internet, it doesn’t mean you didn’t plagiarize.
  Most plagiarism cases today begin with a Google search.
- More examples available at http://aggiehonor.tamu.edu/descriptions

If an incident occurs:
I will report the violation to the AHSO, regardless of the magnitude of the violation.
  - The report is submitted online and includes the details of the violation, specification of
    sanction and student acknowledgement of acceptance/rejection of violation and/or
    sanction.
- I will usually handle the first offense autonomously meaning I decide the sanction. My minimum
  sanction will usually be a one-letter-grade reduction in your course grade. The maximum sanction I
  can give is an F* (failure of the course and notation of “FAILURE DUE TO ACADEMIC DISHONESTY”
  on transcript until cleared by taking the Academic Honesty Remediation Course).
- If the violation is egregious enough, I can refer the incident to the Honor Council for further action.
- I will also typically include taking the Academic Honesty Remediation Course as part of the
  sanction. This is a three-class, one-month course on academic integrity. I will usually give you one
  semester to take the course. If you do not take the course by this time your grade will be changed
  to an F*.
- After I file a report, you are now in the AHSO system. If there is a second violation, in any course,
  you will automatically go before the Honor Council, and you will likely be expelled from the
  university.
- Note that upper division students found guilty of a violation are ineligible to graduate with honors.
- In all cases, you have the right to appeal to the AHSO.

It is my sincerest hope that this policy is never referenced or used. In the unfortunate event you do
decide that cheating is the course you will take, you are now aware of the consequences. As a final and
important note: Remember that I will treat students giving unauthorized help the same as students
receiving unauthorized help.
PETE 629 Advanced Hydraulic Fracturing

2018 Spring Semester Syllabus

Course/Section | Credit | Days    | Time          | First - Last | Location
-----------------|--------|---------|---------------|--------------|----------
PETE 629/600    | 3      | T and R | 08:00 am-09:15 am | 01/16-05/04  | RICH 208
PETE 629/700    | 3      | DL      |               | 01/16-05/04  | DL

Course Description: The purpose of this course is to integrate the necessary fundamentals from flow in porous media, elasticity theory, fracture mechanics and fluid mechanics in order to understand, design, optimize and evaluate hydraulic fracturing treatments. Our goal is to establish a unified design and analysis methodology for propped fracturing. Starting from the reservoir engineering description of the performance of a fractured well, we provide a firm basis for determining the optimum fracture dimensions based on the effective Proppant Number concept. Technical constraints will be satisfied in such a way that the design will depart from the theoretical optimum only to the necessary extent. We discuss fluid, proppant and rock properties, data gathering, design models of various complexity, on-site calibration, real-time and post-job data evaluation, in addition to deriving and solving models of fracture propagation. In this course we put special emphasis on using the computer not just as a number-crunching device but rather to do all kind of mathematical derivations and advanced algorithms. Therefore, approximately one third of the course will be devoted to introduce the Wolfram Mathematica (MMA) software.

Textbooks: The course material is not covered in one single textbook. Materials will be provided in electronic form, downloadable via eCampus.

Software: Mathematica 11 (desktop version) should be installed on the computer you are working on.

Grading Policy: Regular scale will be applied (A: 90+, B: 80+,... ) with weights:
Remark: Based on your semester performance and project, I will offer a grade before the Final Exam. If you accept, your Final Exam is waived. If you opt not to accept, the project grade will be dropped and the last 25 % will come totally from the Final Exam.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm Exam 1</td>
<td>30 %</td>
</tr>
<tr>
<td>Midterm Exam 2</td>
<td>30 %</td>
</tr>
<tr>
<td>Homeworks, Quizzes</td>
<td>15 %</td>
</tr>
<tr>
<td>Project or Final Exam</td>
<td>25 %</td>
</tr>
</tbody>
</table>

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### PETE 629 Advanced Hydraulic Fracturing 2018 Spring Schedule (For updates see the eCampus site)

<table>
<thead>
<tr>
<th>W</th>
<th>D</th>
<th>Date</th>
<th>Fracturing Topics</th>
<th>MMA Topics</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T</td>
<td>01-16</td>
<td>Introduction. Review of fracturing.</td>
<td>How to find info? Notebook initialization. Units.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>01-18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>01-22</td>
<td>Productivity index and material balance.</td>
<td>Simple problem solving, plots and lists. Repetitive tasks.</td>
<td>5 pm. Course drop deadline</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>01-23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>01-25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>T</td>
<td>01-30</td>
<td>Optimum fracture dimensions.</td>
<td>Naming and scoping, building up calculations. Modules.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>02-01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>02-08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>02-15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>T</td>
<td>02-20</td>
<td>Coupling of elasticity and flow.</td>
<td>Programming concepts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>02-22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>T</td>
<td>02-27</td>
<td>Design variants.</td>
<td>Symbolics and Numerics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>03-01</td>
<td>Midterm 1</td>
<td>Midterm 1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>T</td>
<td>03-06</td>
<td>Fracture height and propagation. Softwares.</td>
<td>Wolfram language principles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>03-08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>03</td>
<td>13:15</td>
<td>Spring break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>T</td>
<td>03-20</td>
<td>Non-darcy flow in fracture. Frac &amp; Pack.</td>
<td>Project support</td>
<td>Project selection deadline</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>03-22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>T</td>
<td>03-27</td>
<td>Horizontal well completion. Fracture diagnostics.</td>
<td>Project support</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>03-29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>T</td>
<td>04-03</td>
<td>Productivity</td>
<td>Project support</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>04-05</td>
<td>Midterm 2</td>
<td>Midterm 2</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>T</td>
<td>04-10</td>
<td>Laplace transform models</td>
<td>Laplace inversion. High-level FE.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>04-12</td>
<td>Finite Elements models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>T</td>
<td>04-17</td>
<td>Shale database</td>
<td>Association and Dataset. Neural Net. Manipulate.</td>
<td>5 p.m., Q-drop deadline</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>04-19</td>
<td>Al methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>T</td>
<td>04-24</td>
<td>Project Presentations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>04-26</td>
<td>Project Presentations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>T</td>
<td>05-01</td>
<td>Redefined day (F). No class.</td>
<td>Project submission deadline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>05-04</td>
<td>1:00-3:00 pm. Final Exam (If not waived)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Course title and number: Geostatistics and Data Analytics: PETE 630
Term (e.g., Fall 200X): Fall 2020
Meeting times and location: TR 2:20-3:35 PM

Course Description and Prerequisites
This course covers introductory and advanced concepts in geostatistics and data analytics for petroleum reservoir characterization by integrating static (cores/logs/seismic traces) and dynamic (flow/transport) data. Specific topics are: data partitioning (classification), data correlation (parametric/non-parametric regression), variograms and spatial data analysis, kriging/cokriging, conditional simulation, non-Gaussian approaches (indicator methods/simulated annealing/genetic algorithms) and data driven methods (RF, SVM and GBM). Prerequisite is introductory course in statistics or instructor approval.

Learning Outcomes
The students will be able to utilize core, well logs, seismic data and geologic knowledge to generate classification and regression models, analyze spatial data and build high resolution geomodels for flow simulation.

Instructor Information
Name: Akhil Datta-Gupta
Telephone number: 9798479030
Email address: datta-gupta@tamu.edu
Office hours: TBD
Office location: RICH 401G

Textbook and/or Resource Material
No prescribed textbook. References and class notes will be provided.

Recommended References:

Grading Policies
- Homeworks and Assignments
  - Periodic class assignments (5%)
  - Home Works (15%)
- Projects
  - Project-1 (30%)
  - Project-2 (30%)
- Review Examination
  - In Class Exam or Final Project (20%)

Attendance and Make-up Policies
http://student-rules.tamu.edu/rule07
Course Topics and Calendar

Week - 1: Basic Review of Probability and Statistics
Overview & Objectives
Distribution functions
Moments and Expectations
Covariance/correlation

Weeks - 2&3: Data Correlation/Regression
Multivariate Analysis (PCA, Cluster and Discriminant Analysis)
Data classification/partitioning
Parametric and Non-parametric Regression

Weeks - 4&5: Spatial Interpolation of Properties
Variogram and Variogram Modeling
Linear Regression
Kriging/Cokriging and Variations

Week - 5: Project-1 Due

Weeks - 6&7: Stochastic Simulation
Conditional Simulation
Sequential Simulation
Simulated Annealing
Uncertainty Assessment

Weeks - 8&9: Integration of seismic and Well Data
Scales and resolution
Sequential Simulation with Block Kriging
Bayesian Approaches
Geostatistical Inversion

Week -10: Modeling Facies Variations
Lithofacies characterization
Object-based modeling
Indicator methods
Multipoint Geostatistics

Week -10: Project-2 Due

Week -11&12: Data Driven Methods
Classification and Regression Trees
Random Forest
Gradient Boosting Method
Support Vector Machines
Neural Network

Week -13& onwards:
Review of Research Papers
Review Examination
Other Pertinent Course Information

None

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Academic Integrity
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“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number: Data Integration in Petroleum Reservoirs PETE 633
Term (e.g., Fall 200X): Fall 2019
Meeting times and location: Tuesday and Thursday

Course Description and Prerequisites
This course is designed to cover techniques to incorporate diverse data types during petroleum reservoir characterization, accounting for the scale and precision associated with the data. A particular emphasis will be on the integration of dynamic reservoir behavior into stochastic reservoir characterization through the use of inverse modeling. The dynamic data can be in the form of pressure transient test, tracer test, multiphase production history or interpreted 4-D seismic information. Prerequisite is introductory course in statistics or instructor approval.

Learning Outcomes
The students will be able to reconcile high resolution geologic models to production data using advanced history matching techniques and uncertainty quantification tools.

Instructor Information
Name: Akhil Datta-Gupta
Telephone number: 9798479030
Email address: datta-gupta@tamu.edu
Office hours: TBD
Office location: RICH 401G

Textbook and/or Resource Material
No prescribed textbook. References and class notes will be provided.

Grading Policies
- Homeworaks and Assignments
  - Periodic class assignments (5%)
  - Home Works (15%)
- Projects
  - First (20%)
  - Second (30%)
- Final Project/Examinations
  - Final (30%)

Attendance and Make-up Policies
http://student-rules.tamu.edu/rule07

Course Topics, Calendar of Activities, Major Assignment Dates
- Introduction and Background
• PDF for functions of Random Variable
• Bayes Rule as a Basis for Inverse Problems
• Project-1
• Inverse Problem: An Illustration
• The General Linear Gaussian Case
• Solving the Inverse Problem
• Minimization Method: Gauss Newton and Variations
• Project-2
• Model Assessment and Uncertainty Quantification
• Resolution and Variance of Solution
• Project-3 or Final Exam

Other Pertinent Course Information

None

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Academic Integrity
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“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number: PETE 635 Underbalanced and Managed Pressure Drilling
Term: Fall 2018
Meeting times and location: Tuesday Thursday 11:10-12:25 Rich 311

Course Description and Prerequisites

Prerequisites: Graduate enrollment or approval of instructor

Description of Course: This course provides an introduction and application of techniques utilized in underbalanced and managed pressure drilling. Topics covered are equipment, types of drilling fluids used (air, mist foam, etc.), flow drilling, mud cap drilling and hydraulics calculations.

Learning Outcomes

The students will have general idea of the Managed Pressure Drilling and Underbalanced Drilling Technologies available, when these technologies are applicable as well as which techniques are the best choice. They will also understand the engineering and planning for these technologies.

Instructor Information

Name: Jerome J. Schubert
Telephone number: 979-862-1195
Email address: jschubert@tamu.edu
Office hours: Tuesday Thursday 10:00-11:00 am or by appointment
Office location: Rich 501K

Textbook and/or Resource Material

Required Textbooks

References
“Mudlite Air/Mist/Foam Hysraulics Model”, Maurer Engineering Inc., Houston, 1988

Grading Policies
Exam A 25%
Exam B 25%
Homework 25%
Project 25%
A = 89.5 - 100%
B = 79.5 - 89.499...
C = 69.5 – 79.499...
D = 59.5 – 69.99…
F = 0 – 59.499…
Exams, Homework, and Project presentations will be submitted via ecampus.

Attendance and Make-up Policies

See Student Rule 7 http://student-rules.tamu.edu/rule07. Since all classes will be recorded and made available in ecampus, lectures can be made up by watching videos. If a student cannot submit homework or take exams at the scheduled time, the professor will work with the student given the student notifies the professor in advance.

Course Topics, Calendar of Activities, Major Assignment Dates

(14 weeks - 15th week is first week of finals. Include lab hours. Must include dates on which major exams will be given and assignments will be due and should not be changed without notification of all students in the course. THIS INFORMATION HAS BEEN PLACED HERE FOR REFERENCE ONLY. PLEASE REMOVE BEFORE PREPARING SYLLABUS.)

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Course, Intro to Managed Pressure Drilling and Situational Problems</td>
<td>MPD Ch 1 &amp; 2, App A &amp; B</td>
</tr>
<tr>
<td>2</td>
<td>Constant BHP method as Primary Control, Flow Measurement as Primary control</td>
<td>MPD Chapter 3, MPD Chapter 4</td>
</tr>
<tr>
<td>3</td>
<td>Continuous Circulation System, Simplified Approach to MPD</td>
<td>MPD Chapter 5, MPD Chapter 6</td>
</tr>
<tr>
<td>4</td>
<td>MudCap Drilling Foam Cap Drilling, MPD UBO Committee Meeting</td>
<td>MPD Chapter 7</td>
</tr>
<tr>
<td>5</td>
<td>ATC&amp;E No Classes</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Dual Gradient Drilling</td>
<td>MPD Chapter 8</td>
</tr>
<tr>
<td>7</td>
<td>MPD Equipment, MPD Candidate Selections</td>
<td>MPD Chapter 9, MPD Chapter 10</td>
</tr>
<tr>
<td>8</td>
<td><strong>Exam A</strong></td>
<td>UBD Chapter 1, UBD Chapter 2</td>
</tr>
<tr>
<td>9</td>
<td>Introduction to Underbalanced Drilling Flow Drilling, Gaseated Fluids, Foam Drilling and</td>
<td>UBD Chapter 3, UBD Chapter 4</td>
</tr>
<tr>
<td>10</td>
<td>Foam Drilling, Air and Gas Drilling</td>
<td>UBD Chapter 4, UBD Chapter 5</td>
</tr>
<tr>
<td>11</td>
<td>Snubbing and Underbalanced Drilling</td>
<td>UBD Chapter 6</td>
</tr>
</tbody>
</table>
Coiled Tubing and Underbalanced Drilling UBD Chapter 9
Gasses used in Underbalanced Drilling UBD Chapter 10
Underbalanced Liner Drilling Equipment and Integration UBD Chapter 11

Project Presentations and Exam B

The actual date of Exam A is flexible depending upon when we actually complete all the lessons on MPD and the exam schedules for other classes for the students. The Course Project will be 10-15 minute power point presentation on ANY TOPIC RELATED TO Managed Pressure or Underbalanced Operations. On campus students will present live in class the last week of the semester classes and attendance is mandatory for on campus students. Distance Learning students will prepare their power point presentations and use the voice over option to record their oral presentations. All presentations will be submitted to exampus.

Other Pertinent Course Information

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Academic Integrity

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PETE 636 Horizontal, Multilateral and Intelligent Wells

Textbook Required: *Multilateral Wells*, A.D. Hill, Ding Zhu and Michael J. Economides
Supplemental Material: SPE papers

The course focuses on the fundamentals of well performance evaluation and optimization for horizontal, multilateral and intelligent wells. It emphasizes the impact of wellbore flow and well completion on well performance of complex wells.

**Planned Course Lecture Schedule**

**Unit 1: Complex Well Performance**

Week 1  Introduction, course outline, method of study
- Horizontal well performance model: Steady State
  - Joshi model, Furui model

Week 2  Horizontal well performance model: Pseudo Steady-State
- Babu and Odeh model

Week 3  Wellbore flow and its impact on well performance
- Segment model of horizontal well performance

Week 4  Discussion of wellbore pressure drop effect on segment size
- Gas well model and two-phase correlation

Week 5  In-class exercise of horizontal well performance and horizontal well optimization design
- Project 1 due (30%)

**Unit 2: Multilateral Wells and Well Design Optimization**

Week 6  Multilateral well applications, junction classification
- Multilateral productivity calculation

Week 7  Multilateral well junction design and pressure balance

Week 8  In-class exercise: multilateral well design

Week 9  Formation damage model, completion design and selection
- Horizontal well completion model
- Midterm Exam (40%)

**Unit 3: Intelligent Wells**

Week 10  Inflow control concept ICD/ICV
<table>
<thead>
<tr>
<th>Week 11</th>
<th>Using inflow control to optimize multilateral well performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 12</td>
<td>Intelligent wells monitoring introduction</td>
</tr>
<tr>
<td></td>
<td>Fiber optic sensing, DTS/DAS</td>
</tr>
<tr>
<td>Week 13</td>
<td>Understand DTS measurements: wellbore temperature model</td>
</tr>
<tr>
<td></td>
<td>Completion effect on temperature monitoring</td>
</tr>
<tr>
<td>Week 14</td>
<td>Monitoring horizontal well fracturing</td>
</tr>
<tr>
<td><strong>Week 15</strong></td>
<td><strong>final project/presentation (30%)</strong></td>
</tr>
</tbody>
</table>
Course title and number       PETE 637 Streamline Simulation
Term                          Fall 2013
Meeting times and location    M 3:00-6:00 PM, RICH 313

Course Description and Prerequisites
This course is designed to cover introductory and advanced concepts in streamline simulation and its applications. The theory of streamlines/streamtubes in multidimensions is reviewed. The specific topics include: Streamline, Streamtubes, Streamfunctions. Transport Along Streamlines. Spatial Discretization and Material Balance. Time Stepping and Transverse Fluxes. Impact of Cell Geometry. History Matching and Production Data Integration. Comparison with Finite Difference. Prerequisites: Graduate Classification

Learning Outcomes or Course Objectives
The objective of the course is to familiarize the students with the introductory and advanced concepts in the theory and applications of the rapidly evolving streamline simulation technology. At the end of this class, students will be familiar with modern streamline simulators, their advantages and limitations compared to traditional finite difference models.

Instructor Information
Name                          Dr. Akhil Datta-Gupta
Telephone number              (979) 847-9030
Email address                 datta-gupta@tamu.edu
Office hours                  Rm401G Richardson Building

Textbook and/or Resource Material
No Required Textbook.

Grading Policies
Midterm Exam.................................................................(20%)
Final Exam.................................................................(30%)
Class Projects/Homeworks.................(50%)
## Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>The Role of Streamline Simulation, Historical Precedents, Chronological development</td>
</tr>
<tr>
<td>2</td>
<td>Basic Governing Equations</td>
<td>General Conservation Equations, Pressure Equation, Treatment of Sources and Sinks</td>
</tr>
<tr>
<td>3-4</td>
<td>Streamline, Streamtubes, Streamfunctions</td>
<td>Streamfunctions and Complex Potential, Streamtubes, Streamlines and Time of Flight, Compressible Flow</td>
</tr>
<tr>
<td>5</td>
<td>Transport Along Streamlines</td>
<td>Analytical Solutions, Semianalytic Solution, and Numerical Solutions</td>
</tr>
<tr>
<td>7</td>
<td>Time Stepping and Transverse Fluxes</td>
<td>Concepts of Operator Splitting, Modeling Gravity, Modeling Capillarity and Transverse Dispersion, and Modeling Fractured Reservoirs</td>
</tr>
<tr>
<td>8-9</td>
<td>Impact of Cell Geometry</td>
<td>Corner-Point Extension and Impact on Displacement Calculations</td>
</tr>
<tr>
<td>10-11</td>
<td>History Matching and Data Integration</td>
<td>Assisted History Matching, Automatic History Matching, Streamline and Asymptotic Ray Theory, Sensitivity Computations Using Streamline Models, and Production Data Integration into High-Resolution Models</td>
</tr>
<tr>
<td>14-15</td>
<td>Field Studies 2: Advanced</td>
<td>Flow Visualization/sector models, Fast Runs, Ranking and Uncertainty Assessment, Upgridding/grid design, Upscaling QC, Pseudoization, and History Matching</td>
</tr>
</tbody>
</table>
Other Pertinent Course Information

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity

For additional information please visit: http://www.tamu.edu/aggiehonor

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
PROFESSOR: A. D. HILL,

OFFICE HOURS: MW 2-4
Grader: TBD

Production Logging Measurements and Analysis, Chapter from Production Operations Volume 1, 5th edition, PennWell Publishing

GRADING:

As the focus of the course will be on applying production log interpretation methods, the grade will be based solely on the software you write throughout the course to interpret the logs studied. For each logging method (or combination of logs), your assignment will be to write an interpretation application for that method. You will be given feedback about your work after each assignment. At the end of the semester, your assignment will be to combine all of the codes into one production logging interpretation package. Your grade will be based on this final package.

SUBJECT MATTER:

Production Logging has been described as "that area of well logging concerned with two general goals: (1) problem well diagnosis, and (2) reservoir surveillance." Thus, production logging refers to a suite of logs that are run normally on completed injection or production wells to evaluate the performance of the well itself or of the reservoir as a whole. Many of these logs measure properties of the fluid in the wellbore, rather than formation properties as in openhole logging. Therefore, an understanding of the fluid dynamics in a wellbore is an important part of understanding production logs. This course will cover fluid flow in pipes, the theoretical basis of production logging techniques, production log interpretation techniques, and operational considerations.

A particular emphasis will be on logging tools and methodologies that have been developed over the past 20 years specifically for improved production logging in horizontal wells. This material will come from papers from the literature and from a draft of the second edition of the Production Logging monograph.
COURSE OUTLINE:

I. Single Phase Flow Production Logs
   A. Single-Phase Flow in Pipes
   B. Temperature Logs
   C. Radioactive Tracer Logs
   D. Spinner Flowmeters

II. Multiphase Flow Production Logs
   A. Multiphase Flow in Pipes - flow regime, holdup correlations
   B. Spinner Flowmeters in Multiphase Flow
   C. Packer, Basket flowmeters
   D. Density Logs
   E. Capacitance Logs
   F. Pipe Inclination Effects

III. Noise Logging

IV. Completion Evaluation Logs
   A. Cement Bond Logs
   B. Cement Evaluation (Pulse-Echo) Logs

V. Logs for Horizontal and Highly Deviated Wells

ADA Policy Statement: (Texas A&M University Policy Statement)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.

Coursework Copyright Statement: (Texas A&M University Policy Statement)

The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copy-righted, you do not have the right to copy them, unless you are expressly granted permission.
As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions about plagiarism and/or copying, please consult the latest issue of the *Texas A&M University Student Rules*, under the section "Scholastic Dishonesty."

**Aggie Honor Code**

“An Aggie does not lie, cheat, or steal or tolerate those who do.”

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: [www.tamu.edu/aggiehonor/](http://www.tamu.edu/aggiehonor/).
Petroleum Engineering 406 and 639: High Performance Drilling
Credit 3: (3-0)
Spring 2019 Syllabus

Course Description: The purpose of this course is to prepare the student to be able to achieve differentiating drilling performance in the most complex wells. The physics-based practices taught represent the state of the art in high-performance drilling. This includes the underlying physics of each major type of performance limiter, real time operational practices, engineering redesign practices, and effective workflows for achieving the required change in engineering and operational practices.

Prerequisites: PETE 661 or 355 or Approval of instructor.

Instructor: Sam Noynaert, Associate Professor, Petroleum Engineering Department, RICH 501J, (979) 845-6164, noynaert@tamu.edu
Office hours: By appointment.

Texts: No textbook is required.
- Over the course of the semester students will download SPE papers from One Petro.

Method of Evaluation:
- Homework, in-class quizzes 15%
- Exams 50%
- Final Exam 25%
- Project 10%
- Total 100%

Grading Policy:  
>89.5 = A  
79.5 – 89.4 = B  
69.5 – 79.4 = C  
59.5 – 69.4 = D  
<59.5 = F

Contributions to Professional Component:

<table>
<thead>
<tr>
<th>Math and Science</th>
<th>Student will learn fundamental physical principles in rock mechanics, bit mechanics, vibrations, cuttings transport and hydraulics</th>
</tr>
</thead>
</table>
| Petroleum Engineering | Provides students with the ability to effectively implement new practices that will achieve differentiating field drilling performance, even as new hires.  
Provides a physics-based understanding of field operations that enables the student to learn from future experiences more effective, innovate in the creation of new practices, and to move new practices from one operation to another |
| General Education | None |
**Course Learning Outcomes and Relationship to Program Outcomes:**

<table>
<thead>
<tr>
<th>Course Learning Outcome: At the end of the course, students will be able to…</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students will demonstrate knowledge in Blowout Prevention and the environmental and safety consequences of poor well control.</td>
<td>1, 3, 5</td>
</tr>
<tr>
<td>The students will demonstrate knowledge of new technology developed for UBD, and governmental, societal, and corporate concerns for Underbalanced Operations.</td>
<td>3, 5, 6</td>
</tr>
<tr>
<td>The students will demonstrate knowledge in modern drilling technologies and make decision when to apply them</td>
<td>3, 5, 11</td>
</tr>
<tr>
<td>The students will demonstrate knowledge of various Drilling operations including Offshore, costs, and other differences as compared to land operations.</td>
<td>3, 11</td>
</tr>
<tr>
<td>The students will demonstrate knowledge of contemporary well design of designer wells (e.g. horizontal, extended reach, and multilateral wells).</td>
<td>3, 5, 10</td>
</tr>
<tr>
<td>The students will demonstrate knowledge of the tools and techniques in fishing operations.</td>
<td>5, 11</td>
</tr>
</tbody>
</table>

**Related Program Outcomes:**

<table>
<thead>
<tr>
<th>No.</th>
<th>PETE graduates must have…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An ability to apply knowledge of mathematics, science, and engineering.</td>
</tr>
<tr>
<td>3</td>
<td>An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td>
</tr>
<tr>
<td>5</td>
<td>An ability to identify, formulate, and solve engineering problems.</td>
</tr>
<tr>
<td>6</td>
<td>An understanding of professional and ethical responsibility.</td>
</tr>
<tr>
<td>10</td>
<td>A knowledge of contemporary issues</td>
</tr>
<tr>
<td>11</td>
<td>An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
</tr>
</tbody>
</table>

**Course Topic, Major Calendar of Events, Assignment Dates**

Homework will generally be submitted on Wednesdays although this may change depending on the homework topic and lecture progress. Two project submittals will be developed by your team. Three exams will be given, which are not comprehensive. Late work will not be accepted without prior approval for the delay ([http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07)). Class attendance is required for resident students, per university policy.
Americans with Disabilities Act (ADA) Policy Statement

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Coursework Copyright Statement

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If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."
Aggie Code of Honor
An Aggie does not lie, cheat, or steal or tolerate those who do.

For more information: http://www.tamu.edu/aggiehonor

For my policies on how I handle Honor Code violations, see the notes on the following page

My responsibility based on the Aggie Honor Code:
As a Texas A&M University faculty member, I must follow the Aggie Honor Code. This means that I will not tolerate those who cheat. In addition, as an instructor I must be fair. If I overlook cheating, it is not fair to those who DIDN’T cheat.
I know I can’t create a fool-proof system, but I will try to make the quantitative portion of this class as immune from OPPORTUNITIES to cheat as possible. If someone does cheat or assist in cheating, I will follow the procedure shown.

Departmental Reputation:
As a member of this department, I am charged with assisting in developing future petroleum engineers. Aggies have a reputation in the industry of being technically competent as well as ethical and honest in their business dealings. As a fellow Aggie, I feel very strongly about upholding and continuing this reputation.

Industry Application:
There will be many times in your career during which you will not have someone working with you who can provide technical assistance. In these instances, you will have to perform as an individual in order to make operational and business decisions for you and your company. If you are not able to perform as an individual now, how to do you expect to perform under pressure with millions of dollars and possibly people’s actual lives on the line?
It may seem minor to sneak a look at someone’s exam, however if you are willing to do this, where does it stop? I for one do not want to see or hear of Aggies involved in unethical dealings. Unfortunately, I have been involved in deals in which Aggies on the other side of the table where not ethical. I can personally say that the damage to Texas A&M University’s and our department’s reputation was shameful and irreparable from the viewpoint of the non-Aggies involved.

What constitutes dishonesty:
- Looking at another student’s exam
- Allowing another student to look at YOUR exam
- Using non-authorized aids or sources during a test (phones, texts, notes in calculator, etc)
- Collaborating on assigned work without instructor approval
- Plagiarism – just because you got it off of the internet, it doesn’t mean you didn’t plagiarize.
  Most plagiarism cases today begin with a Google search.
- More examples available at http://aggiehonor.tamu.edu/descriptions
If an incident occurs:

- I will report the violation to the AHSO, regardless of the magnitude of the violation.
  - The report is submitted online and includes the details of the violation, specification of sanction and student acknowledgement of acceptance/rejection of violation and/or sanction.
- I will usually handle the first offense autonomously meaning I decide the sanction. My minimum sanction will usually be a one-letter-grade reduction in your course grade. The maximum sanction I can give is an F* (failure of the course and notation of “FAILURE DUE TO ACADEMIC DISHONESTY” on transcript until cleared by taking the Academic Honesty Remediation Course).
- If the violation is egregious enough, I can refer the incident to the Honor Council for further action.
- I will also typically include taking the Academic Honesty Remediation Course as part of the sanction. This is a three-class, one-month course on academic integrity. I will usually give you one semester to take the course. If you do not take the course by this time your grade will be changed to an F*.
- After I file a report, you are now in the AHSO system. If there is a second violation, in any course, you will automatically go before the Honor Council, and you will likely be expelled from the university.
- Note that upper division students found guilty of a violation are ineligible to graduate with honors.
- In all cases, you have the right to appeal to the AHSO.

It is my sincerest hope that this policy is never referenced or used. In the unfortunate event you do decide that cheating is the course you will take, you are now aware of the consequences. As a final and important note: Remember that I will treat students giving unauthorized help the same as students receiving unauthorized help.
Course Information

Course Number: PETE 640
Course Title: Models for Simulation of Flow and Transport of Fluids and Heat in Porous Media
Section: 600
Time: Lecture: 8:00 AM – 11:10 AM   Lab: 4:10 PM – 7:00 PM
Location: Online
Credit Hours: 4

Instructor Details

Instructor: Dr. George Moridis
Office: RICH 407L
Phone: (979) 458-4470 (office) or (510) 333-0590 (cell)
E-Mail: moridis@tamu.edu
Office Hours: M, 10:00-Noon; 1:00-3:00 p.m.

Course Description

Beginning from basic principles and based on a “starter” code that will be provided by the instructor, the students in this course will design and build numerical simulators that describe the flow of reservoir fluids and the transport of heat through porous media. At the end of this course the non-osothermal multi-dimensional models that will be developed will be capable of handling single mass components (gas, oil or water) in single phases (liquid or vapor).

Course Prerequisites

Prerequisites:
1. Graduate classification.
2. PETE 603 or instructor approval.
3. Programming experience in FORTRAN95, C, C++ or another programming language (NOTE: The extensive coding efforts will be conducted using FORTRAN95/2003. Experience in FORTRAN or another programming language is a MUST for this course. Experience with MatLab or Mathematica programming will be useful, but may (but not necessarily) require some additional effort/preparation for the needs of this course. Note that past experience has shown that the programming language becomes a non-issue after the first 2-3 weeks of the class.
4. A solid understanding of (a) the physical processes of flow and transport through porous media, (b) numerical analysis and (c) linear algebra.
5. Access to a FORTRAN95/2003 compiler on a PC or workstation.

Course Learning Outcomes

The objectives of the course are for students to:
1. Design and build numerical simulators that describe the flow of reservoir fluids and the transport of heat through porous media. Develop non-isothermal multi-dimensional models capable of handling single mass components in single phases.

Textbook and/or Resource Materials

Textbook:
1. *Fortran 95/2003 for Scientists & Engineers, by Stephen J. Chapman (2007)*: This book is the basic FORTRAN 95/2003 reference used in the class, but any other general book on FORTRAN 95 and beyond is acceptable. Note that purchase of a book on FORTRAN is not necessary, but access to one (downloaded from the internet or borrowed from the library) is critically important.
2. Class notes and copies of appropriate scientific publications on relevant subjects will be distributed by the instructor.

Reference Materials:

Grading Policy

Homework (daily assignments; quality and logical thoroughness of code).................... (100%)

Policy on homework:
- All homework is due (even if late); otherwise, an “Incomplete” grade will be given until homework is submitted

**Grading Scale**

A.........................................................................................................................90-100%
B.........................................................................................................................80-89%
C.........................................................................................................................70-79%
D.........................................................................................................................60-69%
F.........................................................................................................................0-59%

*Grading Policy Changes* – Faculty must provide grading policies to students by the first class period. As such, faculty cannot change the course grading policy after the second class session. (See Student Rule 10.)
The late work policy should define what constitutes late work (e.g., submitting a deliverable after the established deadline). Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy. (See Student Rule 7.)

Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fundamental equations of flow and transport of mass and heat through porous media; the Integral Final Difference (IFD) method</td>
</tr>
<tr>
<td>2</td>
<td>Brief overview of simulation approaches in the analysis of coupled non-linear processes</td>
</tr>
<tr>
<td>3</td>
<td>Discussion of the fully implicit method (Jacobian and Newton-Raphson method)</td>
</tr>
<tr>
<td>5</td>
<td>Simulator design – modular OOP approach</td>
</tr>
<tr>
<td>6</td>
<td>Domain discretization (Cartesian and cylindrical)</td>
</tr>
<tr>
<td>7</td>
<td>Process description:</td>
</tr>
<tr>
<td></td>
<td>o Fluid flow (Darcy and non-Darcy flow, diffusive flow)</td>
</tr>
<tr>
<td></td>
<td>o Heat transport (conduction, advection)</td>
</tr>
<tr>
<td></td>
<td>o Equation of state (PVT relationships, no phase changes)</td>
</tr>
<tr>
<td></td>
<td>o Thermophysical properties (phase density, viscosity, solubility, thermal conductivity, etc.)</td>
</tr>
<tr>
<td>8</td>
<td>Initial and boundary conditions – primary and secondary variables</td>
</tr>
<tr>
<td>9</td>
<td>Treatment of sources and sinks (wells)</td>
</tr>
<tr>
<td>10</td>
<td>Setting up the Jacobian matrix</td>
</tr>
<tr>
<td>11</td>
<td>Solution of the matrix equation (linear algebra, direct and iterative solvers)</td>
</tr>
<tr>
<td>12</td>
<td>Solution of 1D, 2D and 3D problems (Cartesian or cylindrical) of isothermal/non-isothermal gas flow</td>
</tr>
<tr>
<td>13</td>
<td>Solution of 1D, 2D and 3D problems (Cartesian or cylindrical) of isothermal/non-isothermal oil flow</td>
</tr>
</tbody>
</table>

University Policies

This section outlines the university level policies that must be included in each course syllabus. The TAMU Faculty Senate established the wording of these policies.

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.
Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor” (Student Rule 7, Section 7.4.1).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual
harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

COVID-19 Temporary Amendment to Minimum Syllabus Requirements

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):
• Self-monitoring—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**

• Face Coverings—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.

• Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

• Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.

• To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

**Personal Illness and Quarantine**

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities**. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, **for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.**

**Operational Details for Fall 2020 Courses**

For additional information, please review the [FAQ](https://www.tamu.edu) on Fall 2020 courses at Texas A&M University.
PETE 641 Course Syllabus

Course Information

Course Number: PETE 641  
Course Title: Models for Simulation of Advanced Coupled Processes in Geologic Media  
Sections: 600  
Time: TBA  
Location: TBA  
Credit Hours: 4, 3 Lecture Hours. 3 Lab Hours

Instructor Details

Instructor: Dr. George Moridis  
Office: RICH 407L  
Phone: (979) 458-4470  
E-Mail: moridis@tamu.edu  
Office Hours: TBA

Course Description

Design and develop advanced multi-phase flow processes and complex geologic media (porous and fractured, with matrix-fracture interactions); structured and unstructured grids, multiple mass components (gas, oil and water) in multi-phase states (liquid, vapor and/or liquid-vapor), and phase changes.

Course Prerequisites

Prerequisites:
1. Graduate classification  
2. PETE 640  
3. Programming experience in FORTRAN95, C, C++ or another programming language (NOTE: The extensive coding efforts will be conducted using FORTRAN95/2003. Experience in FORTRAN or another programming language is a MUST for this course. Experience with MatLab or Mathematica programming will be useful, but may (but not necessarily) require some additional effort/preparation for the needs of this course. Note that past experience has shown that the programming language becomes a non-issue after the first 2-3 weeks of the class.  
4. A solid understanding of (a) the physical processes of flow and transport through porous media, (b) numerical analysis and (c) linear algebra.  
5. Access to a FORTRAN95/2003 compiler on a PC or workstation

Course Learning Outcomes

The objectives of the course are for students:
Course Syllabus: PETE 641

- Develop expanded multi-phase flow processes and more complex geologic models.
- Design and build non-isothermal multi-dimensional models that will be capable of handling complex geologic media (porous and fractured, with matrix-fracture interactions), structured and unstructured grids, multiple mass components (gas, oil and water and water) in multi-phase (liquid, vapor and/or liquid-vapor) states, and phase changes.

Textbook and/or Resource Materials

Textbook:
1. Fortran 95/2003 for Scientists & Engineers, by Stephen J. Chapman (2007): This book is the basic FORTRAN 95/2003 reference used in the class, but any other general book on FORTRAN 95 and beyond is acceptable. Note that purchase of a book on FORTRAN is not necessary, but access to one (downloaded from the internet or borrowed from the library) is critically important.
2. Class notes and copies of appropriate scientific publications on relevant subjects will be distributed by the instructor.

Reference Materials:
2. Petroleum Reservoir Simulation, by Khalid Aziz and Antonin Settari (1979)
3. The Properties of Petroleum Fluids, by W. D. McCain

Grading Policy

Homework (daily assignments; quality and logical thoroughness of code)...................... (100%)

Policy on homework:
- All homework is due (even if late); otherwise, an “Incomplete” grade will be given until homework is submitted.

Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90-100%</td>
</tr>
<tr>
<td>B</td>
<td>80-89%</td>
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<tr>
<td>C</td>
<td>70-79%</td>
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<tr>
<td>D</td>
<td>60-69%</td>
</tr>
<tr>
<td>F</td>
<td>0-59%</td>
</tr>
</tbody>
</table>

Grading Policy Changes – Faculty must provide grading policies to students by the first class period. As such, faculty cannot change the course grading policy after the second class session. (See Student Rule 10.)

The late work policy should define what constitutes late work (e.g., submitting a deliverable after the
established deadline). Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy. (See Student Rule 7.)

**Course Schedule**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Complex geologic media: matrix-fracture interactions in fractured media, and the Multiple Interacting Continua (MINC) concept</td>
</tr>
<tr>
<td>2</td>
<td>Domain discretization (Mixed Cartesian/cylindrical grids, unstructured grids)</td>
</tr>
</tbody>
</table>
| 3-4  | Process description:  
|      | - Wettability (relative permeability and capillary pressure, various models)  
|      | - Equation of state with phase changes (PVT relationships, vapor pressure, phase enthalpies and latent heats of vaporization/condensation)  
|      | - Thermophysical properties (phase density, viscosity, solubility, thermal conductivity, etc.)  
|      | - Phase changes (boiling, vaporization), solution and exsolution |
| 5    | Initial and boundary conditions – primary and secondary variables, primary variable change |
| 6    | Treatment of sources and sinks (wells) |
| 7    | Setting up the Jacobian matrices; change of primary variables |
| 8    | Solution of 2D and 3D problems (Cartesian or cylindrical) of single-component (CH4), single-phase gas flow in fractured media (application to shale gas) |
| 9    | Solution of 2D and 3D problems (Cartesian or cylindrical) of single-component (water), two-phase flow with phase changes (geothermal reservoir problem) |
| 10   | Solution of 1D, 2D and 3D problems (Cartesian, cylindrical, mixed, Voronoi or unstructured grids) of two-component, two-phase isothermal flow (water+oil, oil+gas, water+gas) |
| 11   | Solution of 1D, 2D and 3D problems (Cartesian, cylindrical, mixed, Voronoi or unstructured grids) of three-component, three-phase isothermal flow (water+oil+gas) |
| 12   | Solution of 1D, 2D and 3D problems (Cartesian, cylindrical, mixed, Voronoi or unstructured grids) of three-component, three-phase non-isothermal flow with heat and phase changes (water+oil+gas, steam injection) |
| 13-14| Advanced problems (discussion of approach, coding only if time permits):  
|      | - Coalbed methane  
|      | - Solute/reactive transport |

**University Policies**

**Attendance Policy**

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

**On your third unexcused/undocumented absence, you will have missed the equivalent of three weeks of class, and I will send your advisor an Excessive Absences report through Howdy.**
You may attend the other section of this course if needed. For example, if you feel ill on Monday, you may log in on the Wednesday link instead. Conversely, if you know you have an interview on Wednesday afternoon, you may log into the Monday section. So that you get the correct credit for your Weekly Activity, please email me ahead of time whenever you need to swap logins.

**Makeup Work Policy**

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor” ([Student Rule 7, Section 7.4.1](#))

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” ([Student Rule 7, Section 7.4.2](#))

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See [Student Rule 24](#)).

**Academic Integrity Statement and Policy**

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” ([Section 20.1.2.3, Student Rule 20](#)).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at [aggiehonor.tamu.edu](http://aggiehonor.tamu.edu).

**Americans with Disabilities Act (ADA) Policy**

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit [disability.tamu.edu](http://disability.tamu.edu). Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.
Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

COVID-19 Temporary Amendment to Minimum Syllabus Requirements

Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses.
and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**
- **Face Coverings**—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.
- **Physical Distancing**—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- **Classroom Ingress/Egress**—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

**Personal Illness and Quarantine**

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities.** Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, **for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.**

**Operational Details for Fall 2020 Courses**

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.
Course title and number: PETE 642 Formation Damage: Mechanisms and Remediation
Term: Spring 2019
Meeting times and location: M 11:30-2:40 PM. RICH 302

Course Description and Prerequisites
Formation damage can occur in oil and gas wells during drilling, completion, or even following chemical treatments. It adversely impact well performance and significantly affects the economics of damaged wells. It is essential to understand varies mechanisms that cause formation damage before applying any chemical treatments.

This course is designed to explain: (1) how to identify field problems, then (2) how to solve them. It is important to understand how cleaning fluids will interact with the formation brines, rock and oil. Improper design of chemical treatments can result in a new and more difficult type of damage to remove. This course will cover and explain in detail mechanisms of formation damage that can occur during drilling, completion, and following chemical treatments. Finally, the course will address chemical treatments to remove various types of damage. Field examples will be given to highlight the mechanism of damage, and the best method to remove it.

Learning Outcomes or Course Objectives
The main objective of this course is to highlight the importance of formation damage and how it impact well performance. Oil, gas and water supply wells are damaged during their life time. Various types of damage can occur during drilling, completion and production. Identification of damage type and location is the first step in designing chemical treatment to remove formation damage. Well completion, bottomhole conditions, and type of fluids in the wellbore should be also considered. Failure to consider these parameters will result in more damage than originally thought. Field cases will be discussed in the class to reinforce the importance of problem identification and fluid selection that takes into account downhole pumps and well tubulars.

Instructor Information
Name: H.A. Nasr-El-Din
Telephone number: (979) 862-1473
Email address: hisham.nasreldin@tamu.edu
Office hours: Tuesday and Thursday: 11:30-14:40
Office location: 710 Richardson

Textbook and/or Resource Material
Several textbooks will be used, including, but not limited to:
Reservoir Formation Damage, F. Civan, 2000
Emulsions: Fundamentals and Applications in the Oil Industry, L.L. Schramm, 2000
Technology for Cleaning Industrial Equipment, W. W. Frenier, 2001
Grading Policies
Assignment 30%
Midterm: 30%
Final Project: 40%

Potential Topics:
1. **Introduction Definitions**, impact of well performance, skin damage, and how to measure it in the field.

2. **Formation Damage due to Inorganic Scale**: Types of scales encountered in Oilfield, Mechanisms of scale formation, Scale Removal Methods Radioactive Tracer Logs, and Scale Mitigation Treatments.

3. **Clays, Zeolite, and Feldspars**: Structures and chemical composition of various clays and feldspars, types of clays and how they impact well performance.

4. **Fines Migration, Clay Swelling, and Clay Stabilizers**: Fines migration and permeability decline, coreflood experiment to determine critical salt concentration, impact of pH on migration and swelling of clays, cationic polymers as clay stabilizers.

5. **Types of drilling and completion fluids**: filter cake characteristics, and various methods to remove it, water blockage, surface tension of completion fluids, surfactants to reduce surface tension.

6. **Damage due to Perforation**: How to perforate various wells, perforation and its impact on well performance, damage due to perforation.


8. **Formation Damage due to Inorganic Scale**: Types of scales encountered in Oilfield, Mechanisms of scale formation, Scale Removal Methods Radioactive Tracer Logs, and Scale Mitigation Treatments.

9. **Formation Damage due to EOR**: Damage due to alkaline flooding, damage due to CO₂ flooding, damage due to polymer flooding, damage due to steam flooding.

10. **Formation Damage due to Chemical**: Treatments Damage due to scale squeeze treatments, damage due to mud acid treatments, damage due to acid additives

11. **Damage Removal**: Various chemical treatments available to remove various types of damage. Chemicals used in damage removal will be discusses, including acids, oxidizers, chelating agents, enzymes and combinations of these chemicals.
Other Pertinent Course Information

Americans with Disabilities Act (ADA)
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity
For additional information please visit: http://www.tamu.edu/aggiehonor“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number: PETE 643 - Oil Field Chemistry
Term (e.g., Fall 200X): Spring 2020
Meeting times and location: ROOM 319, Mon and Wed 12:45 to 14:00

Course Description and Prerequisites

The role of chemistry in well stimulation, water shut-off treatments, scale removal, mitigation, downhole corrosion issues, organic deposition, demeting, drilling fluids and various aspects of formation damage; includes problem identification as the first step in designing chemical treatment to remove formation damage.
Prerequisite: Graduate classification

Learning Outcomes or Course Objectives

The objectives of this course are for students to:

1. Highlight the importance of chemistry in well treatments. Oil, gas and water supply wells are damaged during their life time. Various types of damage can occur during drilling, completion and production.
2. Identify problems as the first step in designing chemical treatment to remove formation damage. Well completion, and type of fluids in the wellbore should be also considered. Failure to consider these parameters will result in more damage than originally thought.
3. Discuss field cases to reinforce the importance of problem identification and fluid selection that takes into account downhole equipment and well tubulars.

Instructor Information

Name: H.A. Nasr-El-Din
Telephone number: (979) 862-1473
Email address: hisham.nasreldin@tamu.edu
Office hours: TBD
Office location: 710 Richardson

Textbook and/or Resource Material

Several textbooks will be used, including, but not limited to: Corrosion and Scale Handbook, J.R. Becker, 1998
Technology for Cleaning Industrial Equipment, W. W. Frenier, 2001
Chemicals for Oil Field Operations, J. I. DiStasio, 1981
Well Treatments and Water Shut-off by Polymer Gels, L.J. Zitha, 2000
Surfactants Fundamentals and Applications in the Oil Industry, L.L. Schramm, 2000
Grading Policies

Homework ............................................................................................................................. (30%)
Two mid-term exams ............................................................................................................. (40%)
Final Exam ............................................................................................................................ (30%)
Total ..................................................................................................................................... (100%)

Grading Scale

A ........................................................................................................................................ 90-100%
B ........................................................................................................................................ 80-89%
C ........................................................................................................................................ 70-79%
D ........................................................................................................................................ 60-69%
F ........................................................................................................................................ 0-59%

Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Inorganic Scale</td>
<td>Types of scales encountered in oilfield, Mechanisms of scale formation, Scale Removal Methods, Radioactive Tracer Logs, and Scale Mitigation Treatments</td>
</tr>
<tr>
<td>3-4</td>
<td>Organic Deposition</td>
<td>Asphaltenes and Waxes, Mechanisms of Organic Deposition, Removal of Organic Deposition, and Mitigation of Organic Deposition</td>
</tr>
<tr>
<td>5-7</td>
<td>Corrosion in the Oil Field</td>
<td>Review of corrosion theory, Corrosion protection during well stimulation, Corrosion protection in sour wells, Protection of Cr-based tubulars, Corrosion of organic acids, Microbial corrosion, and Removal of corrosion products</td>
</tr>
<tr>
<td>8-9</td>
<td>Acids Used in Carbonate Formations</td>
<td>Emulsified Acid, In Situ Gelled Acids, Viscoelastic Surfactant-Based Acids, Cement Bond Logs, and Foamed Acids</td>
</tr>
<tr>
<td>10-11</td>
<td>Acids Used in Sandstone Formations</td>
<td>Mud acids, Retarded HF-based acids, and Chelating Agents</td>
</tr>
<tr>
<td>12-13</td>
<td>Water Shut-Off Using Chemical Means</td>
<td>Sodium Silicate Gels, Inorganic scale as a means for water shut-off, Gelling Polymers using metal cross-linkers, and Relative permeability modifiers</td>
</tr>
<tr>
<td>14-15</td>
<td>Recent Advances in Cementing and Drilling Fluids</td>
<td>Light weight cements, Flexible cements, Acid Resistant cement, New weight material for drilling fluids, Emulsifiers used in oil-based mud, and techniques to remove various filter cakes</td>
</tr>
</tbody>
</table>

Other Pertinent Course Information
Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity

For additional information please visit: http://www.tamu.edu/aggiehonor

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Course Description

CO₂ capture and storage (CCS) involves the injection and containment of CO₂ in geological structures such as depleted oil and gas reservoirs, onshore and offshore saline aquifers located deep in the earth’s crust, salt caverns or un-minable coalbeds. This approach can improve the energy production from existing fossil fuel operations (Enhanced Oil and Gas Recovery) as well as reduce greenhouse gas emissions. This course provides a scientific and technological foundation designed to provide answers to questions important to those interested in investigating the potential of CCS to enhance energy production and reduce greenhouse gases as well as to policy makers.

To this effect, the course will provide the students with the methodology and the tools (including commercial software) to evaluate and quantify the potential in CCS and EOR. Safety, economics, uncertainties, risks involved, environmental and legal aspects will be discussed.

Resources

Selected journal publications; industry and governmental reports; handouts (all provided in digital form, Knovel access)

Developments and Innovation in Carbon Dioxide (CO₂) Capture and Storage Technology, Volumes 1 & 2

-Carbon Dioxide (CO₂) Capture, Transport and Industrial, Storage and Utilization

Course Topics and Outline

Module 1

The Need for CO₂ Sequestration & CO₂ Properties
Background Introduction – Drivers (Climate Change, Improved Oil Recovery, Economics)
CO₂ sources and quantities. Point and Distributed Sources
Thermodynamic and Transport Properties for pure CO₂ and fluid mixtures with CO₂ (flue gas, CO₂+Hydrocarbon, CO₂+Brine/Water). Mutual Solubility – Phase Transitions

Module 2

Geological Screening, Reservoir Characterization
Storage Options for CO₂: Types of geological storage projects
Screening reservoirs for suitability of CO₂ storage. Potential of CO₂ sequestration and storage in US (and World) Basins

Module 3

Separation Aspects, Design Calculations, Efficiencies
Fundamentals of Phase Separation Processes
Overview of Power Plants, Gasification and IGCC
Post-combustion flue gas separation: Physical Absorption of CO₂
Chemical Absorption. Membrane Separation

Module 4

Production and Injection Aspects, Transportation, Compression, Well design
CO₂ compression, transportation, and injection in depleted reservoirs and aquifers.
Compressor and Pump Design and Efficiency. Special Considerations for CO₂.
Module 5
CO₂ Uses for Oil and Gas Recovery: Tools and Techniques
Minimum Miscibility Pressure. Simplified Models to assess Oil Recovery.
CO₂ Dispersion / Diffusion - EOR / EGR Uses, Material Balance Approaches.
Thermodynamic Models for Gas Injection in Depleted Oil and Gas Reservoirs.

Module 6
Economics, Regulations
Summary of key steps involved in developing and implementing a CO₂ capture and storage project: Carbon Credits/Trading. Health, safety and environmental issues associated with CO₂ storage.

Module 7
Other Storage Mechanisms Advances and Research Needs
CO₂ Storage Mechanisms and Analytical Modeling.
Numerical Models for CO₂ Storage – Aquifers
Ocean Storage
CO₂ to recover HC from Unconventional plays (shale) - Hydrates

Grading Policy
Homework and reading assignments (leading to selected individual project) .......................(40%)
Final Project (individual) (30% final report, 30% final presentation) ..................................(60%)
Total ........................................................................................................................ .............(100%)

 Miscellaneous

Americans with Disabilities Act (ADA) Policy Statement:
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Academic Integrity Statement and Policy:
For many years Aggies have followed a Code of Honor, which is stated in this very simple verse:

“An Aggie does not lie, cheat, or steal or tolerate those who do.”

The Aggie Code of Honor is an effort to unify the aims of all Texas A&M men and women toward a high code of ethics and personal dignity. For most, living under this code will be no problem, as it asks nothing of a person that is beyond reason. It only calls for honesty and integrity, characteristics that Aggies have always exemplified.

The Aggie Code of Honor functions as a symbol to all Aggies, promoting understanding and loyalty to truth and confidence in each other.

For additional information visit http://aggiehonor.tamu.edu/
Course title and number: PETE 645: Upscaling of Geologic Models for Flow Simulation
Term (e.g., Fall 200X): Fall 2018
Meeting times and location: 3:55 pm – 5:10 p.m., Tuesday and Thursday, RICH 1009

Course Description and Prerequisites

This is an advanced reservoir engineering course which covers the concepts behind 3D geologic modeling and the upscaling of these geologic models for reservoir flow simulation. It is based on published papers and supplemented by research topics. The students will be expected to develop upscaling solvers as part of this course.
Graduate classification. Attendance will be limited to a maximum of 20 students.

Learning Outcomes or Course Objectives

The objectives of the course are for students to:
1. Acquire an awareness of different types of geologic and flow simulation models, their components, their construction, and their uses.
2. Acquire an in-depth understanding of current approaches to upscaling of geologic models for flow simulation.
3. Develop tools that are more advanced than those available within any commercial application

Instructor Information

Name: Prof. Michael J. King
Telephone number: (979) 845-1488
Email address: mike.king@tamu.edu
Office hours: Monday, 3:00-5:30 p.m.
Office location: 401E Richardson Building

Textbook and/or Resource Material

Recommended:
Additional readings will be supplied with the course.

Grading Policies

Presentations & Class Participation.................................................................(10%)
Homework...................................................................................................(15%)
Mid-Term Exam.........................................................................................(25%)
Major Project / Final Exam.......................................................................(50%)
Total..............................................................................................................(100%)

Grading Scale

A...........................................................................................................90-100%
B..........................................................................................................80-89%
C..........................................................................................................70-79%
D..........................................................................................................60-69%
F..........................................................................................................0-59%
Course Topics, Calendar of Activities, Major Assignment Dates  
Details may be modified during the Semester

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
</table>
| 1    | Introduction to geologic modeling and flow simulation  
   |   ○ Uses of geologic models and reservoir simulators  
   |   ○ Understanding the overall iterative workflow  
   |   ○ Streamline flow visualization |
| 2    | Steady state / pseudo steady state / pressure transient flow equations in porous media  
   |   ○ Black oil equations  
   |   ○ Derivation and solution of the pressure transient and PSS pressure equation  
   |   ○ Neumann and Dirichlet boundary conditions |
| 3-4  | Finite difference/Finite element discretizations/flow visualization and solver projects  
   |   ○ Five point discretization (2D)  
   |   ○ Peaceman Well Indices (2D)  
   |   ○ K/O/U methods (2D)  
   |   ○ Development of student projects |
| 5-6  | Upscaling of Flow  
   |   ○ Permeability Upscaling  
   |   ○ Analytic Approaches  
   |   ○ Flow Based Upscaling  
   |   ○ Local / Non-Local / Global Upscaling  
   |   ○ Transmissibility Upscaling  
   |   ○ Near Well Upscaling  
   |   ○ Diagnostics  
   |   ○ Recommendations |
| 7-8  | Upscaling of Static Properties  
   |   ○ Stratigraphic Grids  
   |   ○ Bulk Rock Volume / Net Rock Volume / Pore Volume / Fluid Volumes  
   |   ○ Facies  
   |   ○ Well Blocking  
   |   ○ Diagnostics  
   |   ○ Recommendations |
| 9-10 | Grid Upscaling  
   |   ○ Corner Point Grids  
   |   ○ Multiscale Grid Mapping  
   |   ○ Error Analysis & Simulation Grid Design  
   |   ○ Faults and Fault Blocks  
   |   ○ Unstructured Grids  
   |   ○ Recommendations |
| 11-12| Multiphase Flow  
   |   ○ Relative Permeability End-points and Capillary Pressure  
   |   ○ Steady State Upscaling  
   |   ○ Pseudoization and Unsteady State Upscaling  
   |   ○ Multiscale Simulation  
   |   ○ Recommendations |
| 13-15| Class Projects  
   |   ○ Student Presentations |
Americans with Disabilities Act (ADA)

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For additional information please visit: http://www.tamu.edu/aggiehonor

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number       PETE 647: Petroleum Thermodynamics  
Term                         Fall 2017  
Meeting times and location:  TR 11:10 am – 12:25 pm, RICH 1009

Course Description and Prerequisites

The purpose of this course is to prepare the student to understand the principles of bulk equilibrium, bulk non-equilibrium, interfacial, and thin-film thermodynamics in relation to hydrocarbon reservoirs. Important applications of these principles in shale gas, shale light oil, heavy oil production, CO₂ injection in light and heavy oils, and phase-splitting calculations are presented. A focus of the course will be complex diffusion processes and species distribution in hydrocarbon reservoirs from irreversible thermodynamics.

Prerequisites: graduate classification or instructor approval.

Learning Outcomes or Course Objectives

The objective of the class is to teach thermodynamic principles in relation to hydrocarbon reservoirs and production that will enable the student to achieve differentiating performance as a petroleum engineer.

Instructor Information

Name                     Hadi Nasrabadi, Assistant Professor
Telephone number         979-862-6483
Email address            hadi.nasrabadi@tamu.edu
Office hours             TR 10:00-11:00 am
Office location          401Q Richardson Building

Textbook and/or Resource Material

The main source of material for the course will be class notes and other reference materials. The recorded videos of the lectures will be posted on a shared class site.

Grading Policies

Homework................................. 15%
Quiz.................................................. 15%
Midterm Exam............................ 20%
Final Exam................................. 30%
Project......................................... 20%
Total............................................. 100%
Grading Scale

A……………………………………………………………………………………………………..90-100%
B………………………………………………………………………………………………………80-89%
C………………………………………………………………………………………………………70-79%
D………………………………………………………………………………………………………60-69%
F………………………………………………………………………………………………………..0-59%

Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Introduction and syllabus. Basic Concepts and Equations</th>
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<tbody>
<tr>
<td>Week 2</td>
<td>Basic Concepts and Equations</td>
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<tr>
<td>Week 3</td>
<td>Conservation of Mass, Energy, Entropy</td>
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<td>Week 4</td>
<td>Theory of Phase Equilibria in Hydrocarbon Reservoirs</td>
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<td>Week 5</td>
<td>Complex Diffusion Processes from Irreversible Thermodynamics</td>
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<td>- Molecular Diffusion</td>
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<td>- Pressure Diffusion</td>
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<td>- Thermal Diffusion</td>
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<tr>
<td>Week 6</td>
<td>Natural Convection and Diffusion in Porous Media</td>
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<td>Week 7</td>
<td>Two- and Three-Phase Isothermal Compressibility</td>
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<td>- Two- and Three-Phase Partial Molar Volume</td>
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<td>Week 8</td>
<td>Phase Stability Analysis</td>
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<td></td>
<td>- Tangent Plane Distance Analysis</td>
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<td></td>
<td>- Gibbs Free Energy Surface Analysis</td>
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<tr>
<td>Week 9</td>
<td>Two- and Three-Phase Flash Calculations</td>
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<td>Week 10</td>
<td>Direct Minimization of Gibbs Free Energy in Multiphase Flash</td>
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<td>Week 11</td>
<td>Thermodynamics of Asphaltene Precipitation</td>
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<tr>
<td>Week 12</td>
<td>Cubic-Plus-Association/PC-SAFT Equations of State</td>
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<tr>
<td>Week 13</td>
<td>Hydrocarbon Phase Behavior in Shale Reservoirs – Theory and Simulations</td>
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<tr>
<td>Week 14</td>
<td>Hydrocarbon Phase Behavior in Shale Reservoirs – Experiments</td>
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</tbody>
</table>

Project due date: Thursday November 30, 2017

Policies and Procedures:

- **Attendance:** Attendance in class is expected. Work missed due to absences will be excused for only University-approved reasons in accordance with Texas A&M University Student Rules (see http://studentrules.tamu.edu/rule07). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis.
- **Homeworks:** Homeworks will be assigned to give opportunity to practice and master concepts and calculations needed for the course. Doing them will help you to do well in quizzes, exams, and project.
- **Grading:** Neat, legible, systematic and complete presentation is required in homework assignments, quizzes and project for full credit. Units (for example, Newton-meters) must be included wherever appropriate for numeric quantities. Work which, while possibly correct, cannot be followed, will be considered incorrect. Occasionally, problems will be given out that earns you extra credit for the class.
- **Getting Help:** Every effort will be made to help you master the course material. The instructor is available during the office hours. If you are unable to meet with him during these hours, please contact him by email to find an alternative time. Also note that the instructor does not provide assistance with homework problems, etc. over the telephone.
• **Americans with Disabilities Act (ADA):** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu).

• **Coursework Copyright Statement (Texas A&M University Policy Statement):** The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy them, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writing, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty".

• **Academic Integrity:** “An Aggie does not lie, cheat, or steal, or tolerate those who do.” Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System. For additional information please visit: [http://aggiehonor.ramu.edu](http://aggiehonor.ramu.edu)
Instructor Information:
Petroleum Engineering 648
Pressure Transient Testing
RIC 310 MW 20:00-21:05
(in-class lectures)

Instructor: Dr. Tom BLASINGAME
Richardson 821A
t blasingame@tamu.edu
(please always use e-mail to contact me)

TAs: Mr. Rui KOU
Richardson 821
kouroei.pete@tamu.edu
(please always use e-mail to contact the TAs)

Background for PETE 648: (specific to 2020)
This offering of PETE 648 in the Spring 2020 term continues to be a bit of "rebuild" from the course I taught in the early 2000s. For your reference, you are free to review/use any/all of the course archives on my website. (suggestions—PETE 324, PETE 620, PETE 648, PETE 653)
https://blasingame.engr.tamu.edu/7start=pete%2Ftbblassingame. engr.tamu.edu%2Fp~Course_Archive%2F

Orientation for PETE 648: (specific to 2020)
For the Spring 2020 term I would like to have students return to creating innovative solutions for pressure transient and production data analysis. This will include student development of their own software solutions. My desire is to plant the seeds for future generations of reservoir engineers in terms of the analysis of well performance data (e.g., rates and pressures) — solving old problems in old ways won't get us there...

Goals for PETE 648: (specific to 2020)
- To use the “Portfolio” assignments to provide the student with historical analyses/interpretations of pressure transient and production data.
- To use the "Final Project" to illustrate the student's subject mastery and capabilities with PTA/RTA/DCA methods using literature cases.

Assignments for PETE 648: (specific to 2020) — All problems are taken from the petroleum literature. — Updated 2020.03.26

<table>
<thead>
<tr>
<th>Due Date</th>
<th>Assignment</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>Thu 06 Feb 2020</td>
<td>Portfolio - 1 [PTA - Wellbore Storage]</td>
<td>15 points</td>
</tr>
<tr>
<td>Thu 20 Feb 2020</td>
<td>Portfolio - 2 [PTA - Fractured Wells]</td>
<td>15 points</td>
</tr>
<tr>
<td>Thu 19 Mar 2020</td>
<td>Portfolio - 3 [PTA - Naturally Fractured Reservoirs]</td>
<td>15 points</td>
</tr>
<tr>
<td>Thu 09 Apr 2020</td>
<td>Portfolio - 4 [PTA - Miscellaneous]</td>
<td>5 points</td>
</tr>
<tr>
<td>Thu 23 Apr 2020</td>
<td>Portfolio - 5 [RTA]</td>
<td>20 points</td>
</tr>
<tr>
<td>Thu 06 May 2020</td>
<td>Final Project [Problems in PTA/RTA/DCA]</td>
<td>30 points</td>
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<td>Total</td>
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<td>100 points</td>
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</table>

(All assignments are to be submitted by 16:59:59 (i.e., 5:00 p.m.) US Central Time on the indicated due date)

Philosophy about Students:
I am a teacher, that role defines my life and my career. I am not the best teacher you will ever have, but I can almost guarantee that I will be the best "motivator" you will ever have. Students always come first with me — BUT, students must pull their own weight, I have zero tolerance for those who exhibit a low effort or "just want to get by." My goals as a teacher are:

- To create materials and exercises that ensure that the student masters the concepts and the applications for a given topic.
- To challenge the student to become a creative and independent thinker.
- To provide an understanding of a student/young engineer's responsibilities as a professional (i.e., the work always comes first).

Philosophy about Life:
- Most Important Quote:
  "Opportunities are missed by most people because it is dressed in overalls and looks like work... (hard work is the only path...)"
  Thomas A. Edison, American Inventor (1847-1931)

- Important Rules for Life:
  - Never own anything that eats while you sleep...
  - Never own anything that needs repainting...
  - Never own anything that you can't drive a nail into...
  - Always work harder than those you work for...
  - If you have to herd cats, then be a rat...
  - Never say no, and there's no limit to where you can go...

Brief Bio: Thomas A. Blasingame, Ph.D., P.E. (Holders of the Robert L. Whiting Professors in Petroleum Engineering)
- Professor, Department of Petroleum Engineering at Texas A&M U. (with joint appointment in the Department of Geology and Geophysics)

- Teaching/Research activities:
  - Petrophysics
  - Reservoir engineering
  - Analysis/interpretation of well performance
  - Exploitation of unconventional reservoirs
  - Technical mathematics

- Technical Contributions:
  - Pressure transients test analysis
  - Analysis of production data
  - Reservoir management
  - Diagnostic characterization of reservoir performance
  - General reservoir engineering

- Counts to date (Jan 2020): 68 M.S. (thesis), 34 M.Eng. (report, non-thesis), 14 Ph.D. students, and approximately 160 technical articles.

Guidance: (This is an essential course in reservoir engineering — mastery of this material will provide a career advantage.)

- Orientation: This is graduate school, the (only) person you are competing against is the mirror.
- Work Quality: My highest commandment is that you submit your best work; and ONLY your best work.
- Timelessness: This material is straightforward, but there is much to learn — do not underestimate the workload and timing.
- Course Materials: The material will teach itself (I am just more of a guide/coach), but you must put your full effort into the course.
- Connections: I am here to help; I will answer any/all relevant correspondence within 24 hours (unless I am totally offline).

Practical Points for PETE 648: (specific to 2020)
A few practical points for the Spring 2020 term:
- Class will NOT meet regularly; I will send periodic updates on class meetings by email as we progress through the semester.
- I have several known SPE commitments this term (particularly in Mar/Apr 2020) with more likely in Feb/May.
Petroleum Engineering 648 — Pressure Transient Testing
Instructor Information. Texts. Reference Materials, and Basis for Grade, Policies and Procedures; Scholastic Dishonesty
Spring 2020

Instructor Information:
Petroleum Engineering 648
Pressure Transient Testing
RICH 319 MW 20:00-21:05
(in-class lectures)

Instructor: Dr. Tom BLASINGAME
Richardson 821A
t-blasingame@tamu.edu
(please always use e-mail to contact me)

TAs: Mr. Rui KOU
Richardson 821
kourni.pete@tamu.edu
(please always use e-mail to contact the TAs)

Texts:
Required Texts: (to be purchased) [*Available from http://store.spe.org/* — you must have these texts.]
4. Earlougher, R.C., Jr.: Advances in Well Test Analysis, Monograph No. 8, SPE (1977).*

Required Texts: (provided in electronic form)

etc.: (can be purchased) [#Available from http://store.spe.org/* — you should have these texts.]

Reference Materials:
Course materials for this semester are located at:
— General archive for PETE 648:
https://blasingame.engr.tamu.edu/?start=pete%2Fblasingame.engr.tamu.edu%2F

Assignments for PETE 648: (specific to 2020 — All problems are taken from the petroleum literature — Updated 2020.03.26)
(Due Date: Thu 06 Feb 2020) Portfolio 1 [PTA - Wellbore Storage] ............................................. (3 problems) 15 points
(Due Date: Thu 20 Feb 2020) Portfolio 2 [PTA - Fractured Wells] ............................................. (3 problems) 15 points
(Due Date: Thu 19 Mar 2020) Portfolio 3 [PTA - Naturally Fractured Reservoirs] .................. (3 problems) 15 points
(Due Date: Thu 09 Apr 2020) Portfolio 4 [PTA - Miscellaneous] ................................................ (1 problem) 5 points
(Due Date: Thu 23 Apr 2020) Portfolio 5 [RTA] ........................................................... (2 problems) 20 points
(Due Date: Thu 30 Apr 2020) Final Project [Problems in PTA/RTA/DCA] ......................... (1 problem [3 separate parts]) 30 points
Total = 100 points

(All assignments are to be submitted by 16:59:59 (i.e., 5:00 p.m.) US Central Time on the indicated due date)

Policies and Procedures: (specific to 2020)
1. Students are expected to attend class every session.
   a. Resident (not Distance Learning) students are REQUIRED to attend class every session.
   b. Distance Learning students are expected to review lecture materials within 24 hours of the lecture being given/posted.
   c. This is not a casual requirement, penalties can and will be assigned for missing class.
2. Policy on Grading
   a. All work in this course is graded on the basis of answers only — any partial credit is at the discretion of the instructor.
   b. All work requiring calculations shall be properly and completely documented for credit.
   c. All grading shall be done by the instructor, or under his/her direction and supervision, and the decision of the instructor is final.
3. Policy on Re-grading
   a. Only in very rare cases will exams be considered for re-grading — partial credit (if any) is not subject to appeal.
   b. Work which, while possibly correct, but cannot be followed, will be considered incorrect.
   c. Grades assigned for the Portfolios will only be considered for re-grading per 3.4 (below). (PETE 648)
   d. If re-grading is necessary, the student is to submit a letter to the instructor explaining the situation that requires consideration for re-grading, and the material to be regraded must be attached to this letter. The letter and attached material must be received within one week of the date returned by the instructor.
4. The grade for a late assignment is zero. Late or not, all assignments must be turned in.
5. Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an examination or collaborating on an assignment where collaboration is not specifically authorized by the instructor will be removed from the class roster and given a F (failure grade) in the course.

Scholastic Dishonesty:
THE STUDENT IS HEREBY WARNED THAT ANY ACTS OF SCHOLASTIC DISHONESTY WILL RESULT IN AN "F" GRADE FOR ALL ASSIGNMENTS IN THIS COURSE. As a definition, "scholastic dishonesty" will include any or all of the following acts:
• Unauthorized collaborations — you are explicitly forbidden from working together on EXAMINATION(S).
• Using work of others — you are explicitly forbidden from using the work of others — "others" is defined as students in this course, as well as any other person. You are specifically required to perform your own work.
Work Requirements: (layout/format/etc.)
- You must show ALL work — as appropriate. YOU MUST:
  WORK: You must show all details in your calculations (no skipped steps) — all portions of all analysis relations must be shown.
  UNITS: You must show all units in all calculations.
- Work layout: (as appropriate for a given problem)
  NEATNESS: You will be graded on the neatness of your work.
  LABELS: All work, trends, and features on every plot MUST be appropriately labeled — no exceptions.
  Work: All work must be fully labeled and documented — equations, relations, calculations, etc.
  Trends: This includes the slope, intercept, and the information used to construct a given trend.
  Features: Any description of features/points of interest on a given trend (specific times, pressures, flow regimes, etc.).
  LINES: Use appropriate drafting care in construction of lines, trends, arrows, etc.
  SKETCHING: Take great care in any sketches you create/use in your work.
- Plots/Plotting: (as required)
  SYMBOLS: Use symbols for "data."
  LINES: Use lines to represent models/trends.
  COLORS: Use black for all axes and gridlines. Use primary colors (red, green, blue), (please) avoid pastel colors.
  etc.: Please do NOT use a border or "frame" around your plots.
- Typing: ALL WORK SUBMITTED IN THIS COURSE MUST BE TYPED. NO HANDWRITTEN WORK IS PERMITTED.
- (if used) Scanning: ≤300 dpi COLOR scan from a printer/scanner — DO NOT SUBMIT PHOTOS (photos will not be accepted).

Work Standard:
The expectation of the instructor ( blasin Gname) is that "perfection is the standard" — in other words, your work will be judged against a perfect standard. If your submission is not your very best work, then don't submit it. You have an OBLIGATION to submit only your very best work.

Student Obligation:
You must prepare your work as instructed above, or you will be assessed SEVERE grading penalties.

e-mail Protocols: (specific to 2020)
In order to manage your correspondence, you are required to use the following protocol.

Subject Line: [YYYYMMDD] (YOURURLASTNAME) Subject
Where:
YYYYMMDD = Date in Year/Month/Day format.
YOURLASTNAME = Your last name in ALL CAPS.
Subject = The subject of your correspondence.

Body:
Dr. BLASINGNAME:
I would like to enquire about the following:
  * Question 1 ... (be clear and concise)
  * Question 2 ... (be clear and concise)
  * Question 3 ... (be clear and concise)
I thank you for your assistance.
YourFirstName YOURLASTNAME
E: [\text{\textit{I\textsc{amu}}}] \text{\textsc{(personal)}}
T: (a phone contact) (I W\textsc{ill} NEVER call you without first sending an \textit{e-mail or text}"

Comments:
- DO NOT FORWARD/REPLY TO EMAILS FROM eCampus — SEND A NEW NOTE!
- The subject line is used to file e-mail (this is why this specific subject line is required).
- Every effort will be made to answer every e-mail, but PLEASE avoid trivial inquiries (consult the syllabus for "administrative" issues).
- I am more than happy to address questions by e-mail — i.e., issues/errors/etc. and/or need help with something relevant to the course.
- Courier New 10pt Bold font is required.

Requests-for-Assistance Protocols: (specific to 2020)
On the occasion when a student requires assistance/aid/guidance from the instructor on a specific problem or concept, then the student is to prepare a .pdf file as follows:
- The .pdf file must be titled:
  
  YYMMD (YOURLASTNAME) (v1_III) SPE_##### (pdf) .pdf

Where:
YYYYMMDD = Date in Year/Month/Day format.
YOURLASTNAME = Your last name in ALL CAPS.

v1 = Version (start with 1), updates with have advancing version numbers.

III = Your initials - where I provide edits, I will change to my initials "TAB."

##### = The SPE paper number for the problem in question

- The student must include all details relevant to their query (snips from the paper (as appropriate), plots, data tables, calculations, etc.).
- The student can provide source code if necessary, but it is unlikely that the instructor will be able to "debug" issues (he is willing to try).
- The student is asked to be as complete as possible in these "requests-for-assistance" .pdf files, the instructor can only address what is written.
Computational Tools: (specific to 2020)

In this course you are NOT required to work in a particular computational environment. However, you should be proficient at whatever computational tool(s) you use for work in this course (e.g. MS Excel). Please note that YOU are RESPONSIBLE for your computer-aided solutions. You will be required to submit a copy of your source code and you should provide relevant commentary/documentation in your source code (or spreadsheet) sufficient for your work to be traced. Source code will be submitted in a single .zip file for each assignment, due at the same time the assignment file (pdf) is submitted, but in a separate email named <filename>_work.zip.

Comments:
- You are REQUIRED to use a computational product for your "Portfolios" and the "Final Project."
- You should be as creative as possible with your work — but you are responsible for your proficiency in your chosen computational product.
- For EVERY problem you must submit your work for each problem in a separate "4-slide layout" as prescribed in this syllabus.
- You are NOT PERMITTED to use commercial or research software (e.g., Well Test, PanSystem, Sapphire, etc.) to construct your solutions.

Course Description

The purpose of this course is to provide the student with a working knowledge of the current methodologies used in well testing — including, but not limited to, single and multi-rate testing, single and multiwell testing, homogeneous and heterogeneous reservoirs, infinite and finite-acting reservoir behavior.

Specific topics to be studied include steady-state and pseudosteady-state flow behavior, derivation of the diffusivity equation; solution of the diffusivity equation; analysis of pressure drawdown and buildup tests; wellbore storage and skin effects; behavior of vertically fractured wells; behavior of dual porosity reservoir systems; analysis of production performance; rate forecasting using semi-analytical; empirical; and IPR methods; deliverability testing.
Course Objectives

The student should be able to:

Module 1: Introductory Materials
- Describe the relationships between porosity and permeability; and how these properties influence the flow of fluids in reservoir rocks.
- Use correlations and laboratory data to estimate the properties of reservoir fluids which are relevant for reservoir engineering.
- Sketch plots of pressure as functions of radius and time for steady-state flow, transient radial flow, boundary-dominated flow.

Module 2: Fundamentals of Flow in Porous Media
- Derive and apply the material balance relations for the slightly compressible liquid (oil) system and the dry gas system.
- Derive and apply the steady-state flow equations for horizontal linear and radial flow of fluids in porous media, including the skin factor.
- Develop and apply relations for pseudosteady-state flow in closed black oil or dry gas reservoir systems.
- Derive the "skin factor" (steady-state flow theory), and be able to describe the conditions of damage and stimulation using the skin factor.
- Derive and manipulate the diffusivity equations for the radial and linear flow of single and multiphase fluids (liquids and gases).

Module 3: Solutions/Models for Well Test Analysis
- Define and use dimensionless variables and dimensionless solutions.
  - To illustrate the generic performance of a particular reservoir model using "dimensionless" variables and "dimensionless" solutions.
  - To use the dimensionless solutions for a given reservoir model to predict the (time-dependent) performance of the reservoir system.

Module 4: Analysis of Pressure Transient Data
- (PTA) Interpret and analyze pressure transient data using "conventional" plots:
  - Specialized plotting functions (e.g., the well-test pressure derivative, the superposition time functions for variable rate cases, etc.).
  - Early-Time Cartesian Plot: Wellbore Storage Domination Regime
    - Pressure versus time.
    - Parameters: Pressure-at-Start-of-Test and the Wellbore Storage Coefficient.
  - Semi-Log Plot: Transient Radial Flow Regime
    - Pressure versus the logarithm of time for the pressure drawdown/injection case.
    - Pressure versus the logarithm of superposition time (e.g., Hotte or Agarwal Time) for the pressure buildup/falloff case.
    - Parameters: permeability and the Skin Factor.
  - Log-Log Plot: Diagnostic Interpretation and Specialized Trend Analysis
    - Logarithm of pressure drop and pressure derivative versus the logarithm of time (or superposition time function).
    - Parameters: Wellbore Storage Coefficient, Permeability (radial flow), and Permeability-Fracture Half-Height (vertical fracture).
  - (PTA) "Pressure Transient Analysis" of "time-pressure" data to obtain estimates of reservoir properties (infinite-acting reservoirs)
    - Interpret and analyze pressure transient data using log-log "type curve" plots for the following cases:
      - "Bourdet-Gingarten" TC: Unfractured Vertical Well with Wellbore Storage and Skin Effects.
      - "Stewart" TC: Unfractured Vertical Well with Closed Boundaries or Sealing Faults.
      - "Tang and Brigham" TC: Unfractured Vertical Well in a "Radial Composite" Reservoir.
      - "Onur-Satman-Reynolds" TC: Unfractured Vertical Well in a "Naturally Fractured" Reservoir.
    - Gas wells (using appropriate pseudopressure and pseudotemperatures)

Module 5: Analysis of Production Data
- (DCA) "Decline Curve Analysis" of "time-rate" production data to obtain production forecasts and estimates of EUR:
  - Estimate the "reserves" for an oil or gas well using plots of rate versus cumulative production.
  - Create a production forecast and estimate reserves using a DCA model (e.g., Arps, modified-hyperbolic, power-law exponential).
  - Correlate the DCA results with well completion parameters (e.g., size of well stimulation).
- (RTA) "Rate Transient Analysis" of "time-rate-pressure" production data to obtain reservoir volume and estimates of reservoir properties:
  - Interpret and analyze time-rate-pressure production data using log-log "type curve" plots for the following cases:
    - "Doublet" TC: Vertical well with an Infinite Conductivity Vertical Fracture in a Bounded Circular Reservoir.
    - "Pratikno" TC: Vertical well with a Finite Conductivity Vertical Fracture in a Bounded Circular Reservoir.
    - "Shih" TC: Unfractured Horizontal Well in a Bounded Square Reservoir.
  - Utilize the "flowing material balance" method to confirm estimates/reserves.
  - Deliverability Testing: (also known as "well tests" or "productivity tests")
    - Estimate the "absolute open flow" using data from a gas well "deliverability" test.
  - Analyze and interpret flow-after-flow (4-point) and isochronal flow tests
  - Demonstrate the capability to integrate, analyze, and interpret well test and production data to provide:
    - Estimates of reservoir properties (i.e., a reservoir characterization).
    - Integration of petrophysical properties with the properties estimated from well performance analysis (i.e., a reservoir description).

Note:
The primary goal of this course is for students to be able to perform "hand" and "computer-aided" calculations to solve problems in pressure transient testing and production data analysis. In addition, the student will be exposed to and should also be able to use modern, industry-accepted software for the analysis of well test and production data.

Acronyms:
- PTA = Pressure Transient Analysis (i.e., analysis of "time-pressure" transient data)
- RTA = Rate Transient Analysis (i.e., analysis of "time-rate-pressure" production data)
- DCA = Decline Curve Analysis (i.e., analysis of "time-rate" production data)
Petroleum Engineering 648 — Pressure Transient Testing
Course Guide
Spring 2020

Module 1: Introductory Materials
- Petrophysics
  - PETE 324 "Old Notes"
  - Revised Lee Text (Lee-1)
  - Revised Lee/Wattenberger (LW)
  - Dake Text (Dake-1)
  - Dake Text (Dake-2)
  - Matthews and Russell (MR)
  - Earlougher Monograph (E)

Module 2: Fundamentals of Flow in Porous Media
- Material Balance
  - PETE 324 "Old Notes"
  - Revised Lee Text (Lee-2)
  - Revised Lee/Wattenberger (LW)
  - Dake Text (Dake-1)
  - Dake Text (Dake-2)
  - Matthews and Russell (MR)
  - Earlougher Monograph (E)

Module 3: Solutions/Models for Well Test Analysis
- Dimensionless Variables
  - PETE 324 "Old Notes"
  - Revised Lee Text (Lee-2)
  - Revised Lee/Wattenberger (LW)
  - Dake Text (Dake-1)
  - Dake Text (Dake-2)
  - Matthews and Russell (MR)
  - Earlougher Monograph (E)

Module 4: Well Test Analysis
- Analysis of Pressure Buildup Tests
  - PETE 324 "Old Notes"
  - Revised Lee Text (Lee-2)
  - Revised Lee/Wattenberger (LW)
  - Dake Text (Dake-1)
  - Dake Text (Dake-2)
  - Matthews and Russell (MR)
  - Earlougher Monograph (E)

Module 5: Analysis and Modelling of Production Data
- Analysis of Production Data
  - PETE 324 "Old Notes"
  - Revised Lee Text (Lee-2)
  - Revised Lee/Wattenberger (LW)
  - Dake Text (Dake-1)
  - Dake Text (Dake-2)
  - Matthews and Russell (MR)
  - Earlougher Monograph (E)

Reference Guide:
E = Earlougher, R.C., Jr.: Advances in Well Test Analysis, Monograph Series, SPE, Dallas (1977) 5.

Important Dates:
- 20 January Mon Martin Luther King Day (University Holiday)
- 09-13 March Mon-Fri Spring Break (Student Holiday)
- 10 April Fri Reading Day (No Classes — Good Friday)

Assignment Dates: (send assignments to: t-blasingam@tamu.edu)
- Each Portfolio has its own due date
- P648_20A_Port_#_YOURLASTNAME.pdf (required filename)
- 30 April Thu (final examination due date)
- P648_20A_FinalProj_YOURLASTNAME.pdf (required filename)
Petroleum Engineering 648 — Pressure Transient Testing
Portfolio Assignments — Spring 2020 (the Portfolio Assignments constitute 75 percent of the course grade)

Portfolio - 1: [PTA - Wellbore Storage]  [Reference File Name: P648_20A_Port_1_YOURLASTNAME.pdf (Due: 06 Feb 2020)]

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference</th>
<th>Case</th>
<th>Description</th>
</tr>
</thead>
</table>

Portfolio - 2: [PTA - Fractured Wells]  [Reference File Name: P648_20A_Port_2_YOURLASTNAME.pdf (Due: 20 Feb 2020)]

<table>
<thead>
<tr>
<th>Date</th>
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<th>Case</th>
<th>Description</th>
</tr>
</thead>
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Portfolio - 3: [PTA - Naturally Fractured Reservoirs]  [Reference File Name: P648_20A_Port_3_YOURLASTNAME.pdf (Due: 19 Mar 2020)]

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference</th>
<th>Case</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>SPE 018160</td>
<td>[Table 1 (Buildup)]</td>
<td>Alhain, O. F., and Horne, R. N. (1990) Use of Artificial Intelligence in Well-Test Interpretation. Society of Petroleum Engineers. doi:10.2118/18160-PA</td>
</tr>
</tbody>
</table>

Portfolio - 4: [PTA - Miscellaneous]  [Reference File Name: P648_20A_Port_4_YOURLASTNAME.pdf (Due: 09 Apr 2020)]

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference</th>
<th>Case</th>
<th>Description</th>
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</thead>
</table>

Portfolio - 5: [RTA]  [Reference File Name: P648_20A_Port_5_YOURLASTNAME.pdf (Due: 23 Apr 2020)]

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference</th>
<th>Case</th>
<th>Description</th>
</tr>
</thead>
</table>

For Portfolio 5, in addition to your "RTA" work, you are to also prepare a "time-rate" analysis for each case (i.e., SPE 004629 and SPE 013169) using a log-log "q/Dt" plot (including cumulative production (Q) on the rate (q) axis). You are to only use the "modified hyperbolic" DCA relation for the "time-rate" this Portfolio assignment. This "time-rate" analysis is to be added to the standard 4-slide package. no additional slides are required (nor permitted).

*Updated on 2020.03.26.
* Updated on 2020.04.05.

Guidance on the Portfolio Assignments: You must submit a SINGLE .pdf file to b-lassingame@tamu.edu for each portfolio on the prescribed due date.
- ALL WORK SUBMITTED IN THIS COURSE MUST BE TYPED. NO HANDWRITTEN WORK IS PERMITTED.
- You are REQUIRED to use a computational product of YOUR OWN CONSTRUCTION for your "Portfolio" problems.
- The standard of submission must be near "publication quality." Poor, fair, quality work submissions will NOT be accepted.

Note:
- Students ARE permitted to communicate and collaborate — HOWEVER, students ARE NOT permitted to submit shared or copied work.
- Students ARE NOT permitted to use commercial or research software (e.g., Well Test, Pet. ProdSystem, Sapphire, etc.) to construct their solutions.
- Using commercial or research software, and or sharing or copying work will result in a zero (0) score for the given assignment.

(Page 7 of 19)
### Final Project: [Problems in PTA/RTA/DCA]

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference</th>
<th>Case</th>
<th>Reference</th>
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</thead>
</table>

*Updated on 2020.03.26.*

**Required:**

This problem has 3 distinct parts, as prescribed below:

- **Part-1 Pressure Transient Analysis (PTA)** of the major shut-in event in this dataset. (4 slides, same format as "portfolio" assignments)
- **Part-2 Rate Transient Analysis (RTA)** of the entire production history in this dataset. (4 slides, same format as "portfolio" assignments)
- **Part-3 Decline Curve Analysis (DCA)** see specifics below. (8 slides, prescribed below)

**Specific tasks for DCA part:**

3a. **[DCA slide 1]** Using the data from the reference Ilk et al reference (SPE 114947), you are to calculate the $D(t)$ and $b(t)$ data functions (selective data editing (i.e., removal) may be required) and create the following plots (these are "data only" plots)

- **Combined $q-G_p$ plot:** left axis: $\log[a(t)]$ and right axis: $G_p(t)$ vs. time (show edited points as light gray)
- **Log-log $qGb$ plot:** left axis: $\log[a(t)]$ and right axis: $\log[D(t)]$ and $\log[b(t)]$ vs. log(time) (show edited points as light gray)

3b. **[DCA slides 2-6]** Using the data from the reference Ilk et al reference (SPE 114947), you are to create the following plots (these are "data only + model" plots)

- **Log-log $qGb$ plot:** left axis: $\log[a(t)]$ and right axis: $\log[D(t)]$ and $\log[b(t)]$ vs. log(time)
- **Combined $q-G_p$ plot:** left axis: $\log[a(t)]$ and right axis: $G_p(t)$ vs. time
- **Log-log $qGb$ plot:** left axis: $\log[a(t)]$ and right axis: $\log[G_p(t)]$ vs. log(time)

An individual plot must be provided for each model (show data and model). You are to fit each model in the reference list below.

- **[DCA slide 2]** (SPE 119369) ("Modified Hyperbolic") Robertson, S. 1988. Generalized Hyperbolic Equation. Paper SPE 18731, Society of Petroleum Engineers, Richardson, TX. Use the "Fekete" formulation of this result — i.e., the Modified Hyperbolic Decline form given at:


3c. **[DCA slide 7]** You are to create a single "summary" log-log $qGb$ plot with the data and all models shown

3d. **[DCA slide 8]** You are to create your own $q(t)$ model and provide a log-log $qGb$ plot with the data and your model shown.

**Guidance on the Final Project:** You must submit a SINGLE.pdf file to t-blasingame@tamu.edu for the Final Project on 30 Apr 2020.

- **ALL WORK SUBMITTED IN THIS COURSE MUST BE TYPED. NO HANDWRITTEN WORK IS PERMITTED.**
- **You are REQUIRED to use a computational product of YOUR OWN CONSTRUCTION for your "Portfolio" problems.**
- **The standard of submission must be near "publication quality," poor/fair quality work submissions will NOT be accepted.**

**Note:**

- **Students ARE permitted to communicate and collaborate — HOWEVER, students ARE NOT permitted to submit shared or copied work.**
- **Students ARE NOT permitted to use commercial or research software (e.g., Well Test, Pio, PanSystem, Sapphire, etc.) to construct their solutions.**
- **Using commercial or research software, and/or sharing or copying work will result in a zero (0) score for the given assignment.**
## Additional Problems for Self-Study

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference</th>
<th>Case</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>(URTeC 2464916)</td>
<td>[Fig 7 - PBU]</td>
<td>Pettigrew, J., Qiu, J., and Zhan, L. (2016) Understanding Wolfcamp Well Performance - A Workflow to Describe the Relationship between Well Spacing and EUR. Unconventional Resources Technology Conference. doi:10.15530/URTeC-2016-2464916</td>
</tr>
</tbody>
</table>
Time-Rate Relations


\[
q(t) = \begin{cases} 
q_{\text{hyp}} \frac{1}{[1+hD_d/t]^{1/h}} & (t < t_{\text{lim}}) \\
q_{\text{lim}} \exp[-D_{\text{lim}}(t-t_{\text{lim}})] & (t > t_{\text{lim}})
\end{cases}
\]

where

\[
q_{\text{lim}} = q_{\text{hyp}} \left[ \frac{D_{\text{lim}}}{D_d} \right]^{1/h}
\]


\[
q(t) = q_i \exp[-D_{\text{eff}}(t - t_{\text{ref}})]
\]


\[
q(t) = q_i t^{-m} e^{-m(1-m)(t-1)}
\]


\[
q(t) = \frac{\dot{a} K n}{(\dot{a} + t)^3} t^{\dot{a}-1}
\]


\[
q(t) = M \left[ \frac{t}{\alpha} \right]^{\gamma-1} \exp \left[ -\left( \frac{t}{\alpha} \right)^\gamma \right]
\]
Example 4-Slide Layout: (pptx slide template is provided separately, you must use EXACTLY this .pptx template)

Slide 1 — Problem Description/Data/Reference Slide.

Slide 2 — Diagnostic/Hand Analysis Plots Slide.

Slide 3 — Analysis Summary Plots Slide.

Slide 4 — Method of Work/Discussion of Results Slide.
Example 4-Slide Layout: (SPE 012777 (Bourdet))

Slide 1 — Problem Description/Data/Reference Slide.

Slide 2 — Diagnostic/Hand Analysis Plots Slide.

Slide 3 — Analysis Summary Plots Slide.

Slide 4 — Method of Work/Discussion of Results Slide.
Example 4-Slide Layout: (SPE 029594 (Doublet) (NRI_3510))

Slide 1 — Problem Description/Data/Reference Slide.

Slide 2 — Diagnostic/Hand Analysis Plots Slide.

Slide 3 — Analysis Summary Plots Slide.

Slide 4 — Method of Work/Discussion of Results Slide.
Assignment Coversheet

This sheet (or the sheet provided for a given assignment) must be included with EACH work submission.

Required Academic Integrity Statement: (Texas A&M University Policy Statement)

Academic Integrity Statement

All syllabi shall contain a section that states the Aggie Honor Code and refers the student to the Honor Council Rules and Procedures on the web.

Aggie Honor Code

"An Aggie does not lie, cheat, or steal or tolerate those who do."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: www.tamu.edu/aggiehonor/

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

Aggie Code of Honor:

An Aggie does not lie, cheat, or steal or tolerate those who do.

Required Academic Integrity Statement:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

(Print your name)

(Your signature)
Faculty-Student Contract: (T. Blasingame)

The most important element of your education is your participation. No matter how hard we as faculty try (or don’t try) to prepare you to learn, we cannot force you to work. We can only provide examples of how you should perform and we can only evaluate your performance — not your intentions or your personality, nor can we make allowances for your personal problems or your lack of preparation.

We can of course provide some pretty unpleasant alternatives as incentives (e.g., poor grades), but poor grades are a product of only two issues, a lack of subject mastery, or apathy. We as faculty can do much to prepare you for a rewarding career, not only as engineers, but also as productive members of society in whatever capacity you wish to serve. But we cannot make you care; we cannot make you prepare, and we cannot make you perform — only you can do this.

We have chosen our path in life to help you find yours, we want you to succeed (perhaps sometimes more than you do) and we will do our best to make your education fulfilling and rewarding. As we embark on what will likely be a tedious and challenging experience, we reaffirm our commitment to seeing that you get the most out of your education. When it seems as though we are overbearing taskmasters (and we may well be), remember that we are trying to prepare you for challenges where there is no safety net — and where there may be no second chance.

Our goal is to be your guide — we will treat you with the respect and consideration that you deserve, but you must have the faith to follow, the dedication to prepare, and the determination to succeed — it will be your turn to lead soon enough.

General Procedures for Studying: (Adapted from Arizona State U., 1992)

1. Before each lecture you should read the text carefully, don’t just scan topics, but try to resolve sections of the reading into a simple summary of two or three sentences, emphasizing concepts as well as methods.

2. During the lecture take careful notes of what your instructor says and writes, LISTEN to what is being said as well as how it is emphasized. Don’t try to be neat, but do try to get every detail — think of the lecture as an important story that you will have to tell again later.

3. As soon as possible after the lecture (and certainly the same day), reread the text and your "messy" lecture notes, then rewrite your lecture notes in a clear and neat format — redrawing the figures, filling in missed steps, and reworking examples. You are probably thinking that no one in their right mind would do this—but the secret is that successful students always review and prepare well in advance of exams.

4. Prepare a list of questions or issues that you need clarified, ask your instructor at the start of the next class (so others can benefit) or if you need one-one-one help, see your instructor as soon as possible, do not assume that it will "come to you later."

5. Work one homework problem at a time, without rushing. You are not learning if you are rushing, copying, or scribbling. Spread the problems out in time and write down any questions you have.

6. ASK QUESTIONS. In class, during office hours, ANY chance you get. If you do not understand something you cannot use it to solve problems. It will not come to you by magic. ASK! ASK! ASK!

7. Practice working problems. In addition to assigned problems, work the unassigned ones. Where do you think faculty get exam questions? You should establish a study group and distribute the lead — but you should work several of each type of problem that you are assigned.

8. Before a test, you should go over the material covered by preparing an outline of the important material from your notes as well as the text. Then rewrite your outline for the material about which you are not very confident. Review that material, then rewrite the notes for the material about which you are still not confident. Continue until you think that you understand ALL of the material.

9. "Looking over" isn’t learning, reading someone else’s solution is insufficient to develop your skills, you must prepare in earnest — work lots of problems, old homework, old exams, and study guide questions.

10. Speed on exams is often critical. It is not just a test of what you know, but how well you know it (and how fast you show it). The point is not just to "understand" but to "get it in your bones."

11. Participate in class. The instructor must have feedback to help you. Force the issue if you must, it is your education.

Motivational Thoughts:

Participation:
- Go to class — I can’t help you if I don’t know you. (Blasingame)
- Use the rule: “3 hours of work outside of class for every 1 hour in class” — do not procrastinate and do not underestimate. (Blasingame)
- The secret of getting ahead is getting started. (Mark Twain)

Anxiety:
- Be anxious about your classes — anxiety is a sign that something is important to you, and anxiety can serve to motivate. (Blasingame)
- Anxiety is the hand maiden of creativity. (T. S. Eliot)

Success:
- No one succeeds by themselves — working alone is both inefficient and ineffective. (Blasingame)
- Success is a state of mind — a willingness to fail is essential to success (and to learning). (Blasingame)
- Success consists of going from failure to failure without loss of enthusiasm. (Winston Churchill)

Education:
- Education is the only investment that never loses principal. (Blasingame)
- An investment in knowledge pays the best interest. (Benjamin Franklin)
- Education is the passport to the future, for tomorrow belongs to those who prepare for it today. (Malcolm X)
- The function of education is to teach one to think intensively and to think critically. (Martin Luther King, Jr.)

Leadership: (Blasingame)
- Step 1 — Look/Listen: Pay attention. Being able to focus on what you see, read, and hear is the first step in learning.
- Step 2 — Learn: Master the skill for the task. Some try to take short-cuts or avoid learning critical skills; this leads directly to failure.
- Step 3 — Lead: Leadership is a process that requires both knowledge and personal sacrifice — above all, a true leader serves others.
Instructor Responsibilities

The instructor is responsible for

- A learning environment where students of all skill levels are appropriately challenged.
- Showing respect and consideration to all students.
- Being prepared for class and keeping on schedule with the syllabus.
- Preparing exercises that follow the course objectives.
- Covering the material that will be tested on exams.

The instructor is not responsible for

- Work missed by absent students (unless a University-excused absence is provided to the instructor).
- Poor performance by inattentive or disinterested students.
- Personal issues:
  - If you have personal issues that impair your performance in this course, you should discuss these issues with your instructor.
  - However, your grade is assigned solely on your performance—personal appeals will not influence your grade.

Student Responsibilities

The student is responsible for

- Class attendance. **Students must attend all scheduled class meetings.**
- Being prepared for class. Always bring your books, course notes, and calculator to each class meeting.
- Being prepared for exams.
  - The instructor or TA may choose to review materials prior to exams, but do not rely on this review as your only exam preparation.
  - You should NOT rely solely on old assignments or old exams for your exam preparation.
  - The best preparation for exams is to stay current with the class, reread assignments, and get plenty of rest the night before the exam.
- Showing respect and consideration to his classmates and the instructor.
  - Do not talk excessively with your neighbors during class.
  - Do not take up class time for discussions with the instructor that should be held outside of class.
  - Students who disrupt the class will be asked to leave.
Americans with Disabilities Act (ADA) Statement: (Last Revision: 05 November 2015 (http://disability.tamu.edu/facultyguide/syllabus))
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.

Aggie Honor Code: (http://student-rules.tamu.edu/aggiecode)

"An Aggie does not lie, cheat or steal, or tolerate those who do."

The Aggie Honor Code of Honor is an effort to unify the aims of all Texas A&M men and women toward a high code of ethics and personal dignity. For most, living under this code will be no problem, as it asks nothing of a person that is beyond reason. It only calls for honesty and integrity, characteristics that Aggies have always exemplified.

The Aggie Code of Honor functions as a symbol to all Aggies, promoting understanding and loyalty to truth and confidence in each other.

Definitions of Academic Misconduct: (http://library.tamu.edu/services/library_tutorials/academic_integrity/academic_integrity_5.html)

1. CHEATING: Intentionally using or attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
2. FABRICATION: Making up data or results, and recording or reporting them; submitting fabricated documents.
3. FALSIFICATION: Manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
4. MULTIPLE SUBMISSION: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from the instructor of the class for which the student submits the work.
5. PLAGIARISM: The appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
6. COMPILICY: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.
7. ABUSE AND MISUSE OF ACCESS AND UNAUTHORIZED ACCESS: Students may not abuse or misuse computer access or gain unauthorized access to information in any academic exercise. See Student Rule 22: http://students-rules.tamu.edu/
8. VIOLATION OF DEPARTMENTAL OR COLLEGE RULES: Students may not violate any announced departmental or college rule relating to academic matters.
9. UNIVERSITY RULES ON RESEARCH: Students involved in conducting research and/or scholarly activities at Texas A&M University must also adhere to standards set forth in the University Rules.

For additional information please see:
http://students-rules.tamu.edu/

Reasons for Academic Honesty: (http://library.tamu.edu/services/library_tutorials/academic_integrity/academic_integrity_5.html)

1. INDIVIDUAL REPUTATION: While acquiring a reputation for academic dishonesty can ruin your reputation with the faculty of the institution, it can also have detrimental effect on your status with your acquaintances and friends.
2. PERSONAL INTEGRITY: The reality that you may have completed a degree program may be tarnished by the knowledge that you did so fraudulently.
3. PROFESSIONAL COMPETENCE: You may be called upon to use the specific skills or knowledge that you were supposed to have acquired, but you plagiarized instead.
4. INTRINSIC QUALITY OF DEGREE: You, as a student, are here to learn – how to research, how to write, how to think – and you are paying for the privilege. By plagiarizing, you are, in a very real sense, shortchanging yourself.
5. STATUS OR STANDING OF THE INSTITUTION: Ultimately, the awareness of academic dishonesty, either acknowledged or uncertain, finds its way outside of the University, to other institutions, employers, former students and the world-at-large, affecting the perceived value of the degree and the integrity of the University.

Coursework Copyright Statement: (Texas A&M University Policy Statement)
The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy them, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."
Specific Course Objectives

1. Describe the concepts of porosity and permeability and be able to relate their respective influences on fluid flow in porous media.

2. Estimate oil, gas, and water properties pertinent for well test or production data analysis using industry accepted correlations and/or laboratory data.

3. Sketch pressure—time and pressure—distance trends for a reservoir system which exhibits transient, pseudosteady-state, and steady-state flow behavior.

4. Derive the material balance relations for a slightly compressible liquid (oil), as well as the material balance relations for a dry gas.

5. Derive the steady-state flow equations for horizontal linear and radial flow of liquids and gases (including the pseudopressure and pressure-squared forms).

6. Develop and apply relations for pseudosteady-state flow in a black oil or dry gas reservoir system.

7. Derive the "skin factor" variable from the steady-state flow equation and be able to describe the conditions of damage and stimulation using this skin factor.

8. Derive the "skin factor" variable from the steady-state flow equation and be able to describe the conditions of damage and stimulation using this skin factor.

9. Derive the steady-state flow equations for horizontal linear and radial flow of liquids and gases (including the pseudopressure and pressure-squared forms).

10. Develop and apply relations for pseudosteady-state flow in a black oil or dry gas reservoir system.

11. Develop the analysis and interpretation methodologies (i.e., "conventional" plots and type curve analysis) for pressure tests (for oil, gas, and multiphase flow).

12. Apply dimensionless solutions ("type curves") and field variable solutions ("specialized plots") for constant rate behavior in an infinite-aacting homogeneous reservoir.

13. Define and apply the pseudopressure and pseudotemperature concepts for the analysis of well test and production data from dry gas and gas-oil reservoir systems.

14. Design and implement a well test sequence, as well as a long-term production/injection surveillance program.

15. Analyze production data to obtain reservoir volume and estimates of reservoir properties the student should also be able to make performance forecasts.

16. Design and interpret deliverability test data.

17. Demonstrate the capability to integrate, analyze, and interpret well test and production data to characterize a reservoir in terms of reservoir properties and performance potential (field study project).

Learning Outcome

- Describe the relationships of porosity and permeability and explain the influence of each parameter on reservoir flow behavior.

- Demonstrate the ability to estimate/calculaet and plot the various fluid property variables as functions of pressure. Also demonstrate an understanding of laboratory data.

- Demonstrate via hand and/or computer plots (as appropriate) the graphical relations for pressure, distance, and time — for the pre-scribed flow regimes.

- Demonstrate the derivation and application of the common material balance relations. Demonstrate use of field data.

- Demonstrate the derivation and application of the prescribed relations: Describe the applicability of each solution, and explain the influence of "near-Darcy" effects.

- Demonstrate the derivation, application, and interpretation of pseudosteady-state flow relations: black oil and dry gas systems.

- Demonstrate the calculation of the skin factor using the steady-state flow model. Explain extensions of the general "skin factor" concept for transient radial flow behavior.

- Demonstrate the derivation/development and application of IPR functions. Estimate/predict the flowrate at some future time.

- Demonstrate an understanding of the basic relations for mass continuity and motion — derive the diffusivity relations for the liquid and gas cases (all details).

- Explain the rationale for using dimensionless variables and demonstrate the derivation of dimensionless variables for the transient radial flow case.

- Demonstrate the development, construction, and application of specialized Cartesian, semilog, and log-log plots used for "conventional" well test analysis.

- Demonstrate the construction and application of "type curves" (dimensionless solutions) for the analysis of pressure transient test data (log-log plot format).

- Demonstrate the appropriate use of the pseudopressure and pseudotemperature transformations for analysis of well test and production data. The gas case must be demonstrated via analysis of field data.

- Demonstrate the proper design of a well test sequence using currently accepted practices and equipment.

- Demonstrate the estimation of reservoir properties using "decline curve" techniques — and be able to estimate extrapolate future performance using simplified rate models.

- Demonstrate the analysis of "4-point" and "12-point" production test data using current techniques.

- Provide an example case of a "performance-based reservoir characterization" — specifically the integration of well performance, well completions, geological, and petrophysical data.

Program Outcome

17. Competency in characterization and evaluation of subsurface geological formations and their resources using geoscience and engineering methods.


11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

19. Competency in application of reservoir engineering principles and practices for optimizing resource development and management.


19. Competency in application of reservoir engineering principles and practices for optimizing resource development and management.

16. Competency in design and analysis of well systems and procedures for drilling and completing wells.

16. Competency in design and analysis of well systems and procedures for drilling and completing wells.


5. An ability to identify, formulate, and solve engineering problems.

19. Competency in application of reservoir engineering principles and practices for optimizing resource development and management.

19. Competency in application of reservoir engineering principles and practices for optimizing resource development and management.


2. An ability to design and conduct experiments, as well as to analyze and interpret data.

19. Competency in application of reservoir engineering principles and practices for optimizing resource development and management.

16. Competency in design and analysis of well systems and procedures for drilling and completing wells.

21. An ability to deal with the high level of uncertainty in petroleum reservoir problems in problem definition and solution.
Please provide a self-evaluation of the course competencies by addressing the questions given below.

<table>
<thead>
<tr>
<th>Competency</th>
<th>Not At All</th>
<th>Not Well</th>
<th>Adequate</th>
<th>Well with Effort</th>
<th>Easily</th>
<th>NR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I can explain the relationships between porosity and permeability, and how these properties influence the flow of fluids in reservoir rocks.</td>
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<tr>
<td>2. I can use correlations and laboratory data to estimate the properties of reservoir fluids which are relevant for reservoir engineering — analysis and modeling.</td>
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<tr>
<td>3. I can sketch a plot of pressure versus logarithm of radius and identify the primary flow regimes (i.e., transient radial flow, pseudosteady-state flow, and steady-state flow behavior)</td>
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<tr>
<td>4. I can derive and apply the material balance relation for a slightly compressible liquid (oil) system and the material balance relation for a dry gas system.</td>
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<tr>
<td>5. I can derive and apply the steady-state flow equations for horizontal linear and radial flow of liquids and gases, including the pseudopressure and pressure-squared forms.</td>
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<tr>
<td>6. I can derive and apply the pseudosteady-state flow equations for the &quot;black oil&quot; and &quot;dry gas&quot; reservoir systems (&quot;black oil&quot; — pressure form; &quot;dry gas&quot; — pseudopressure form).</td>
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<tr>
<td>7. I can derive and apply the &quot;skin factor&quot; concept derived from steady-state flow to represent damage or stimulation (including the apparent wellbore radius concept).</td>
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<tr>
<td>8. I am familiar with and can use the &quot;definitive&quot; equations for liquids and gases — and I am aware of the assumptions, limitations, and applications of these relations.</td>
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<td>9. I am familiar with and can use of dimensionless variables and dimensionless solutions to provide a generic mathematical representation for a particular reservoir model.</td>
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<tr>
<td>10. I am familiar with and can use the concepts of temporal (time) and spatial superposition — time superposition is used for variable rate/pressure problems; spatial superposition is used to generate reservoir boundary configurations (faults, closed boundaries, etc.).</td>
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<tr>
<td>11. Well Test Analysis — Conventional Plots</td>
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<tr>
<td>a. Pressure versus time to establish the parameters related to wellbore storage (domination) behavior (i.e., the &quot;early time&quot; plot).</td>
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<tr>
<td>b. Pressure versus the logarithm of time (pressure drawdown case) or versus the logarithm of superposition time (e.g., Horner Time for the pressure buildup case) to establish the parameters related to radial flow behavior (i.e., the &quot;semilog&quot; plot).</td>
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<tr>
<td>c. The logarithm of pressure drop and pressure drop derivative versus the logarithm of time (or an appropriate superposition time function) to establish the parameters for wellbore storage, radial flow, and vertical fracture behavior (i.e., the &quot;log-log&quot; plot).</td>
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<tr>
<td>12. Well Test Analysis — Type Curve/Model-Based Analysis</td>
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<tr>
<td>a. An unfractured well which includes wellbore storage distortion and radial flow behavior (including damage/stimulation (i.e., skin effects)).</td>
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<tr>
<td>b. A vertically fractured well (finite or infinite fracture conductivity cases) which includes wellbore storage distortion, fracture flow regimes, and radial flow behavior.</td>
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<td>c. A well test performed in a reservoir with closed boundaries or sealing faults.</td>
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<td>d. A well test performed in a &quot;dual porosity&quot; or &quot;naturally fractured&quot; reservoir system.</td>
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<tr>
<td>13. Production Data Analysis</td>
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<tr>
<td>a. Estimate the &quot;absolute open flow&quot;, from a gas well &quot;deliverability&quot; test.</td>
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<tr>
<td>b. Develop and use an Inflow Performance Relation (IPR) which uses flowrate, wellbore pressure, and average reservoir pressure data to create an interpretive/predictive relation.</td>
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<tr>
<td>c. Estimate the &quot;reserves&quot; for an oil or gas well using plots of rate versus time (semilog rate format) and rate versus cumulative production.</td>
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<tr>
<td>d. Use decline type curves (or an equivalent software-based tool) to analyze production data from an uniformly or hydraulically fractured or gas well.</td>
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<tr>
<td>e. Provide a forecast of future rate or pressure performance of an oil or gas well using empirical methods (hand/software) and analytical/numerical models (software).</td>
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</tbody>
</table>
Course Information

Course Number: PETE 649  
Course Title: Boundary Element Method for Geomechanics  
Section:  
Time: TTH 9:45-11:00 AM  
Location: Online or face to face (you can choose) the room number is announced later.  
Credit Hours: 3 credit

Instructor Details

Instructor: Nobuo Morita  
Office: 501 P Richardson Bldg  
Phone: 979-458-3273  
E-Mail: Nobuo.morita@tamu.edu  
Office Hours: By appointment

Course Description

Course Description: Fundamental solutions of 2D and 3D boundary element methods; formulation of 2D and 3D direct, indirect, displacement discontinuity and dual boundary element methods; development of a 2-D boundary element computer program as a student project; applications of linear constitutive relation for hard rocks; applications of linear porous fluid flow problems for petroleum engineers; application of linear elasticity problems for fracture stability and fracture propagation problems

Course Prerequisites

Computer language such as Fortran, C, C#, C++, Matlab

Course Learning Outcomes

- The course teaches various boundary element methods so that students can select a specific method suitable for their applications.  
- If student research is related to 2D/3D hydraulic fracturing problems, he may use the codes provided in the course for his projects.  
- If student research is related to various aspects of geomechanics, the codes provided in the course may be used after some modifications.

Textbook and/or Resource Materials

A textbook is provided.
Grading Policy

Homework ... 60%
Program coding ... 10%
  • Attendance ... 30% (I will check online if you are listening to my lecture)

Course Schedule

Fundamentals
1. Fundamental elasticity equations
   (1.1) Fundamental elasticity equations
   (1.2) Boundary conditions
2. Flow through porous media
   (2.1) Fundamental equations of fluid flow through porous media
   (2.2) Boundary conditions
3. Tensor and matrix expressions
4. Fundamental solutions
   (4.1) Fundamental solutions for elasticity problems
   (4.2) Fundamental solutions for fluid flow through porous media
   (4.3) Fundamental solutions for boundary element methods for various problems.

Theoretical development
5. Boundary element methods
   (5.1) Direct boundary element method (Direct BEM)
   (5.2) Indirect boundary element method (Indirect BEM)
   (5.3) Discontinuous displacement method (DDM)
   (5.4) Dual boundary element method (Dual BEM)
   (5.5) Integral equation for poro-elasticity problems
6. Discretization of the integral equations
   (6.1) Simple discretization using elements with a constant strain
   (6.2) Strain and stress calculations within domain
   (6.3) Rigid body displacement conditions
   (6.4) Discretization using tetrahedral and eight node solid elements
   (6.5) High order elements
7. Numerical integration
   (6.1) Integration methods suitable for boundary element methods
   (6.2) Gauss integration
   (6.3) Pseudo singular integration and singular integrations
8. System of linear equations
   (8.1) Transformation from local coordinate to global coordinate
   (8.2) System of linear equations
9. Discretization of fluid flow through porous media
   (9.1) Fluid flow through porous media
   (9.2) Fundamental solution for steady state flow
   (9.3) Boundary element method for unsteady state flow through porous media
Course Syllabus

Programming

10. 2D structure code (Direct BEM) with stiffness matrix without numerical integration

   10.1 A boundary element method for 2D elasticity problems (analytical integration of H and G matrices)

   10.2 Stiffness matrix

   10.3 Code example

11. 2D structure code (Direct BEM) with stiffness matrix with numerical integration

   11.1 Discontinuous quadratic element for 2D elasticity problems

   11.2 Integration of stiffness matrix

   11.3 Code example

12. 2D Discontinuous Boundary Element Method (DDM) suitable for crack problems

   12.1 Analytical formulation of 2D DDM

   12.2 Flow chart

   12.3 Example input data for line crack problems

13. 2D boundary element method (Direct BEM) for unsteady state fluid flow problems

   13.1 2D boundary element method with discontinuous quadratic elements for fluid flow through porous medium

   13.2 Flow matrix

   13.3 Code example

14. 3D boundary element code (Direct BEM) for solid elasticity problems

   14.1 3D boundary element method with discontinuous quadratic element for linear elasticity problems.

   14.2 Code example

15. 3D boundary element method (Dual BEM) for fracture stability

   15.1 Stress intensity factor and fracture tip element

   15.2 3-D code for fracture problems

16. 3D fracture propagation code coupled with 2D finite element flow and 3D fracture code (DDM)

Optional Course Information Items

Consider adding the following additional information items to the course syllabus when appropriate.

Technology Support – Contact IT staff to install Fortran compiler and Matlab.

Learning Resources – Various boundary element books are available in the University library.
University Policies

This section outlines the university level policies that must be included in each course syllabus. The TAMU Faculty Senate established the wording of these policies.

NOTE: Faculty members should not change the written statements. A faculty member may add separate paragraphs if additional information is needed.

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

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Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor” (Student Rule 7, Section 7.4.1).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).
You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

**NOTE:** Faculty associated with the main campus in College Station should use this Academic Integrity Statement and Policy. Faculty not on the main campus should use the appropriate language and location at their site.

**Americans with Disabilities Act (ADA) Policy**

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

**NOTE:** Faculty associated with the main campus in College Station should use this Americans with Disabilities Act Policy statement. Faculty not on the main campus should use the appropriate language and location at their site.

**Title IX and Statement on Limits to Confidentiality**

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).
Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

**NOTE:** Faculty associated with the main campus in College Station should use this Title IX and Statement on Limits of Liability. Faculty not on the main campus should use the appropriate language and location at their site.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

COVID-19 Temporary Amendment to Minimum Syllabus Requirements

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

**Campus Safety Measures**

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. Students **who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**
- **Face Coverings**—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the **Face Covering policy** and **Frequently Asked Questions (FAQ)** available on the **Provost website.**
- **Physical Distancing**—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- **Classroom Ingress/Egress**—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- **To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter).** If a student refuses to wear a face covering, the instructor should ask the
student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

**Personal Illness and Quarantine**

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities**. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.

**Operational Details for Fall 2020 Courses**

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.

**College and Department Policies**

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.
Syllabus

Course Information

Course Number: PETE 408/651
Course Title: Probabilistic Reserves Evaluation
Sections: 500, 700
Time: WF 2:20-3:35 PM
Location: Online
Credit Hours: 3

Instructor Details

Instructor: W. John Lee
Office: 501 F Richardson
Phone: 979-945-2208
E-Mail: john-lee@tamu.edu
Office Hours: by appointment

Course Description

Oil and gas reserves definitions and reporting regulations. Probabilistic reserves estimation methods. Unconventional resources characterization. Reserves valuation techniques.

Course Prerequisites

PETE 353 or approval of instructor

Special Course Designation

Graduate students will have two assigned projects in this stacked course.

Course Learning Outcomes

This course will equip students to classify and categorize petroleum resources properly and to estimate and report these resources (especially reserves) correctly using probabilistic estimation procedures. Students will be able to estimate reserves and non-reserves resource volumes using probabilistic techniques in unconventional (low permeability) resource petroleum accumulations. Students will be able to summarize and apply technology from state-of-the-art papers in the petroleum literature.

Textbook and/or Resource Materials

Grading Policy

Grading Policies (PETE 408)

Homework........................................................................................................... 30%
Mid-semester exam........................................................................................... 30%
Final Exam......................................................................................................... 40%
Total.................................................................................................................... 100%

Grading Policies (PETE 651)

Homework........................................................................................................... 20%
Projects (2) ........................................................................................................ 20%
Mid-semester exam........................................................................................... 20%
Final Exam......................................................................................................... 40%
Total.................................................................................................................... 100%

Grading Scale

A......................................................................................................................90-100%
B....................................................................................................................80-89%
C.......................................................................................................................70-79%
D....................................................................................................................60-69%
F....................................................................................................................0-59%

Course Topics, Calendar of Activities, Major Assignment Dates

Late Work Policy

Homework will be due at noon central time USA on the first class day after it is assigned, and will be submitted electronically. Late homework will not be accepted (grade = 0) without prior approval except in emergencies or approved university absences. Classes will be recorded and students may access the recordings. Students are expected to attend class. Graduate students (PETE 651) will submit at least two term projects during the semester.

Course Schedule

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Descriptive statistics, basic probability concepts</th>
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<tbody>
<tr>
<td>Week 2</td>
<td>Expected value, decision trees</td>
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<tr>
<td>Week 3</td>
<td>Probability distributions</td>
</tr>
<tr>
<td>Week 4</td>
<td>Probability distributions</td>
</tr>
</tbody>
</table>
Optional Course Information Items

**Technology Support**

Please contact the TA/grader or instructor by email if you need technology support.

**Learning Resources**

Please contact the TA/grader or instructor by email if you need additional access to learning resources.

**University Policies**

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To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- Self-monitoring—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**
- Face Coverings—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.
- Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
• To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

**Personal Illness and Quarantine**

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities**. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, **for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.**

**Operational Details for Fall 2020 Courses**

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.

**College and Department Policies**

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.
Course title and number: PETE 652: Deterministic Reserves Evaluation
Term: Spring 2021
Meeting times and location: Remote 302 WF 1:50-3:05 PM

Course Description and Prerequisites

Oil and gas reserves definitions and reporting regulations and deterministic estimation methods. Unconventional resources characterization. Reserves valuation techniques.

Prerequisites

Approval of instructor

Learning Outcomes and Course Objectives

This course will equip students to classify and categorize petroleum resources properly and to estimate and report these resources (especially reserves) correctly using deterministic estimation procedures. Students will be able to estimate reserves and non-reserves resource volumes in unconventional (low-permeability) resource petroleum accumulations. Students will be able to read and summarize relevant technical literature in oil and gas reserves definitions and deterministic reserves estimation and evaluation.

Instructor Information

Name: John Lee, Professor
Telephone number: 979.845.2208
Email address: john.lee@pe.tamu.edu
Office hours: By appointment, Monday through Friday
Office location: 501F Richardson Building

Textbook and/or Resource Material


Grading Policies

Homework ................................................................. 20%
Term projects (2) ...................................................... 20%
Mid-semester exam .................................................. 20%
Final Exam ......................................................... 40%
Total ................................................................. 100%

Grading Scale

A ......................................................... 90-100%
B ......................................................... 80-89%
C ......................................................... 70-79%
D ......................................................... 60-69%
F ......................................................... 0-59%
Course Topics, Calendar of Activities, Major Assignment Dates

Homework will be due before the start of each class, and will be submitted electronically. Late homework will not be accepted (grade will be zero) without prior approval except in emergencies. **Failure to turn in all homework (even late) will result in a grade of “I” for the course, which will be removed only after all homework is submitted.** Classes will be recorded and students may access the recordings. Resident students will be **required** to either attend designated classes or have university approved absences.

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<thead>
<tr>
<th>Week 1</th>
<th>Overview, introduction to PRMS</th>
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<td>Week 8</td>
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<td>Week 14</td>
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<tr>
<td>Week 15</td>
<td><strong>final exam</strong></td>
</tr>
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**Americans with Disabilities Act (ADA)**

The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy Statement was forwarded to the Faculty Senate for information.

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu.

Coursework Copyright Statement: (Texas A&M University Policy Statement)

The handouts used in this course are copyrighted. By "handouts," this means all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy them, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writing, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section “Scholastic Dishonesty”.

Academic Integrity

For additional information please visit: http://aggiehonor.ramu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Term  Summer 2020
Meeting times and location  TR 10:00 – 11:50 PM I need a lecture room, not a computer room

Course Description and Prerequisites
This course derives various analytical methods in Geomechanics used in oil industries. Formulation of linear poro-elasticity equations; formulation of non-linear poro-elasticity and plasticity equations; formulation of various rock failure theories; estimations of in-situ stress, pore volume, permeability changes during production and injection; solving linear and non-linear elasticity and plasticity equations using analytical methods; solving 2-D and 3-D poro-elasticity and plasticity equations using a semi-analytical method; using a simple displacement discontinuity method, solve the stress shadow problems for hydraulic fracturing; applying the solutions to formation stability during water and CO2 injection, reservoir compaction, borehole breakouts, sand production and casing problems. Prerequisites are the general knowledge of oil and gas explorations.

Learning Outcomes
Formulation and practice of various analytical methods in geomechanics used in oil industries. The course derives linear and non-linear constitutive equations, failure theories and porosity and permeability equations in solving geomechanics problems for drilling, production and reservoir engineers; practice reservoir compaction, subsidence, formation stability, borehole breakout, drill string stability, casing stability, stress intensity factor and stress shadow problem for hydraulic fracturing problems using analytical solutions and using a semi-analytical program to be developed by students. This course provides essential knowledge of geomechanical problems when students get a job in the oil and gas exploration companies in future. It also provides fundamental background if students take the finite element and boundary element methods for geomechanics taught by the same instructor.

Prerequisites: Simple programing language (such as Fortran, C, Basic, Matlab, Mathematica, Excel VBA)

Instructor Information
Name  Nobuo Morita
Telephone number  979-458-3273
Email address  Nobuo.morita@tamu.edu
Office hours  By appointment
Office location  501 P Richardson Bldg

Textbook and/or Resource Material
A textbook is provided.

Grading Policies
Homework ... 70%

Project: program coding … 30%

**Attendance and Make-up Policies**

A high score is essential for the final exam if absences are repeated.

**Course Topics, Calendar of Activities, Major Assignment Dates**

Required reading: a textbook written by Morita is provided.

(Part 1): Linear elasticity and analytical solutions

Week 1-3: Fundamental equations of poro-elasticity
1. Force, displacement, stress, strain, and displacement-strain relations
2. Equations of equilibrium and stress strain relations
3. Compatibility condition
4. Boundary conditions
5. Cylindrical and spherical coordinates
6. Tensor and matrix expressions
7. Strain energy and uniqueness of solutions
8. Elasticity coefficients
9. Visual presentations of contour maps

Week 4&5: Two dimensional problems
1. Plane stress, plane strain problems
2. Two dimensional fundamental elasticity equations in the Cartesian coordinate system
3. Airy’s stress function
4. Simple solutions useful for petroleum engineering problems

Week 6: Complex two dimensional geomechanics problems
1. Fundamentals of the complex function theory
2. Stress in a thick wall cylinder
3. Stress and displacement around a borehole or a tunnel
4. Stress and displacement around a circular well with non-uniform boundary stress
5. Earth surface deformation induced by a heavy rectangular structure
6. Stress around an elliptical hole
7. Beam problems

Week 7&8: Complex 3D geomechanics problems: subsidence, reservoir compaction and fracture problems using the strain nuclei method and displacement discontinuity method
1. Strain nuclei method
2. Application to reservoir compaction problems
3. Analytical solution at the center of a reservoir for a radial reservoir
4. Parameter studies for stress change, strain, pore pressure change and displacement induced by reservoir compaction without elastic modulus contrast between reservoir and cap rock.
5. Quick estimation of magnitudes of stress and pore pressure changes and strain induced by reservoir compaction
6. Analytical method of displacement discontinuity method
7. 3-D fracture width and stress intensity factors
8. Stress shadow for 3D fractures

Week 9: Effective stress concept and in-situ stresses
1. Effective stresses concept
2. Vertical and horizontal in-situ stresses
3. Formation stability during production and injection
4. Focal method and stress polygon
(Part 2): Nonlinear elasto-plastic analysis for analytical and semi-analytical solutions

Week 10 & 11: Rock strength, non-linear stress strain and fundamental equations of elasto-plastic analysis

- (6.1) Rock failure and failure theories
- (6.2) Nonlinear stress strain relation
- (6.3) Stress and strain invariants
- (6.4) Nonlinear elastic moduli
- (6.5) Nonlinearity at low stress state
- (6.6) Shear type nonlinear strain due to micro-crack growth
- (6.7) Yield envelope fitted to real polyaxial stress strain empirical data
- (6.8) Flow direction and magnitude of elasto-plastic problems
- (6.9) Incremental stress strain relation
- (6.10) Pore collapse model
- (6.11) Elasto-visco-plastic materials
- (6.12) Analytical solutions for visco-elastic model
- (6.13) Stress and displacement around a casing using a numerical method

Week 12: Analytical solutions of plasto-elasticity problems

- (7.1) Compression and extension of a cylindrical bar
- (7.2) Simple torsion of a cylindrical bar
- (7.3) Bending a beam with pure bending moment
- (7.4) A beam with a uniform load
- (7.5) Elasto-plastic problems for a thick wall cylinder
- (7.6) Analytical solution of stress state around a borehole with a linear Mohr-Coulomb yield criterion
- (7.7) Analytical solution of stress state around a borehole with a linear work hardening material
- (7.8) Field application of non-linear problems: parametric study of sand production prediction

Week 13: Application of iterative methods to solve general non-linear problems

- (8.1) Iterative method using semi-analytical solutions
- (8.2) Permeability, porosity and stress change around a borehole during fluid injection

Week 14: Slip line theories of plasticity problems

- (9.1) Fundamentals of hyperbolic type differential equations
- (9.2) Slip line theory for Tresca yield criterion
- (9.3) Slip line theory for Mohr-Coulomb criterion
- (9.4) Applications of the slip line theory to geomechanical problems
- (9.5) Application of the linear Mohr-Coulomb yield envelope to slip line method

8 Assignments and 2 project reports

Other Pertinent Course Information

Computer usage: Require Fortran or C language

Americans with Disabilities Act (ADA)

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Academic Integrity

For additional information please visit: http://aggiehonor.tamu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Term (e.g., Fall 200X)  Spring 2021
Meeting times and location  TTH 1:30 – 2:45 PM

Course Description and Prerequisites
Formulation and practice of the finite element method in solving geomechanics and transient flow problems; coupling transient flow code and geomechanics; practice 3D transient fluid flow around perforations; 3D oil reservoir formation stability and cap rock stability during production and fluid injection; finite element method for 3D fracture geometry and fracture propagation for layered formation; and borehole breakout and casing stability problems using a program to be developed by students.

Learning Outcomes
Course Description: Formulation of the 3D finite element method for fluid flow and geomechanics problems; linear and non-linear constitutive relation for soft and hard rocks; applications to porous flow and geomechanics problems.
Students learn how to run the 3D finite element computer programs. Using the codes, student practice to solve various field geomechanics problems, reservoir flow, reservoir compaction, subsidence, 3D fracture propagation; and borehole breakout and casing stability problems.

No prerequisites: Knowledge of computer language such as Fortran, C, C#, C++, or Matlab is desired. I teach Fortran during the class (two weeks are enough to learn Fortran since it is very simple language).

Instructor Information
Name  Nobuo Morita
Telephone number  979-458-3273
Email address  Nobuo.morita@tamu.edu
Office hours  By appointment
Office location  501 P Richardson Bldg

Textbook and/or Resource Material
A textbook is provided.

Grading Policies
Homework … 30%
Program assignment … 20%
Attendance … 50%

Attendance and Make-up Policies
A high score is essential for the assignments if absences are repeated.
Other Pertinent Course Information

Americans with Disabilities Act (ADA)
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu

Academic Integrity
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Part 1 Basics of the finite element method
1. Fundamental equations of poro-elasticity and fluid flow through porous media
   (1.1) Force, displacement, stress-strain and displacement-strain relations
   (1.2) Equation of equilibrium and stress strain relation
   (1.3) Fluid flow through porous media
   (1.4) Matrix expression
2. Finite element methods
   (2.1) Discretization using the virtual work principle
   (2.2) Discretization using the minimization of total potential energy
   (2.3) Discretization using the residual method
   (2.4) Discretization of the set of flow equations through porous media using the residual method
3. Finite element method with analytical integration using simple elements
   (3.1) Discretization using 3D tetrahedral elements
   (3.2) Analytical integrations
   (3.3) Assembling the elements
   (3.4) Nodal forces
   (3.5) Body forces
4. Finite element method with isoparametric elements
   (4.1) Isoparametric elements
   (4.2) Brick elements
   (4.3) Infinite element
5. Numerical integration
   (5.1) Gaussian integration
   (5.2) Integration formula for triangle and tetrahedron shape functions
6. Solution of linear simultaneous equations
   (6.1) Matrix transformation for the boundary condition given by local coordinates
   (6.2) Solution of linear simultaneous equations
7. Convergence and error analysis
   (7.1) Theoretical estimation of error
   (7.2) Numerical evaluation of error
8. Application of the finite element method to non-linear geological materials
   (8.1) Non-linear problems
   (8.2) Application of the Newton-Raphson method to non-linear problems
   (8.3) Calculation method of $\lambda$ and $D_{ep}$
   (8.4) Implementation
9. Coupling geomechanics and transient fluid flow
   (9.1) Fundamental equation for isotropic poro-elasticity problems
   (9.2) Discretization using the virtual work principle
   (9.3) Discretization of transient fluid flow equations through porous media
   (9.4) Coupling flow and geomechanic codes
   (9.4.1) Full coupling
   (9.4.2) Sequential coupling
      (9.4.2.1) Fixed strain method
      (9.4.2.2) Fixed total stress methods
      (9.4.2.3) Drained split method
      (9.4.2.4) Undrained split method
   (9.5) Stability of the sequential methods
      (9.5.1) 1D compaction problem coupled with fluid flow and geomechanics
      (9.5.2) Stability analysis of the coupled problem
      (9.5.3) Stability of drained split method
      (9.5.4) Stability of undrained split method
      (9.5.5) Stability of fixed strain method
      (9.5.6) Stability of fixed total stress method
      (9.5.7) Numerical example of 1D compaction problem using the fixed total stress method
   (9.6) Sequential coupling with commercially available reservoir models.
      (9.6.1) Sequential calculation of flow and geomechanics with uniaxial compaction assumption
      (9.6.2) Single or multi-phase problems without assuming uniaxial compaction
      (9.6.3) One step undrained method for short period production problems
      (9.6.4) General multi-phase problems
10. Pressure profile around perforations – field problems using Flow3D
    (10.1) Pressure profile around a single perforation
    (10.2) Numerical solution for pressure distribution around a single perforation
    (10.3) Pressure distribution around a perforation for gravel packed well
    (10.4) Quantitative analysis of the effect of perforation interaction on flow efficiency
11. Evaluation of mechanical stability of perforations using Geo3D.
    (11.1) Stability of perforations during oil and gas production
    (11.2) Field observation of sand production problems
    (11.3) A quick method to forecast the possibility of sand problems: perforation stability analysis using TWC or TPS test equipment
12. Numerical methods for the borehole breakout problems using Geo3D
    (12.1) Rock failure and failure theories

Part 2 Applications of Flow3D and Geo3D to real field problems
10. Pressure profile around perforations – field problems using Flow3D
    (10.1) Pressure profile around a single perforation
    (10.2) Numerical solution for pressure distribution around a single perforation
    (10.3) Pressure distribution around a perforation for gravel packed well
    (10.4) Quantitative analysis of the effect of perforation interaction on flow efficiency
11. Evaluation of mechanical stability of perforations using Geo3D.
    (11.1) Stability of perforations during oil and gas production
    (11.2) Field observation of sand production problems
    (11.3) A quick method to forecast the possibility of sand problems: perforation stability analysis using TWC or TPS test equipment
12. Numerical methods for the borehole breakout problems using Geo3D
    (12.1) Rock failure and failure theories
(12.2) Failure envelopes from empirical results
(12.3) Stress state around an inclined well drilled through inclined formation
(12.4) Comprehensive analysis of stress state around a borehole with temperature, swelling and pore pressure change for layered and orthotropic formation
(12.5) Failure theories to predict breakout angle around a borehole
(12.6) Effect of controllable parameters on safe mud window design

13. Casing collapse for hydrostatic and geotechnical loads
14. 3D reservoir compaction problems
   (14.1) Introduction of reservoir compaction problems
   (14.2) Strain nuclei method
   (14.3) Analytical solution at the center of a reservoir for a radial reservoir
   (14.4) Subsidence, pore pressure and stress change in the overburden formation using the finite element method coupled with transient flow and geomechanics models
   (14.5) Parametric analysis of subsidence and compaction
15. 3D finite element method for fracture geometry and fracture propagation problems
   (15.1) 3D fracture shape for layered media
   (15.2) Practice 3D hydraulic fracture propagation program using STIM_PLAN

Appendix A Apparent elastic modulus with pore fluid

Part 3 Programing of the finite element methods
Appendix B 2D and 3D finite element code for single phase transient porous fluid flow problems
Appendix C Geo3D code
Course title and number  PETE 656: Advanced Numerical Methods for Reservoir Simulation
Term (e.g., Fall 200X)  Spring 2021
Meeting times and location  TR  11:30 am-12:45 pm
STANDARD Web Based (ZOOM Link TBD)

Course Description and Prerequisites

This class covers the numerical simulation of multiphase flow in heterogeneous porous media with emphasis on advanced techniques based on numerical methods for discretization of partial differential equations combined with state-of-the-art linear and nonlinear solvers and well modeling; The students are expected to develop a numerical reservoir simulator and benchmark against commercial-of-the-shelf software;
Prerequisites: Basic Reservoir Simulation or equivalent class; Linear Algebra and Matrix Computations of equivalent class; Advanced Calculus or equivalent class; Programming experience.
Graduate classification.

Learning Outcomes or Course Objectives

The objectives of the course are for students to:
1. Develop an in-depth understanding of current approaches to building models of flow in porous media and their numerical simulation.

Instructor Information

Name  Dr. Eduardo Gildin
Telephone number  (979) 862-4578
Email address  egildin@tamu.edu
Office hours  TBD (or by appointment – send e-mail!)
Office location  401J Richardson Building/ ZOOM

Textbook and/or Resource Material

The main source of material for the course will be a series of notes and slides handed out to the students. Complementary textbooks are:
1. Applied Partial Differential Equations, R. Habernam, 2004
6. Petroleum reservoir simulation, Aziz and Settari, 1979
Grading Policies

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<td>Mid-Term Exam</td>
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<td>Final Project</td>
<td>(40%)</td>
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<td>Total</td>
<td>(100%)</td>
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Grading Scale (base)

A.................................................................90-100%
B.................................................................80-89%
C.................................................................70-79%
D.................................................................60-69%
F.................................................................0-59%

Course Topics, Calendar of Activities

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<td>o Understanding the overall iterative workflow</td>
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<td></td>
<td>o Introduction to partial differential equations</td>
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<td>o PDE’s solution methods</td>
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<td>2-3</td>
<td>Porous Media Flow and Transport Equation</td>
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<td>o Rock and Fluid Properties</td>
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<td>o Black-oil model</td>
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<td>4</td>
<td>Introduction to numerical computing</td>
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<td>o Floating point arithmetic and round-off errors</td>
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<td>o Truncation errors and Taylor Series</td>
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<td></td>
<td>o Numerical methods – roots of equation (Newton Raphson)</td>
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<td>Numerical Methods – Discretization of PDE’s</td>
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<td>o Finite difference methods --&gt; <strong>Mid Term Project: Single/Two-Phase Finite Differences</strong></td>
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<td>o Control Volume Methods – TPFA and MPFA</td>
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<td>o Standard Finite Element Methods and Mixed Finite Element Methods</td>
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<td>o IMPES and AIM</td>
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<td>11-13</td>
<td>Solution to Linear and Nonlinear Systems</td>
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<td>o Gaussian Elimination</td>
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<td>o CG/GMRES/BiCGStab/CGS</td>
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<td>o Preconditioning</td>
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<td>o High resolution methods (TVD) and Godunov’s Methods</td>
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<td>o Model Reduction</td>
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<td>o Gridding</td>
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<td>o Other requests</td>
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Course Projects

Mid Term Project → usually assigned at the 7th-8th week
Representation of a single and two-phase (oil-water) partial differential equations;
Finite Differences discretization;
Well Modeling;
Direct Solvers (Gaussian Elimination)
Project Report: mathematical formulation and discretization; codes and results

Final Project → usually assigned at the 13th. week
Representation of a two-phase (oil-water or oil-gas) partial differential equations;
Finite Volumes/Elements discretization;
Well Modeling;
Iterative Solvers (GMRES, CG, BiCGSTAB)
Project Report: mathematical formulation; codes and results; comparison of iterative and direct solvers

Other Pertinent Course Information

Since general reservoir simulation concepts will be discussed with no emphasis on specific areas, all engineering majors are welcome to attend the class. Also, mathematics and applied mathematics students are well suited to attend this course, although there will be no specific emphasis on the numerical algorithms and theorems proofs. The prerequisites for the class are the following: Basic Reservoir Simulation or equivalent class; Linear Algebra and Matrix Computations of equivalent class; Advanced Calculus or equivalent class; Programming experience. Although Matlab will be emphasized in this class, any other language that the student is familiar with (Fortran, C, C++, etc) will be fine as well.

Academic Integrity Statement

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Collaboration on examinations and assignments is forbidden except when specifically authorized.

If I catch you cheating (and by you, I mean an individual, anyone involved in the cheating, or a team in the case of a team exercise), usually by turning in work that is not your own but represented as your own work, the following will happen:

- You will receive a zero on that individual or team assignment, quiz, or test,
- I will report you to the Aggie Honor Code Office by filing an Aggie Honor Code Violation,
- I will handle the first offense autonomously (meaning I decide the sanction for cheating), which may range from a letter grade reduction for the course to submitting an F* for the course to the Aggie Honor Code Office (which is
the usual penalty for a violation per the Aggie Honor Code Office),

- You will probably have to take a three-class, one-month course on Academic Integrity,
- You may fail the class, and have to retake it, and
- You may not graduate on time.

See Policy on Academic Integrity at the end of this syllabus. For additional information, visit aggiehonor.tamu.edu

Americans with Disabilities Act (ADA) Policy Statement

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling and Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

Campus Safety Measures
To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**

- **Face Coverings**—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the **Face Covering policy** and **Frequently Asked Questions (FAQ)** available on the Provost website.

- **Physical Distancing**—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

- **Classroom Ingress/Egress**—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.

- **To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.**

**Personal Illness and Quarantine**

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities.** Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See **Student Rule 7, Section 7.2.2.**) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, for Fall 2020 only, **students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.**
Academic Integrity Policy – (by Dr. McVay, 2013)

**Rationale – Why I Do What I Do**

**Technical competence:** I want you to be able to perform well technically as an engineer. I want each of you to be able to perform well individually, not just when you are working with your buddies. It is very unlikely that you and your buddies will end up working together. To remain employed and prosper in your career, you will have to perform individually. In addition to developing technically, deciding that you will not cheat will force you to develop self-discipline and time management skills in order to get good grades, which will also help you immensely in your career.

**Ethical competence:** I want you to be ethically competent. While you may be able to succeed in the short term by being unethical, just as you may get good grades by cheating in school, long-term success can only be achieved with ethical behavior. Don’t think that cheating in school is different from being unethical in the workplace, or that once school is over you will change or won’t need to cheat anymore. If you cheat in school, you won’t think twice about padding your expense account. If you do that, then overstating reserves to increase your bonus won’t bother you. It’s not a big step from there to cooking the books of your company to inflate the value of your stock options. I don’t want any Aggies involved in the next Enron debacle, and it starts with cheating in school.

**Fairness:** Those who cheat have an unwarranted advantage over those who don’t. I want to be fair to those who don’t cheat.

**The Aggie Honor Code:** As a Texas A&M University faculty member, I am also bound by the Aggie Honor code, which includes that I will not tolerate those who cheat.

**What I Will Do**

For the reasons above, and because I feel quite strongly about them,

1. I will do everything I reasonably can to prevent cheating. I don’t do everything I possibly can because this would be a full-time job.
2. Because I can’t do everything possible to prevent cheating, when I determine a cheating violation has occurred I will (a) report it through the Aggie Honor System Office (AHSO), and (b) punish to the full extent that I am able to.

**What Constitutes Academic Dishonesty**

You may be surprised at what is considered academic dishonesty. For example,

- During an examination, looking at another student's examination or using external aids (for example, books, notes, calculators, conversation with others, or electronic devices) unless specifically allowed in advance by the instructor.
- Acquiring answers for any assigned work or examination from any unauthorized source. This includes, but is not limited to, using the services of commercial term paper companies, purchasing answer sets to homework from tutoring companies, and obtaining information from students who have previously taken the examination.
- Collaborating with other students in the completion of assigned work, unless specifically authorized by the instructor teaching the course.
- Knowingly allowing another to copy from one's paper during an examination or test.

See [http://aggiehonor.tamu.edu/Descriptions/](http://aggiehonor.tamu.edu/Descriptions/) for a complete list.

**Reporting an Academic Violation – What Happens**

- I will report the violation to the AHSO, regardless of the magnitude of the violation.
- The report is submitted online and includes (1) the details of the violation, (2) an election to handle autonomously or refer to the Honor Council, (3) specification of sanction, and (4) student acknowledgement of acceptance/rejection of violation and/or sanction.
- I will usually handle the first offense autonomously; e.g., I decide the sanction. My minimum sanction will usually be a one-letter-grade reduction in your course grade. The maximum sanction I can and will award is an F* (failure of the course and notation of “FAILURE DUE TO ACADEMIC DISHONESTY” on transcript until cleared by taking the Academic Honesty Remediation Course).
- I will usually include taking the Academic Honesty Remediation Course as part of the sanction. This is a three-class, one-month course on academic integrity. I will usually give you one semester to take the course. If you do not take the course by this time your grade will be changed to an F*.
- Importantly, you are now logged into the AHSO system. If there is a second violation, in any course, you will automatically go before the Honor Council, and you will likely be expelled from the university.
- Note that upper division students found guilty of a violation are ineligible to graduate with honors. I will treat students giving unauthorized help the same as students receiving unauthorized help.
- In all cases, you have the right to appeal to the AHSO.

**Final Words**

Please understand that none of this is personal. My desire is for academic integrity, regardless of who you are. I want you all to do well. I just want you to do it honestly. You will be a better engineer because of it.

You now know what I will do. Don’t claim ignorance or ask for a second chance if you are caught. I have given the consideration I will give by telling you in advance and in no uncertain terms what I will do so that you can make an informed decision about cheating.
Course title and number  CSCE/PETE 657: High Performance Computing for Earth Science and Petroleum Engineering
Term (e.g., Fall 200X)  Spring 2019
Meeting times and location  Monday, 12:40–3:30pm,  RICH 319

Course Description and Prerequisites

Covers numerical simulation of problems in Earth Sciences and Petroleum Engineering using high performance computing (HPC). Students are expected to develop a parallel reservoir simulator as part of this course.

Graduate classification.

Additional Information: Since general reservoir simulation concepts will be discussed with no emphasis on specific areas, all engineering and computer science majors are welcome to attend the class. Also, mathematics and applied mathematics students are well suited to attend this course, although there will be no specific emphasis on the numerical algorithms and theorems proofs. Students are expected to know the following: Basic Reservoir Simulation or equivalent class; Linear Algebra and Matrix Computations of equivalent class; Advanced Calculus or equivalent class; Programming experience in a language such as Matlab, Fortran, C, or C++.

Learning Outcomes or Course Objectives

The objectives of the course are for students to:
1. Develop an in-depth understanding of current approaches to building and simulating complex models of flow in porous media and Earth sciences using high performance computing.
2. Bridge the gap between reservoir modeling and simulation, high performance computing and parallel implementations, having a solid theoretical background in parallel architectures (software and hardware) and practical solutions to real world large-scale problems faced by scientist and petroleum engineers.

Instructor Information

Name  Dr. George Moridis  Dr. Vivek Sarin
Telephone number  (979) 458-4470  (979) 458-2214
Email address  moridis@tamu.edu  sarin@tamu.edu
Office hours  TBD  TBD
Office location  RICH 407L  HRBB 309C

Textbook and/or Resource Material

The main source of material for the course will be a series of notes and slides handed out to the students. Complementary textbooks are:
1. Introduction to Parallel Computing, 2nd ed., by A. Grama, A. Gupta, G. Karypis, and V. Kumar, Addison-Wesley
2. An Introduction to Parallel Algorithms, by Joseph JaJa, Addison-Wesley Publishing Company
3. Numerical Analysis, Burden and Faires, 2005
4. Matrix Computations, Golub and Van Loan, 1996

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**Grading Policies and Grading Scale**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>50%</td>
<td>A</td>
</tr>
<tr>
<td>Final Project Presentation</td>
<td>15%</td>
<td>B</td>
</tr>
<tr>
<td>Final Project Report</td>
<td>35%</td>
<td>C</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F</td>
</tr>
</tbody>
</table>

**90-100%** A ……… 90-100%
**80-89%** B ……… 80-89%
**70-79%** C ……… 70-79%
**60-69%** D ……… 60-69%
**0-59%** F ……… 0-59%

---

**Course Topics, Calendar of Activities, Major Assignment Dates (TENTATIVE)**

**Week** | **Topic**                                                                                                                                 |
----------|-----------------------------------------------------------------------------------------------------------------------------------------|
1         | Introduction to the Course and Reservoir Simulation – Sarin/Moridis                                                                     |
2         | Introduction to reservoir simulation and numerical computing I – Moridis                                                             |
3         | Introduction to reservoir simulation and numerical computing II – Moridis                                                            |
4         | Parallel computing technology – Sarin                                                                                              |
5         | Parallel algorithms – Sarin                                                                                                          |
6         | Programming (MPI) – Sarin                                                                                                           |
7         | Programming (OpenMP) – Sarin                                                                                                         |
8         | Numerical algorithms – Sarin                                                                                                          |
9         | Numerical algorithms – Sarin                                                                                                          |
10        | Simulation Project – Moridis                                                                                                         |
11        | Reservoir Simulation Code: Parallelization – Moridis                                                                                |
12        | Industry Presentation                                                                                                               |
13        | Reservoir Simulation Code: Parallelization – Moridis                                                                                |
14        | Final project presentation                                                                                                          |

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**Other Pertinent Course Information**

Students may refer to Students Rule 07 for attendance policies: [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07).

**Americans with Disabilities Act (ADA)**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu)

**Academic Integrity**

For additional information please visit: [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor)

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
PETE 659
Rock Mechanics Related to Hydraulic Fracture
Fall 2019

<table>
<thead>
<tr>
<th>Instructor:</th>
<th>Dr. Kan Wu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office:</td>
<td>RICH 501Q</td>
</tr>
<tr>
<td>Phone:</td>
<td>862-7654</td>
</tr>
<tr>
<td>Office Hrs:</td>
<td>MW 10:00 am – 11:00 am</td>
</tr>
<tr>
<td>E-mail:</td>
<td><a href="mailto:kan.wu@tamu.edu">kan.wu@tamu.edu</a></td>
</tr>
</tbody>
</table>

| Lectures: | RICH 1009 | MW 01:50 pm - 03:05 pm |

| Credit: | 3 (3:0) |
| Catalog Description: | Basic principal of stress and strain, pore pressure and in situ stress estimation, rock failure description and analysis, linear elasticity, stress shadow analysis, fracture near-tip stress analysis, fracture propagation, and hydraulic fracturing. The emphasis will be on the unconventional reservoirs. |

<table>
<thead>
<tr>
<th>Week</th>
<th>date</th>
<th>Day</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aug.26</td>
<td>M</td>
<td>Introduction and overview</td>
</tr>
<tr>
<td></td>
<td>Aug.28</td>
<td>W</td>
<td>Stress, strain, and traction</td>
</tr>
<tr>
<td>2</td>
<td>Sep.2</td>
<td>M</td>
<td>In-situ stress and pore pressure</td>
</tr>
<tr>
<td></td>
<td>Sep.4</td>
<td>W</td>
<td>Structure geology</td>
</tr>
<tr>
<td>3</td>
<td>Sep.09</td>
<td>M</td>
<td>Structure geology</td>
</tr>
<tr>
<td></td>
<td>Sep.11</td>
<td>W</td>
<td>2D stress resolution</td>
</tr>
<tr>
<td>4</td>
<td>Sep.16</td>
<td>M</td>
<td>2D stress resolution</td>
</tr>
<tr>
<td></td>
<td>Sep.18</td>
<td>W</td>
<td>3D stress resolution</td>
</tr>
<tr>
<td>5</td>
<td>Sep.23</td>
<td>M</td>
<td>Rock failure analysis</td>
</tr>
<tr>
<td></td>
<td>Sep.25</td>
<td>W</td>
<td>Rock failure analysis</td>
</tr>
<tr>
<td>6</td>
<td>Sep.30</td>
<td>M</td>
<td>No class (ATCE)</td>
</tr>
<tr>
<td></td>
<td>Oct.2</td>
<td>W</td>
<td>No class (ATCE)</td>
</tr>
<tr>
<td>7</td>
<td>Oct.7</td>
<td>M</td>
<td>Linear elasticity</td>
</tr>
<tr>
<td></td>
<td>Oct.9</td>
<td>W</td>
<td>Exam 1</td>
</tr>
<tr>
<td>8</td>
<td>Oct.14</td>
<td>M</td>
<td>Linear elasticity</td>
</tr>
<tr>
<td></td>
<td>Oct.16</td>
<td>W</td>
<td>Plane stress and plane strain</td>
</tr>
<tr>
<td>9</td>
<td>Oct.21</td>
<td>M</td>
<td>Displacements of an opening fracture</td>
</tr>
<tr>
<td></td>
<td>Oct.23</td>
<td>W</td>
<td>2D hydraulic fracture models (PKN and KGD)</td>
</tr>
<tr>
<td>10</td>
<td>Oct.28</td>
<td>M</td>
<td>Induced stresses around an opening fracture</td>
</tr>
<tr>
<td></td>
<td>Oct.30</td>
<td>W</td>
<td>Stress shadow analysis</td>
</tr>
<tr>
<td>11</td>
<td>Nov.4</td>
<td>M</td>
<td>Stress shadow analysis</td>
</tr>
<tr>
<td></td>
<td>Nov.5</td>
<td>W</td>
<td>Near-tip stress analysis</td>
</tr>
<tr>
<td>12</td>
<td>Nov.11</td>
<td>M</td>
<td>Fracture propagation criterion and direction</td>
</tr>
<tr>
<td></td>
<td>Nov.13</td>
<td>W</td>
<td>Hydraulic fracturing and completion in unconventional reservoirs</td>
</tr>
<tr>
<td>13</td>
<td>Nov.18</td>
<td>M</td>
<td>Exam 2</td>
</tr>
<tr>
<td></td>
<td>Nov.20</td>
<td>W</td>
<td>Hydraulic fracture modeling in unconventional reservoirs</td>
</tr>
<tr>
<td>14</td>
<td>Nov.25</td>
<td>M</td>
<td>Multiple fracture propagation in unconventional reservoirs</td>
</tr>
<tr>
<td></td>
<td>Nov.27</td>
<td>W</td>
<td>No class (Thanksgiving Holiday)</td>
</tr>
<tr>
<td>15</td>
<td>Dec.02</td>
<td>M</td>
<td>Interaction between hydraulic and natural fractures</td>
</tr>
<tr>
<td></td>
<td>Dec.04</td>
<td>W</td>
<td>Final Presentation</td>
</tr>
</tbody>
</table>
COURSE POLICIES

Attendance: Class attendance is important. It is students’ responsibility to attend the class.

Assignments: Homework will normally be given at lecture. Assignments are due at the beginning of the following lecture unless otherwise stated. You can dispute your graded homework and exams within a week of their return to students. Examinations are not optional. Make-up examinations will be given only for university excused absences.

Work Quality: Neat, legible, systematic and complete presentation is required in assignments and examinations for full credit. Units and explanation must be written wherever appropriate for the answers.

Academic Integrity: “An Aggie does not lie, cheat, or steal, or tolerate those who do.” Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System. For additional information please visit: http://aggiehonor.ramu.edu.

Feedback: During this course I will be asking you to give me feedback on your learning in informal or formal ways so we can create a better learning experience. Feel free to contact me anytime with feedback, concerns, suggestions, etc.

Grading weights (%):

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Project</td>
<td>20</td>
</tr>
<tr>
<td>Homework assignments</td>
<td>20</td>
</tr>
<tr>
<td>Examinations (30% each, 2)</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Grading Policy:
Regular university scale will be applied (A: 90-100, B: 80-89,…). Based on the final grade distribution, the curving method might be applied.

ADA Policy Statement: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Cain Hall or call 979-845-1637. For additional information visit http://disability.tamu.edu.
PETE 660.600: COURSE SYLLABUS

TECHNICAL WRITING AND PRESENTATIONS FOR PETROLEUM ENGINEERS

Instructor

<table>
<thead>
<tr>
<th>Name</th>
<th>Gia Alexander</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email Address</td>
<td><a href="mailto:Gia.Alexander@tamu.edu">Gia.Alexander@tamu.edu</a></td>
</tr>
<tr>
<td>Office Location</td>
<td>916G Richardson</td>
</tr>
<tr>
<td>Office Hours</td>
<td>Mondays and Wednesdays 1:00-3:00 p.m. and by appointment on ZOOM</td>
</tr>
<tr>
<td>Office Phone</td>
<td>(979) 847-8855</td>
</tr>
</tbody>
</table>

COURSE PURPOSE AND DESCRIPTION

**Purpose:** The purpose of this course is to prepare you to produce professional written and oral communication as an emerging petroleum engineer with an advanced degree.

**Credits:** 3.0  Lecture: 3 hrs./wk.  Lab: 0 hrs./wk.

**Class Hours and Location:** Online, asynchronous, beginning Monday, March 23, 2020.

**Catalog Description:** “Planning, drafting and editing reports, proposals, correspondence, technical papers and procedures for workplace and academic applications; research and citation guidelines; working with templates; effective figures, graphs and tables; presentation design and practice.”

**Prerequisites:** Graduate standing in Petroleum Engineering or permission of instructor.

COURSE OBJECTIVES/LEARNING OUTCOMES

Specific objectives for your coursework in PETE 660 include the following:

1. Participate in the Spring 2020 Society of Petroleum Engineers Student Paper Contest.
2. Learn and apply the elements of SPE professional communication, including conducting archival research, using stylesheets and templates, creating and captioning graphics, and citing intellectual property.
3. Prepare a letter of introduction for funding and networking purposes.
4. Create a research statement for your graduate-level work.
5. Write a project prospectus/internal proposal for project funding (Crisman or OGAPS).
6. Develop and present a 20-minute conference-quality technical presentation for one of your graduate-level research projects (can be for prelim or defense).
7. Write a technical paper suitable for submission to an SPE journal.

TEXTBOOKS AND RESOURCE MATERIALS

• Required: *2019 SPE Style Guide*. Available as PDF on eCampus.
• Additional readings provided as accessible PDFs or links on eCampus.
• Access to Microsoft PowerPoint

**GRADING AND COURSE COMPLETION POLICIES**

Your grade will be based on the sum of points earned on the following assignments:

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in the 2020 SPE Student Paper Contest</td>
<td>100</td>
</tr>
<tr>
<td>Letter of Introduction</td>
<td>100</td>
</tr>
<tr>
<td>Research Statement</td>
<td>100</td>
</tr>
<tr>
<td>Project Prospectus</td>
<td>150</td>
</tr>
<tr>
<td>Technical Presentation</td>
<td>250</td>
</tr>
<tr>
<td>Final Paper</td>
<td>300</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1000</strong></td>
</tr>
</tbody>
</table>

**Final Grade Calculation.** Course grades are calculated on the following standard scale:

- A = 90.00-100.00 (900-1000 points)
- B = 80.00-89.99 (800-899 points)
- C = 70.00-79.99 (700-799 points)
- D-F = 0.00-69.99 (Work at this level is not acceptable for graduate study at Texas A&M University)

**Overall Work Quality Expectations.** Each major assignment in this course has its own prompt and rubric that highlights its specific measures of expectation and means of evaluation. Overall, however you may refer to the following table for guidelines behind those rubrics, and to track your progress in the course as a whole:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (90.00-100.00 %)</td>
<td>Your work is excellent and indicative of outstanding progress toward your degree. Your document contains all of the required elements with keen attention to detail. You have gone beyond the basic expectations of the assignment in terms of critical thinking, research, and organization/presentation. Your document is very well designed, is free of errors, and meets the needs of the target audience with finesse. In the workplace, consistent performance at this level could earn you recognition and possible promotion.</td>
</tr>
<tr>
<td>B (80.00-89.99%)</td>
<td>Work at this level is still very good, and also indicates good progress toward your degree. Your document is complete and shows competence in design and audience analysis. Critical thinking, research support, and good organization are present, but do not rise to the level of sophistication noted above. A technical document that falls into this category usually has some errors that could have been avoided with careful proofreading. In the industry, you could expect this level of work to be turned back to you for minor revisions.</td>
</tr>
<tr>
<td>C (70.00-79.99%)</td>
<td>Work at his level is considered average, but we all know that the petroleum industry expects Aggie engineers to be above average. Often, this level of work shows major weakness in identification and analysis of a viable engineering problem, organization, audience appropriateness, or completeness. Its presentation design is not well thought through, and the content just meets the requirements of the task at hand. In the industry, consistent performance at this level might earn you a “Meets Expectations” on your annual evaluation, but it will hold you back in your career, causing you to be...</td>
</tr>
<tr>
<td>Grade</td>
<td>Indicators</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>D (60.00-69.99%)</td>
<td>Technical documents that fall into this category show major patterns of careless errors, lack of thought given to the engineering problem, poor concept of audience, poor design, and lack of completeness. Work at this level in the oil and gas industry will draw the attention and ire of superiors, and can result in reprimand, demotion, and even job termination.</td>
</tr>
<tr>
<td>F (0.00-59.99%)</td>
<td>These documents are usually incomplete, missing major sections of content. They show no effort to meet the needs of the audience, and little if any attention to design. Sources are either not used, or they have not been cited correctly. Lack of attention to detail is evident. Major errors stand out throughout the document. We all know what a failed document looks like when we see one. In most instances, it is better to admit lack of preparation and ask for an extension in order to produce better work. Persistence at this level in the industry can very easily and quickly result in job loss, and is an embarrassment to Texas A&amp;M.</td>
</tr>
</tbody>
</table>

**Attendance.** As professional students, you need to use your best judgment and time-management skills. While interviews, conferences, personal and family emergencies, and unforeseen problems in the lab may cause you to miss the occasional class, do understand that our meetings will work largely as writing workshops. You need to be present to work on your own writing and to provide feedback to your colleagues.

**eCampus Submissions.** Submit your assignments to eCampus **early** to ensure that they submit properly. After you upload your document and click Confirm, you will see a confirmation screen and then receive a confirmation email. Don’t forget to click Confirm after the initial upload and preview. Make sure that you receive and keep a record of the confirmation so there are no discrepancies about submissions. In the event that there is an eCampus error blocking a submission, simply send me an email with your submission attached and explain the difficulty. Please use this as a last resort.

**Late Work.** As with attendance, things happen. The way we handle being late in the industry involves notifying our superiors ahead of time when we are going to be late. If you need to submit work late, please email me with the following information:

1. Which assignment will be late
2. Why it will be late
3. How much of the work you have completed
4. When you expect to submit

**Rewrites/Regrades.** Not in graduate school.

**CLASSROOM CIVILITY AND ELECTRONIC DEVICE POLICY**

**Civility.** In this class, we will behave like the engineering professionals we are in accordance with our Aggie value of having a Community of Respect on our campus. If you disrupt class, I will ask you to leave for the day and to come explain your unprofessional behavior to me during office hours.

**Electronic Device Policy.** Please feel free to bring your electronic study aids to class. We will actually use our devices (phones, tablets, and laptops) in class quite a bit this semester. You are responsible for the privacy and security of your devices.
COMMUNICATION VIA EMAIL, eCAMPUS, AND SOCIAL MEDIA

This course is dedicated to teaching you to communicate professionally. As such, you should approach correspondence with me and others in the course in a professional manner. All emails to me should include the course and section number in the subject line. Your emails should address me as Ms. Alexander, and they should also be formatted professionally.

Please also respect the following social media boundaries:

1. I will not be Facebook Friends with you as long as you are still in university.
2. I will not be LinkedIn Contacts with you until after you have completed my course.

FOR STUDENTS NEEDING SUPPORT SERVICES

Students with Disabilities. The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on West Campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.

Safe Space. Student advocacy is a big part of my pedagogy. My office is a safe and private space where you can come during office hours and appointments without fear of being judged or ridiculed. Please keep in mind, though, that I am not a licensed counselor, but if you need one, I can direct you to someone on campus who is. Also, please understand that if you tell me you are thinking about hurting yourself or someone else, or that someone else has harmed you, by state law I am required to report it to the university’s Title IX Coordinator. Please read the following text carefully:

Title IX and Statement on Limits to Confidentiality. Texas A&M University and the College of Liberal Arts are committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws provide guidance for achieving such an environment. Although class materials are generally considered confidential pursuant to student record policies and laws, University employees — including instructors — cannot maintain confidentiality when it conflicts with their responsibility to report certain issues that jeopardize the health and safety of our community. As the instructor, I must report the following information to other University offices if you share it with me, even if you do not want the disclosed information to be shared:

• Allegations of sexual assault, sexual discrimination, or sexual harassment when they involve TAMU students, faculty, or staff.

These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In many cases, it will be your decision whether or not you wish to speak with that individual. If you would like to talk about these events in a more confidential setting, you are encouraged to make an appointment with the Student Counseling Service (https://scs.tamu.edu/). Students and faculty can report concerning, non-emergency behavior at http://tellsomebody.tamu.edu.

ACADEMIC INTEGRITY

"An Aggie does not lie, cheat or steal, or tolerate those who do."
Students are expected to be aware of the Aggie Honor Code, the specific rules on plagiarism, and the Honor Council Rules and Procedures pertaining to classroom behavior as explained at http://aggiehonor.tamu.edu.

**Plagiarism.** In this course, plagiarism is the intentional act of doing any of the following things:

1. Turning in someone else’s intellectual property and claiming it as your own.
2. Turning in work you have done previously for other courses and claiming it as new.
3. Engaging in unauthorized collaboration that results in unoriginal work, **including signing someone else into class.**
4. Neglecting to cite your sources to give proper attribution.

If I find that you have intentionally plagiarized, you will **fail PETE 660** and **receive a referral** to your advisor, Dr. Liang, and the Aggie Honor System Office. Unintentional plagiarism, such as forgetting to include a source on your References, constitutes an error in research methods and will cause your grade on the affected assignment to be lower.

**UNIVERSITY WRITING CENTER**

The University Writing Center (UWC), located on the second floor of Evans Library and Room 205 in the West Campus Library, offers one-on-one consultations to writers preparing documents, slides, or oral presentations. UWC consultations are highly recommended but are not required. Help is available for all of the steps of the writing and speechwriting process including assistance with brainstorming ideas, narrowing the topic, creating outlines or drafts, and presenting a speech to an audience. UWC consultants can help you practice your speech with a real audience or develop visual presentation aids like slides and handouts. Consultants can also help you improve your proofreading and editing skills. If you visit the UWC, take a copy of your assignment, a hard copy of your draft or any notes you may have, as well as any material you need help with. To find out more about UWC services or to schedule an appointment, call 458-1455, visit the web page at [http://writingcenter.tamu.edu/](http://writingcenter.tamu.edu/), or stop by in person.

**COURSE CALENDAR**

We will develop the course calendar and set assignment due dates as a group based on our travel and prior commitment schedules. I will then post the class schedule and due dates in eCampus. If we choose to make any changes after that, I will ensure that the change works in everyone’s favor and I will state it in writing in Course Announcements.
PETE 661 – DRILLING ENGINEERING

Syllabus

Course Information

Course Number: PETE 661  
Course Title: Drilling Engineering  
Section: 600, 700  
Time: MW 12:00 pm – 1:15 pm  
Location: RICH 114 and Online via Zoom  
Credit Hours: 3

Instructor Details

Instructor: Dr. JC Cunha  
Office: RICH 401 (office will be closed the entire Spring 2021; office hours will be provided by Zoom meeting only – see office hours below)  
Phone: 979-458-0721  
E-Mail: jc.cunha@tamu.edu  
Office Hours: By email request preferably every MW from to 8 am to 10 am. If you need to talk to me, we can find another time mutually convenient. I will try to accommodate all requests. Please request your office time by email only.

Course Description

Introduction to drilling systems: wellbore hydraulics; identification and solution of drilling problems; well cementing; drilling of directional and horizontal wells; wellbore surveying abnormal pore pressure, fracture gradients, well control; offshore drilling, underbalanced drilling.

Course Prerequisites

Approval of Advisor/Instructor.

Course Learning Outcomes

By the end of this course, students will be able to:

1. Understand the overall drilling process for onshore and offshore drilling.  
2. Have an understanding of main drilling operations.  
3. Understand wellbore hydraulics and drilling fluids function.
4. Know the different types of drilling rigs and understand the function of the several drilling systems in a rig.
5. Understand the process of directional drilling and main direction drilling calculation methods.
6. Know the importance of pore pressure and fracture gradient on wellbore planning and how they are attained.
7. Know the main methods and causes of well control situations.

Textbook and/or Resource Materials

- Fundamentals of Drilling Engineering
  Edited By: Robert F. Mitchell and Stefan Z. Miska
  SPE Textbook Series No. 12
  ISBN: 978-1-55563-207-6
  Society of Petroleum Engineers

  How to access the content of the book “Fundamentals of Drilling Engineering”:
  - Go to library.tamu.edu
  - Type the name of the book on the search line (you may be asked to log in with your NetID and password).
  - The eBook version of the book will show up in the results of the search.
  - Click on “Connect to the full text of this electronic book”
  - You will then have the option to download the book to your computer, for a maximum time of 21 days, or read it online (after 21 days you can download it again).

- Selected Technical papers

- Halliburton Cement Tables (Red Book), available on HAL website & installed on PETE computers. You can also download it to your computer or smartphone. Go to Halliburton.com and look for the eRedBook® Software link.

- Handouts available on a weekly basis on CANVAS.

Grading Policy

A (89-100) Excellent, 4 grade points per semester hour
B (79-88.9) Good, 3 grade points per semester hour
C (69-78.9) Satisfactory, 2 grade points per semester hour
D (59-68.9) No passing grade for graduate students
F (Below 59) Fail

Evaluation

Mid Term 1 (24 Feb): 20%
Mid Term 2 (31 Mar): 20%
Final (TBA): 25%
Assignments: 15%
Technical paper, reading, research and presentation (TBA): (20%)

Late Work Policy

- Assignments will be accepted up to 24 hours late for a maximum of 80% of the full mark.

Late work means “submitting a deliverable after the established deadline”. Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy. (See Student Rule 7.)

Course Schedule

**Classroom Lectures: 15 weeks - 45 hours**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Drilling Systems</td>
<td>5</td>
</tr>
<tr>
<td>- Well Construction Overview</td>
<td></td>
</tr>
<tr>
<td>- Exploration, appraisal, and development drilling</td>
<td></td>
</tr>
<tr>
<td>- Typical well profiles</td>
<td></td>
</tr>
<tr>
<td>- The well construction process</td>
<td></td>
</tr>
<tr>
<td>- The Drilling Team</td>
<td></td>
</tr>
<tr>
<td>- Types of drilling rigs</td>
<td></td>
</tr>
<tr>
<td>- Overview of Routine Drilling Operations</td>
<td></td>
</tr>
<tr>
<td>Drilling Fluids</td>
<td>3</td>
</tr>
<tr>
<td>Wellbore Hydraulics</td>
<td>3</td>
</tr>
<tr>
<td>Wellbore Casing and Cementing</td>
<td>3</td>
</tr>
<tr>
<td>Drilling Problems</td>
<td>2</td>
</tr>
<tr>
<td>Directional Drilling</td>
<td>3</td>
</tr>
<tr>
<td>Pore Pressure and Fracture Gradient</td>
<td>4</td>
</tr>
<tr>
<td>Well Control</td>
<td>4</td>
</tr>
<tr>
<td>Offshore Drilling</td>
<td>5</td>
</tr>
<tr>
<td>Underbalance Drilling</td>
<td>4</td>
</tr>
<tr>
<td>Midterms</td>
<td>3</td>
</tr>
<tr>
<td>Technical Paper Presentation</td>
<td>3</td>
</tr>
<tr>
<td>Final (TBA)</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
</tr>
</tbody>
</table>
University Policies

*This section outlines the university level policies that must be included in each course syllabus. The TAMU Faculty Senate established the wording of these policies.*

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor” (Student Rule 7, Section 7.4.1).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.
Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.
Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

COVID-19

Campus Safety Measures (This is the same from Fall 2020 and will be updated once new directions are available)

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- Self-monitoring—Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
- Face Coverings—Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.
- Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

Personal Illness and Quarantine
Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities.** Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See [Student Rule 7, Section 7.2.2.](#)). To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, **for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation.** Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.
COURSE SYLLABUS

Description: This course is a survey course in petroleum production engineering, beginning with the material in the textbook, and going beyond this level with the aid of other material from the literature. I will review basic undergraduate production engineering material at a fairly rapid pace. The primary topics that will be covered include reservoir inflow, skin effects and formation damage, well completion performance, multiphase flow in pipes, and well stimulation. A course outline is given below.

Objectives:

- Learn engineering methods to evaluate and optimize oil and gas well performance.

Text: Petroleum Production Systems, 2nd edition by M. J. Economides, A. D. Hill, C. Ehlig-Economides, and D. Zhu + supplemental papers

Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Chapter(s) covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Introduction to production engineering; review of reservoir inflow</td>
<td>1-5</td>
</tr>
<tr>
<td>4-5</td>
<td>Skin effects and formation damage; well completion performance</td>
<td>6</td>
</tr>
<tr>
<td>6-10</td>
<td>Well stimulation, acidizing and hydraulic fracturing</td>
<td>14-18</td>
</tr>
<tr>
<td>11-13</td>
<td>Multiphase flow in pipes</td>
<td>7-9</td>
</tr>
<tr>
<td>14-15</td>
<td>Artificial lift; overview</td>
<td>11-12</td>
</tr>
</tbody>
</table>
COURSE POLICIES

1. Attendance: Class attendance is important. I will supplement the material in the textbook with a considerable amount of additional published and unpublished material, some of which may be presented only during class time. I encourage you to attend class regularly.

2. Examinations: Examinations are not optional. Make-up of major examinations will be given only for university excused absences.

3. GRADING:

<table>
<thead>
<tr>
<th>Exam</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-term Exam I (February 13th)</td>
<td>30%</td>
</tr>
<tr>
<td>Mid-term Exam II (March 19th)</td>
<td>30%</td>
</tr>
<tr>
<td>Mid-term Exam II (April 16th)</td>
<td>30%</td>
</tr>
<tr>
<td>Summary Reports of Guest Lectures &amp; Power-point Summary for Selected Textbook Exercises</td>
<td>10%</td>
</tr>
</tbody>
</table>

- **For on-campus students:** The mid-term exams will be from 7 pm to 9 pm on the date of exam in RICH 1009.
- **For DL students:** The mid-term exam problems will be available for DL students to download from eCampus from 7 PM College Station time on the date of exam (Thursday) until 11:59 PM Sunday College Station time. Once downloaded, the DL students will have two hours and thirty minutes to complete and finish uploading your answer sheets in one PDF file back on eCampus.

The course grade will be based on three mid-term exams, summary reports on guest lectures, and power-point summary for selected textbook exercises. There will be no final exam. There will be two guest lectures during the semester. Summary reports of the guest lectures are due one week after the lecture and will be graded. Power-point summary of selected textbook exercises are also due one week after they are assigned. On-campus students will be randomly selected to present in front of the class. There will be homework sets assigned during the semester. These will not be graded, but solutions will be posted a week after the homework is assigned so that you can check your work. I strongly encourage you to work the homework assignments to be prepared for the exams.

4. Late Work Policy: You are required to complete your work during the time allotted. Late submission will result in a grade of 0. The three mid-term exams are required. For in-class students missing an exam, a valid medical excuse is required or the grade will be 0. Distance Learning students must submit the mid-term exams by the assigned date and time or the grade will be 0. Distance Learning students, if you have a short-term work assignment that will prevent you from submitting an assignment on time, you must petition well ahead of time to get an exception to this rule. In general, you are given sufficient time to complete all assignments, so this circumstance should be rare.
5. **Academic Integrity Statement:** “An Aggie does not lie, cheat, or steal or tolerate those who do.” Collaboration on examinations and assignments is forbidden except when specifically authorized. Students violating this policy may be removed from the class roster and given an F in the course or other penalties as outlined in the *Texas A&M University Student Rules*. See [http://aggiehonor.tamu.edu/](http://aggiehonor.tamu.edu/) for definitions of academic misconduct and other related information and resources.

6. **ADA Policy Statement:** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information visit [http://disability.tamu.edu/](http://disability.tamu.edu/)

7. **Accommodation of Religious Observance:** See student-rules.tamu.edu, Appendix IV. Please review your calendar now, so we can begin discussion of appropriate accommodation.
Course Instructor/Supervisor: (Classroom: RICH 319, Class meeting times: TBD depending on instructor)

(Petroleum Geoscience) Dr. Juan Carlos Laya
Tel. (979) 845-7279
Office: 263 Halbouty
Office Hours: by appointment/Zoom
e-mail: layajc@tamu.edu

(Formation Evaluation) Dr. David Schechter
Tel. (979) 845-2275
Zoom: by appointment
Office: 610 RICH
Office Hours: tba/appointment
e-mail: schechter@tamu.edu

(Analysis of Reservoir Performance) Dr. Tom Blasingame
Tel. (979) 845-2292
Zoom: by appointment
Office: 821A RICH
Office Hours: tba/appointment
e-mail: t-blasingame@tamu.edu

Text Materials:

Petroleum Geosciences (Laya)

(Formation Evaluation) (Schechter) (.pdf reading will be provided from Halliburton Manual)

(Analysis of Reservoir Performance) (Blasingame)

Reference Materials: Will be handed out or placed on an accessible website as needed.

1. Reference notes.
2. Journal articles.
3. Presentation materials.

Basis for Grade: (components given as percentage of total grade average)

Geology: Hwk/Quizzes/Projects/Module Exam................................................................. 33.33 percent
Formation Evaluation: Hwk/Quizzes/Projects/Module Exam........................................ 33.33 percent
Reservoir Performance: Hwk/Quizzes/Projects/Module Exam....................................... 33.33 percent
Total = 100.00 percent

Grade Cutoffs: (Percentages)

A: 100 to 90  B: 89.99 to 80  C: 79.99 to 70  D: 69.99 to 60  F: < 59.99

Policies and Procedures:

1. Students are expected to attend class every session. Resident students (not Distance Learning students) are REQUIRED to attend class every session. Distance Learning students are expected to review lecture materials within 24 hours of the lecture being given. This is not a casual requirement, penalties can and will be assigned for missing class.
2. Always bring your textbook, notes, homework problems, and calculator to class.
3. Homework and other assignments will be given at the lecture session. All work shall be done in an acceptable engineering manner; work shall be as complete as possible. Assignments are due as stated. Late assignments will receive a grade of zero.
4. Policy on Grading
   a. It shall be the general policy for this class that homework and exams shall be graded on the basis of answers only — partial credit, if given, is given solely at the discretion of the instructor.
   b. All work requiring calculations shall be properly and completely documented for credit.
   c. All grading shall be done by the instructor, or under his supervision, and the decision of the instructor is final.
5. Policy on Regrading
   a. In very rare cases when an exam is considered for regrading; e.g., when the total number of points deducted is not consistent with the assigned grade. Partial credit (if any) is not subject to appeal.
   b. Work which, while correct, but cannot be followed, will be considered incorrect — and will not be considered for a grade change.
   c. Grades assigned to homework problems will not be considered for regrading.
   d. If regrading is necessary, the student is to submit a letter to the instructor explaining the situation that requires consideration for regrading and the material to be regraded must be attached to this letter. The letter and attached material must be received within one week from the date returned.
Policies and Procedures: (Continued)

6. The grade for a late assignment is zero. Homework will be considered late if it is not turned in at the start of class on the due date. If a student comes to class after homework has been turned in and after class has begun, the student's homework will be considered late and given a grade of zero. Late or not, all assignments must be turned in.

7. Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an exam or collaborating on an assignment where collaboration is not specifically allowed will be removed from the class roster and given an F (failure grade) in the course. Specifically, you are NOT AUTHORIZED to collaborate any individual assignment, exam, quiz, etc.; this includes discussions, sharing materials, etc. You are expressly FORBIDDEN from such actions on any and all assignments. You are only permitted to collaborate on assignments if the instructor specifically authorizes such collaborations, and then for only for the assignment where such collaboration is authorized. Failure to abide by this guideline will invoke an F (failure grade) in the course or on the assignment, at the discretion of the instructor, based on the severity of the infraction.

Course Description

The purpose of this course is to provide the student with a working knowledge of the current methodologies used in geological description/analysis, formation evaluation (the analysis/interpretation of well log data), and the analysis of well performance data (the design/analysis/interpretation of well test and production data). The overall course objective is to provide the student with the ability to assess field performance and to optimize hydrocarbon recovery by analyzing/interpreting/integrating geologic, well log, and well performance data.

Course Objectives

The student should be able to perform the tasks given below for each course module.

Course Module 1: (2020) Petroleum Geosciences (Laya)

- Identify components of a petroleum system; name and describe the organic sources of hydrocarbons.
- Describe the processes of thermal maturation, primary and secondary migration, and hydrocarbon trapping; name and describe types of self-sourcing reservoirs.
- Describe the origin and significance of structural features, including folds, fractures, and traps; describe unconformities; describe the methods and tools used for structural evaluations.
- Characterize clastic and carbonate reservoirs by describing the geometry, orientation, and continuity of sedimentary facies and their relations to flow units and reservoir quality. List examples of diagenetic effects on clastic and carbonate reservoir quality.
- Describe porosity-permeability relations in clastic and carbonate reservoirs; give examples of scalar effects on permeability determination. Explain/describe stratigraphic traps.
- Describe the methods, tools, and workflow for developing a reservoir model.

Course Module 2: (2020) Formation Evaluation (Schechter)

1. Describe and explain determination of static original oil in place (volumetric OOIP) from open-hole logging:
   - “How to Read a Log”
   - Calculate volumetric estimate of original fluids in place from log example.
   - Discussion of reservoir mechanisms, recovery factor and EUR

2. Explain and apply the principles of operation and interpretation of the following logs:
   - Gamma Ray: demonstrate calculation of $V_{shale}$, determine gamma ray response for common rocks
   - Spontaneous Potential: demonstrate calculation of $V_{shale}$, calculation of formation water resistivity, $R_w$
   - Sonic: calculate sonic porosity, describe $R_{wa}$ technique
   - Neutron Density: describe gas and shale effect, determine neutron density crossplot porosity, and determine lithology from neutron-density cross plot
   - Resistivity: describe resistivity measurements in terms of invasion diameter
   - Analysis and application of all porosity cross-plots
   - Shallow, intermediate and deep resistivity
   - Ordering of resistivity curves
   - Oil-water contact and transition zone concepts
   - Capillary pressure and relative permeability concepts

3. Apply the following techniques to calculate water saturation:
   - Archie’s empirical equation
   - Analysis of Archie’s law parameters ($m, n, R_w, R_r, a, \phi$)
   - Pickett plot
Course Module 3: (2020) Analysis of Reservoir Performance (Blasingame)

- Pressure Transient Analysis: (PTA)
  - Derive and apply the analysis and interpretation methodologies for pressure drawdown and pressure buildup tests — for liquid, gas, and multiphase flow systems (i.e., "conventional" plots and type curve analysis)
  - Apply dimensionless solutions ("type curves") and field variable solutions ("specialized plots") for:
    - Unfractured and fractured wells in infinite and finite-acting, homogeneous and dual porosity reservoirs.
    - Variable-rate convolution (specialized plots).
    - Pseudopressure and pseudotime concepts for the analysis of well test data for dry gas reservoir systems.

- Production Analysis: (PA)
  - (Time-Rate) Perform "Decline Curve Analysis" (DCA) to estimate reserves and predict future performance.
  - (Time-Rate-Pressure) Perform "model-based analysis" to estimate reservoir properties and reserves.

- Demonstrate the capability to integrate, analyze, and interpret well test and production data to characterize a reservoir in terms of reservoir properties and performance potential (field study project).

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 27 Wed</td>
<td>(Geol) Introduction; petro. systems; source rocks; therm. mature; HC migration</td>
<td>eCampus, pdf</td>
</tr>
<tr>
<td>May 29 Fri</td>
<td>(Geol) Geologic principles, trapping mech; seals; struct. styles and features</td>
<td>eCampus, pdf</td>
</tr>
<tr>
<td>June 03 Wed</td>
<td>(Geol) Structural assessment and traps; folds and fractures; unconformities</td>
<td>eCampus, pdf</td>
</tr>
<tr>
<td>June 05 Fri</td>
<td>(Geol) Geophysical methods in petroleum evaluation</td>
<td>eCampus, pdf</td>
</tr>
<tr>
<td>June 10 Wed</td>
<td>(Geol) Res. Char.; stratigraphic analysis; depositional systems; stratigraphic traps</td>
<td>eCampus, pdf</td>
</tr>
<tr>
<td>June 12 Fri</td>
<td>(Geol) Reservoir properties and diagenesis</td>
<td>eCampus, pdf</td>
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</table>

Module 3: Analysis of Reservoir Performance (Blasingame)

Notes:
- Blasingame is unavailable 20-22 July 2020 due to the 2020 URTeC (http://urtec.org/2020) — students are encouraged to attend.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 14 Tu</td>
<td>(ResPrf) Reservoir Engineering: Basic Theory, Petrophysics, PVT, Material Balance</td>
<td>pdf materials (Blasingame)</td>
</tr>
<tr>
<td>July 16 Th</td>
<td>(ResPrf) Pressure Transient Analysis: Introduction to Pressure Transient Analysis</td>
<td>pdf materials (Blasingame)</td>
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<tr>
<td>July 23 Th</td>
<td>(ResPrf) Pressure Transient Analysis: &quot;Conventional&quot; and &quot;Type Curve&quot; Analyses</td>
<td>pdf materials (Blasingame)</td>
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<tr>
<td>July 24 Fr</td>
<td>(ResPrf) Production Analysis: History, Basic Concepts, Simple Time-Rate Analysis</td>
<td>pdf materials (Blasingame)</td>
</tr>
<tr>
<td>July 28 Tu</td>
<td>(ResPrf) Production Analysis: Time-Rate (&quot;Decline&quot;) Analyses</td>
<td>pdf materials (Blasingame)</td>
</tr>
<tr>
<td>July 30 Th</td>
<td>(ResPrf) Production Analysis: Time-Rate-Pressure (&quot;RTA&quot;) Analyses</td>
<td>pdf materials (Blasingame)</td>
</tr>
</tbody>
</table>

Notes:
- There is no comprehensive final examination for this course.
Americans with Disabilities Act (ADA) Statement:
Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit http://disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible. (Last updated and approved by Faculty Senate on 11/11/2019)

"An Aggie does not lie, cheat or steal, or tolerate those who do."

Definitions of Academic Misconduct:
1. CHEATING: Intentionally using or attempting to use unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise.
2. FABRICATION: Making up data or results, and recording or reporting them; submitting fabricated documents.
3. FALSIFICATION: Manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
4. MULTIPLE SUBMISSION: Submitting substantial portions of the same work (including oral reports) for credit more than once without authorization from the instructor of the class for which the student submits the work.
5. PLAGIARISM: The appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
6. COMPLICITY: Intentionally or knowingly helping, or attempting to help, another to commit an act of academic dishonesty.
7. ABUSE AND MISUSE OF ACCESS AND UNAUTHORIZED ACCESS: Students may not abuse or misuse computer access or gain unauthorized access to information in any academic exercise. See Student Rule 22: http://student-rules.tamu.edu/
8. VIOLATION OF DEPARTMENTAL OR COLLEGE RULES: Students may not violate any announced departmental or college rule relating to academic matters.
9. UNIVERSITY RULES ON RESEARCH: Students involved in conducting research and/or scholarly activities at Texas A&M University must also adhere to standards set forth in University Rule 15.99.03.M1 - Responsible Conduct in Research and Scholarship. For additional information please see: https://aggiehonor.tamu.edu/Rules-and-Procedures/Rules/Honor-System-Rules

Copyright Statement:
The materials used in this course are copyrighted. These materials include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless permission is expressly granted.

Plagiarism Statement:
As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, http://student-rules.tamu.edu, under the section "Scholastic Dishonesty."
Instructor: George Voneiff

Contact Information:
Voneiff: Phone 979-574-7179; Email george.voneiff@tamu.edu

Office: Campus office: 901K Richardson, but I am rarely in this office.

Office Hours: By appointment, Fridays before class is best

Description: Deterministic evaluation techniques for oil & gas properties focusing on economic analyses, reserves classifications and decision making.

Objectives:

Primary Topics:

1) Production Forecasting Using Arps Equations
   a. History match of historic data
   b. Monthly production forecast with forced exponential tail
   c. Difference between nominal and effective decline rates

2) Monthly Cash Flow Economics
   a. Before income tax
   b. Petroleum project economics, both single-well and multi-well onshore development
   c. Specific to US/Canada
   d. Economic Limit
   e. Reversionary interests
   f. Commonly used investment yardsticks (IRR, PV, PWI, Payout, F&D, ROI)
   g. Difference between nominal & effective interest/discount rates.
   h. Purposes for conducting an economic analysis

3) Reserves Estimation & Classification
   a. PRMS reserves framework/classification
   b. General criteria for Proved, Probable, Possible, Contingent (+ nomenclature of 1P, 2P, 3P, etc.)
   c. A&D market & banking perception of value for the various reserves classes
   d. Effective Date
   e. Reserves & reserves value
   f. Purposes for conducting a reserves analysis
4) **How to Present Your Work Product and Conclusions/Recommendations**
   a. Mid-Term & Final are reports generated by each student
   b. Forecast monthly production for individual wells (both existing and undrilled locations)
   c. Both single-well and multi-well projects
   d. Include a drilling recommendation based on economic analysis
   e. Include reserves estimates for whatever reserves classes are appropriate and reserves value
   f. Executive Summary – What to include, how to make it concise and useful
   g. Create a complete report – Another engineer should be able to reproduce all your work with only your report, no conversation needed

**Secondary Topics: (no in-depth analysis)**

1) **After-Tax Economics**
   a. D, D & A
   b. Scheduling of capitalized costs for tax purposes (culminating with MACRS)
   c. Tangible vs intangible capital items

2) **Corporate Finances**
   a. Balance Sheet
   b. P&L/Cash Flow
   c. EBITDA
   d. Cash vs. non-cash items

3) **Commodity Prices**
   a. Historic, futures pricing/market
   b. Hub pricing
   c. Focus is US/Canada

4) **Advanced Decline Curve Analysis**
   a. Beyond using the basic ARP’s equations
   b. Fetkovich
   c. Stretched exponential & Duong models

**Text:** You must purchase the textbook **BEFORE** classes start. The Mian book can be purchased on-line and takes a few days to arrive. Not having the textbook is not an acceptable excuse for incomplete or late homework.

ISBN: 9781593702083

**Class Schedule:** 1:50 – 5:00, Fridays, Richardson 1009

**Prerequisite:** While there is no prerequisite, it is assumed you have a basic understanding of reservoir engineering principles and are proficient with MS Excel. If you are lacking either of these traits, then you may need to supplement this class with reservoir engineering study and/or spreadsheet training.
Basis for grade:

Homework and class discussion ............................................. 20%
Mid Project ........................................................................... 30%
Final Project .......................................................................... 50%

Notes:

1. Homework is due at the start of class and should be turned in electronically. Word documents, Excel spreadsheets and .PDF files are acceptable. Late homework will receive a grade of zero.
2. Mid-Term and Final Projects will be turned in electronically. In-Class students will also turn in a printed version of those projects.
3. Class discussions will include reading assignments and homework. Please come to class prepared to discuss the assigned topics for the day.
4. Assignments and other course materials will be posted on eCampus.

eCampus Account

Because course information will be posted on eCampus regularly, I ask that you please monitor at least once a day. To set up your Vista account for this course, please do the following:

Go to http://ecampus.tamu.edu.
If you have problems, click on the link “Check Browser Support” on the entry page to eCampus
Find the link to Log In. Click the link.
Use your NetID (Neo ID and password) to logon.
Click on the course name.

This should be all you need. If you think you can't get there from here, please contact Mary Lu Epps (marylu.epps@pe.tamu.edu) in the 407 office suite for help.
Academic Integrity Syllabus Statement

"An Aggie does not lie, cheat, or steal or tolerate those who do."

All syllabi shall contain a section that states the Aggie Honor Code and refers the student to the Honor Council Rules and Procedures on the web http://www.tamu.edu/aggiehonor < http://www.tamu.edu/aggiehonor>

It is further recommended that instructors print the following on assignments and examinations:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

________________________________
Signature of student

Americans with Disabilities Act (ADA) Policy Statement

The following ADA Policy Statement (part of the Policy on Individual Disabling Conditions) was submitted to the UCC by the Department of Student Life. The policy statement was forwarded to the Faculty Senate for information.

The Americans with Disabilities Act (ADA) is a federal antidiscrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe that you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room 126 of the Koldus Building, or call 845-1637.
Syllabus

Course Information

Course Number: PETE 665
Course Title: Petroleum Reservoir Engineering
Sections: 600, 700
Time: TR 11:30 AM – 12:45 PM
Location: On-campus students via Zoom, DL students via recorded lectures
Credit Hours: 3

Instructor Details

Instructor: Dr. Jenn-Tai Liang
Office: RICH 401T
Phone: 845-0173
E-Mail: jenn-tai.liang@tamu.edu
Office Hours: R 1:30 PM – 4:30 PM via Zoom by appointment

Course Description

Reservoir description techniques using petrophysical and fluid properties; engineering methods to
determine fluids in place, identify production-drive mechanisms, and forecast reservoir performance;
implementation of pressure-maintenance schemes and secondary recovery

Course Prerequisites

Approval of instructor or graduate classification

Textbook


Grading Policy

The course grade will be based on three mid-term exams and power-point summary for selected textbook
exercises. There will be no final exam. Power-point summary of selected textbook exercises are due one
week after they are assigned. On-campus students will be randomly selected to present in front of the
class.

Mid-term Exams:

- Mid-term Exam I (September 24th) 30%
- Mid-term Exam II (October 22nd) 30%
- Mid-term Exam III (November 19th) 30%
- Power-point Summary for Selected Textbook Exercises 10%
For on-campus students: The mid-term exam problems will be e-mailed to on-campus students at 7 PM on the day of exam, and you have until 9:30 PM to solve the problems, scan and e-mail your solutions back to me. I will look at the time stamp on your e-mail to determine the time you send your solutions to me. No late submission will be accepted. You are expected to work independently on the exam problems. All exams are open-book and open-note.

For DL students: The mid-term exam problems will be available for DL students to download from eCampus from 7 PM College Station time on the date of exam (Thursday) until 11:59 PM Sunday College Station time. Once downloaded, the DL students will have two hours and thirty minutes to complete and finish uploading your answer sheets in one PDF file back on eCampus. You are expected to work independently on the exam problems. All exams are open-book and open-note.

Late Work Policy

You are required to complete your work during the time allotted. Late submission will result in a grade of 0. The three mid-term exams are required. For on-campus students missing an exam, a valid excuse (see Student Rule 7) is required or the grade will be 0. Distance Learning students must submit the mid-term exams by the assigned date and time or the grade will be 0. Distance Learning students, if you have a short-term work assignment that will prevent you from submitting an assignment on time, you must petition well ahead of time to get an exception to this rule. In general, you are given sufficient time to complete all assignments, so this circumstance should be rare.

Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Chapter(s) covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Basic concepts in reservoir engineering &amp; PVT analysis for oil</td>
<td>1-2</td>
</tr>
<tr>
<td>4-5</td>
<td>Oil reservoir material balance; Darcy’s law</td>
<td>3-4</td>
</tr>
<tr>
<td>6-9</td>
<td>Well inflow equations; oil well testing</td>
<td>5-7</td>
</tr>
<tr>
<td>10-12</td>
<td>Gas well testing; Natural water influx</td>
<td>8-9</td>
</tr>
<tr>
<td>13-14</td>
<td>Immiscible displacement</td>
<td></td>
</tr>
</tbody>
</table>

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).
You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to
COVID-19 Response

Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**

- **Face Coverings**—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the **Face Covering policy** and **Frequently Asked Questions (FAQ)** available on the Provost website.

- **Physical Distancing**—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

- **Classroom Ingress/Egress**—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.

- To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the **Student Conduct office** for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

Personal Illness and Quarantine

Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See **Student Rule 7, Section 7.2.2.** To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, for Fall 2020 only, **students may use the Explanatory Statement for Absence**
from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.

**Operational Details for Fall 2020 Courses**

For additional information, please review the [FAQ](#) on Fall 2020 courses at Texas A&M University.
## Pre-Class Reading Assignments

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Date</th>
<th>Day</th>
<th>Topic</th>
<th>Homework Due</th>
<th>Textbooks</th>
<th>Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17-Jan</td>
<td>Friday</td>
<td>Unconventional Resources</td>
<td></td>
<td>Mian 1-55</td>
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<tr>
<td>1</td>
<td>17-Jan</td>
<td>Friday</td>
<td>Statistics/Prob - Basics</td>
<td></td>
<td>Mian 56-99</td>
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<tr>
<td>2</td>
<td>24-Jan</td>
<td>Friday</td>
<td>Statistics/Prob - Uncertainty</td>
<td>HW 1</td>
<td>Mian 99-141</td>
<td>SPE 77422</td>
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<tr>
<td>3</td>
<td>31-Jan</td>
<td>Friday</td>
<td>Statistics/Prob - Distributions</td>
<td>HW 2</td>
<td>SPE 25830, SPE - PRMS</td>
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<tr>
<td>3</td>
<td>31-Jan</td>
<td>Friday</td>
<td>Probabilistic Reserves</td>
<td></td>
<td>Mian 347-375</td>
<td>SPE 23586, 37932</td>
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<tr>
<td>4</td>
<td>7-Feb</td>
<td>Friday</td>
<td>Expected Value &amp; Decision Trees</td>
<td>HW 3</td>
<td>Mian 151-226</td>
<td>Murtha Article, SPE 123384</td>
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<tr>
<td>5</td>
<td>14-Feb</td>
<td>Friday</td>
<td>Utility Theory / Simulation</td>
<td>HW 4</td>
<td>Mian 235-279</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>21-Feb</td>
<td>Friday</td>
<td>Simulation</td>
<td></td>
<td>Mian 311-347</td>
<td>SPE 13776</td>
</tr>
<tr>
<td>6</td>
<td>21-Feb</td>
<td>Friday</td>
<td>Intro To @RISK</td>
<td>HW 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>28-Feb</td>
<td>Friday</td>
<td>Simulation - Correlations</td>
<td>HW 6</td>
<td>Mian 347-375</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>6-Mar</td>
<td>Friday</td>
<td>Volumetrics, DCA &amp; Classification</td>
<td>HW 7</td>
<td></td>
<td>HW7 DCA Data.XLS</td>
</tr>
<tr>
<td>8</td>
<td>6-Mar</td>
<td>Friday</td>
<td>Assign Mid-Term Project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFF</td>
<td>13-Mar</td>
<td>Friday</td>
<td>Spring Break</td>
<td>No Class</td>
<td>SPE 36633, 95974, 104550</td>
<td></td>
</tr>
<tr>
<td>OFF</td>
<td>20-Mar</td>
<td>Friday</td>
<td>Classes Cancelled</td>
<td>No Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>27-Mar</td>
<td>Friday</td>
<td>Prod Forecasts &amp; Scoping Analysis</td>
<td>HW 8</td>
<td>HW8 Correlation Data.XLS</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3-Apr</td>
<td>Friday</td>
<td>Aggregation &amp; Bootstrap</td>
<td>HW 9</td>
<td></td>
<td>SPE 73828, 96879, 96899</td>
</tr>
<tr>
<td>11</td>
<td>10-Apr</td>
<td>Friday</td>
<td>Reading Day - No Class</td>
<td>HW10</td>
<td>HW10 CashFlowCalc.XLS</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>17-Apr</td>
<td>Friday</td>
<td>Value of Information</td>
<td>HW 11</td>
<td>HW10 OGIPCalc.XLS</td>
<td>HW10 EURCalc.XLS</td>
</tr>
<tr>
<td>12</td>
<td>24-Apr</td>
<td>Friday</td>
<td>Field Application Presentation</td>
<td>HW 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFF</td>
<td>28-Apr</td>
<td>Tuesday</td>
<td>No Class - Work on Final Project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-MAY</td>
<td>Friday</td>
<td></td>
<td>Term Project Due</td>
<td>Term Project</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6-May Grades due for degree candidates, 6 PM  
11-May Grades due at noon
Course title and number  PETE 681 Graduate Seminar
Term (e.g., Fall 200X)  Spring 2019
Meeting times and location  Tuesday’s 3:55 – 5:10pm in RICH 101

Course Description and Prerequisites

PETE 681 – Seminar. (Zero Credit Hours) Presentations will include current research in a wide range of fields described by guest lecturers who are prominent in their fields. Discussion period at the end of each lecture will permit the students to learn more about the lecturer and his/her work.

Learning Outcomes

(A learning outcome is defined as a statement of what the student will know or be able to do upon successfully completing the course. It must be both observable and measureable. The outcomes may include competencies developed in the course. Learning outcomes define what students need to do to show mastery of course materials. Additional assistance with learning outcomes is available through the Center for Teaching Excellence http://cte.tamu.edu and the Office of Institutional Assessment https://assessment.tamu.edu/.)

<table>
<thead>
<tr>
<th>Course Learning Outcomes: At the end of the course, students will be able to…</th>
<th>Possible Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expose and Visualize different research visions of petroleum engineering related research problems</td>
<td>1,3,5</td>
</tr>
<tr>
<td>Evaluate the solution methodologies provided by the seminar speakers and integrate those methodologies into their MSc and PHD studies</td>
<td>1,5,11</td>
</tr>
<tr>
<td>Gain presentation skills by observing the presentations of different research areas.</td>
<td>5</td>
</tr>
<tr>
<td>Improve and Update their knowledge according to the current developments in the petroleum engineering fields</td>
<td>5</td>
</tr>
<tr>
<td>Improve their communication skills by interacting with the seminar speakers</td>
<td>1,3,5</td>
</tr>
<tr>
<td>Evaluate and Analyze the Texas A&amp;M resources provided for them throughout their research studies to publish higher quality research</td>
<td>5</td>
</tr>
<tr>
<td>Build networking skills</td>
<td>3,5</td>
</tr>
</tbody>
</table>
Related Program Outcomes:

<table>
<thead>
<tr>
<th>No.</th>
<th>PETE graduates must have…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An ability to apply knowledge of mathematics, science, and engineering.</td>
</tr>
<tr>
<td>3</td>
<td>An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.</td>
</tr>
<tr>
<td>5</td>
<td>An ability to identify, formulate, and solve engineering problems.</td>
</tr>
<tr>
<td>11</td>
<td>An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
</tr>
</tbody>
</table>

Instructor Information

Name: Dr. Kan Wu  
Telephone number: 979-862-7654  
Email address: kan.wu@tamu.edu  
Office hours: Anytime when the door is wide open  
Office location: Richardson 501Q

Course Facilitators: Eleanor Schuler; e-schuler@tamu.edu; 979-845-8402, RICH 401 U & Barbi Miller; barbi.miller@tamu.edu; 979-845-2287, RICH 401W

Textbook and/or Resource Material

Required Textbook: None

Grading Policies

(Must include a grading scale (A=90-100%, B=80-89%, etc.). Include weights as applicable to exams, laboratory assignments, field student work, projects, papers, homework, class attendance and participation, and other graded activities in the calculation of the course grade. If more than 10% of grade is based on participation, syllabus should explicitly define and outline how grade is determined. Stacked courses – syllabus must clearly indicate additional work required for graduate students. Changing grading policies should occur only under extraordinary circumstances.

Your grading is based on your attendance. The passing grade is S (Satisfactory) and non-passing grade is U (Unsatisfactory). There will be 14 classes throughout spring 2020 semester. Students have to attend at least 12 of those classes to earn passing grade. First day of classes is 01/14/2020 and last day of the classes is 04/21/2020. Students must sign the attendance sheets, otherwise, they will be counted as absent. If students miss any classes during withdraw period, those missed classes will be counted as absence.
Attendance and Make-up Policies

(Include website link to student rule 7 http://student-rules.tamu.edu/rule07. Must include attendance and make-up policy, especially if attendance/class participation will count as a grade. Policies should detail excused absences, unexcused absences, and make-up policies. Attendance and make-up policies should not contradict student rules.

**Attendance is mandatory for PETE 681.** Texas A&M views class attendance as an individual student responsibility (http://studentrules.tamu.edu/rule07). Attendance is essential to complete the course successfully. **Excused Absences:** Rules concerning excused absences may be found at http://studentrules.tamu.edu/rule07. Except for absences due to religious obligations, the student must notify her or his instructor in writing (acknowledged e-mail message is acceptable) prior to the date of absence, if such notification is feasible. In cases where advance notification is not feasible (e.g. accident, or emergency), the student must provide notification by the end of the second working day after the absence. This notification should include an explanation of why notice could not be sent prior to the class.

**Excused Absences for Religious Holy Days:** Texas House Bill (effective 9/1/03) states “An institution of higher education shall excuse a student from attending classes or other required activities, including examinations, for the observance of a religious holy day, including travel for that purpose. A student whose absence is excused under this subsection may not be penalized for that absence and shall be allowed to take an examination or complete an assignment from which the student is excused within a reasonable amount of time after the absence.”

Course Topics, Calendar of Activities, Major Assignment Dates

(14 weeks - 15th week is first week of finals. Include lab hours. Must include dates on which major exams will be given and assignments will be due and should not be changed without notification of all students in the course.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/14/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>01/21/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>01/28/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>02/04/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>02/11/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>02/18/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>02/25/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>03/03/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>03/10/20</td>
<td>SPRING BREAK</td>
<td></td>
</tr>
<tr>
<td>03/17/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>03/24/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>03/31/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>04/07/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>04/14/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>04/21/20</td>
<td>Speaker: TBD</td>
<td></td>
</tr>
<tr>
<td>04/28/20</td>
<td>REDIFINED DAY – Students attend Friday classes</td>
<td></td>
</tr>
</tbody>
</table>
**Exams and Assignments:** There will be no exams, but there might be pop quizzes

**Other Pertinent Course Information**

**Classroom Behavior:** Texas A&M University supports the principle of freedom of expression for both instructors and students. The university respects the rights of the instructors to teach and the students to learn. Maintenance of these rights requires classroom conditions that do not impede their exercise. Classroom behavior that seriously interferes with either (1) instructor’s ability to conduct the class or (2) the ability of other students to profit from the instructional program will not be tolerated. An individual engaging in disruptive classroom behavior may be subject to disciplinary action. For additional information please visit [http://student-rules.tamu.edu/rule21](http://student-rules.tamu.edu/rule21).

**Coursework Copyright Statement:** (Texas A&M University Policy Statement) Video recording is not allowed throughout semester. Because these materials are copyrighted, you do not have the right to record them, unless you are expressly granted permission. If you have any questions about plagiarism and/or copying, please consult the latest issue of the Texas A&M University Student Rules, under the section “Scholastic Dishonesty”.

**Americans with Disabilities Act (ADA)**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit [http://disability.tamu.edu](http://disability.tamu.edu).

**Academic Integrity**

*For additional information please visit: [http://aggiehonor.tamu.edu](http://aggiehonor.tamu.edu)*

"An Aggie does not lie, cheat, or steal, or tolerate those who do."
Introduction to nanomechanics and micromechanics, experimental nanomechanical characterization of geomaterials, as well as introduction to fracture mechanics, micromechanics, and poromechanics based on energy principles for modeling porous materials behaviors.

By the end of the course, students will be familiar with experimental characterization of geomaterials, concepts of energy release and fracture energy, toughness and stress intensity factors, saturated and partially saturated microporomechanics of deformable porous materials, Darcy's law, linear micromechanics with application to porous materials, homogenization schemes.

Instructor Information

Name: Sara Abedi
Telephone number: 979.845.2920
Email address: sara.abedi@tamu.edu
Office hours: Rich 401L

Textbook and/or Resource Material

Microporomechanics by Dormieux et al., 2006

Grading Policies

(Must include a grading scale (A=90-100%, B=80-89%, etc.). Include weights as applicable to exams, laboratory assignments, field student work, projects, papers, homework, class attendance and participation, and other graded activities in the calculation of the course grade. If more than 10% of
grade is based on participation, syllabus should explicitly define and outline how grade is determined. Stacked courses – syllabus must clearly indicate additional work required for graduate students. Changing grading policies should occur only under extraordinary circumstances. **THIS INFORMATION HAS BEEN PLACED HERE FOR REFERENCE ONLY. PLEASE REMOVE BEFORE PREPARING SYLLABUS.**

95% term poroject
5% class attendance
A= 90-100%
B=80-89%
C=70-79%
D=60-69%
F=< 59%

**Attendance and Make-up Policies**

(Include website link to student rule 7 [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07). Must include attendance and make-up policy, especially if attendance/class participation will count as a grade. Policies should detail excused absences, unexcused absences, and make-up policies. Attendance and make-up policies should not contradict student rules. **THIS INFORMATION HAS BEEN PLACED HERE FOR REFERENCE ONLY. PLEASE REMOVE BEFORE PREPARING SYLLABUS.**)

**Course Topics, Calendar of Activities, Major Assignment Dates**

(14 weeks - 15th week is first week of finals. Include lab hours. Must include dates on which major exams will be given and assignments will be due and should not be changed without notification of all students in the course. **THIS INFORMATION HAS BEEN PLACED HERE FOR REFERENCE ONLY. PLEASE REMOVE BEFORE PREPARING SYLLABUS.**)

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nano/micro mechanical characterization of geomaterials</td>
<td>Class handouts</td>
</tr>
<tr>
<td>2</td>
<td>Nano/micro mechanical characterization of geomaterials</td>
<td>Class handouts</td>
</tr>
<tr>
<td>3</td>
<td>Nano/micro mechanical characterization of geomaterials</td>
<td>Class handouts</td>
</tr>
<tr>
<td>4</td>
<td>Fracture, Damage, and Energy release</td>
<td>Class handouts</td>
</tr>
<tr>
<td>5</td>
<td>Fracture Modes, Stress Intensity Factors and Toughness</td>
<td>Class handouts</td>
</tr>
<tr>
<td>6</td>
<td>Fracture Modes, Stress Intensity Factors and Toughness</td>
<td>Class handouts</td>
</tr>
<tr>
<td>7</td>
<td>Poromechanics</td>
<td>Microporomechanics by Dormieux et al., 2006</td>
</tr>
<tr>
<td>8</td>
<td>Poromechanics</td>
<td>Microporomechanics by Dormieux et al., 2006</td>
</tr>
<tr>
<td>9</td>
<td>Microporomechanics</td>
<td>Microporomechanics by Dormieux et al., 2006</td>
</tr>
<tr>
<td>10</td>
<td>Microporomechanics</td>
<td>Microporomechanics by Dormieux et al., 2006</td>
</tr>
<tr>
<td>11</td>
<td>Microporomechanics</td>
<td>Microporomechanics by Dormieux et al., 2006</td>
</tr>
<tr>
<td>12</td>
<td>Unsaturated Poromechanics</td>
<td>Microporomechanics by Dormieux et al., 2006</td>
</tr>
<tr>
<td>13</td>
<td>Unsaturated Poromechanics</td>
<td>Microporomechanics by Dormieux et al., 2006</td>
</tr>
</tbody>
</table>
Other Pertinent Course Information

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Academic Integrity
For additional information please visit: http://aggiehonor.tamu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number  PETE 689 – Sp. Tp. Finite element methods for geomechanics
Term (e.g., Fall 200X)  Spring 2019
Meeting times and location  TR

Course Description and Prerequisites
Formulation of linear and non-linear poro-elasticity equations; formulation and practice of the finite element methods in solving geomechanics problems; practice borehole breakout and reservoir compaction problems using a program to be developed by students.

Learning Outcomes
Formulation and practice of linear and non-linear finite element method; practice various non-linear constitutive equations and failure theories in solving geomechanics problems

Prerequisites: Petroleum Engineering Numerical Methods

Instructor Information
Name Nobuo Morita
Telephone number 979-458-3273
Email address Nobuo.morita@tamu.edu
Office hours By appointment
Office location 501 P Richardson Bldg

Textbook and/or Resource Material
A textbook is provided.

Grading Policies
A(80-100), B(70-79), C(60-69), D(50-59), F(below 50)
Class attendance …. 40%
Homework … 40%
Program coding … 20%

Attendance and Make-up Policies
A high score is essential for the final exam if absences are repeated.
Course Topics, Calendar of Activities, Major Assignment Dates

Part 1 Basics of the finite element method
1. Fundamental equations of poro-elasticity and fluid flow through porous media
   (1.1) Force, displacement, stress-strain and displacement-strain relation
   (1.2) Equation of equilibrium and stress strain relation
   (1.3) Fluid flow through porous media
   (1.4) Matrix expression
2. Finite element methods
   (2.1) Discretization using the virtual work principle
   (2.2) Discretization using the minimization of total potential energy
   (2.3) Discretization using the residual method
   (2.4) Discretization of the set of flow equations through porous media using the residual method
3. Finite element method with analytical integration using simple elements
   (3.1) Discretization using 3D tetrahedral elements
   (3.2) Analytical integrations
   (3.3) Assembling the elements
   (3.4) Nodal forces
   (3.5) Body forces
4. Finite element method with isoparametric elements
   (4.1) Isoparametric elements
   (4.2) Brick elements
5. Numerical integration
   (5.1) Gaussian integration
   (5.2) Integration formula for triangle and tetrahedron shape functions
6. Solution of linear simultaneous equations
   (6.1) Matrix transformation for the boundary condition given by local coordinates
   (6.2) Solution of linear simultaneous equations
7. Convergence and error analysis
8. Application of the finite element method to non-linear geological materials
   (8.1) Non-linear problems
   (8.2) Application of the Newton-Raphson method to non-linear problems
   (8.3) Calculation method of $\lambda$ and $D_{cp}$
   (8.4) Implementation
9. Coupling problems for fluid flow through geomechanics structure
   (9.1) Fundamental equation
   (9.2) Discretization using the virtual work principle
   (9.3) Discretization of fluid flow through porous media
   (9.4) Coupling
   (9.5) Apparent elastic moduli with pore fluid
   (9.6) Accelerating the convergence for sequential coupling
   (9.7) Coupling for non-linear problems
   (9.8) Sequential coupling of a geomechanics model and a reservoir without model without modifications of both models

Part 2 Applications of the finite element method
10. Pressure profile around perforations
11. Numerical evaluation of gravel pack damage
12. Realistic on-set of sand-production prediction: numerical approach
13. Sand rate model for gas and light oil
14. Numerical methods for the borehole breakout problems
15. Casing collapse problems for hydrostatic and geotechnical loads
Part 3 Pragraming of the finite element method
Appendix A 2D and 3D finite element code for single phase transient porous fluid flow problems
Appendix B Geo3D code

Other Pertinent Course Information

Computer usage: Require Fortran or C language, or MATELAB (You may call Fortran files as MEX-files from MATELAB)

Americans with Disabilities Act (ADA)
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“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number
PETE 689: Hydrocarbon Phase Behavior in Shale Reservoirs

Term (e.g., Fall 200X)
Summer 2019

Meeting times and location
TR 11:10 am - 1:00 pm, RICH 302

Course Description and Prerequisites
The purpose of this course is to prepare the student to understand the differences between hydrocarbon phase behavior in ultra-tight reservoir formations such as shale and the behavior in conventional reservoirs. The course will include a review of various experimental techniques and simulation approaches to model the phase behavior in shale reservoirs. The relative strength and weakness of each method will be discussed in details.

Prerequisites: graduate classification or instructor approval.

Learning Outcomes
- **Describe** the differences between hydrocarbon phase behavior in shale reservoirs and conventional reservoirs
- **Describe** the effect of altered phase behavior in shale reservoirs on important production factors such as gas-oil-ratio and condensate-gas-ratio
- **Determine** the confinement effect on the hydrocarbon phase behavior in shale reservoirs based on pore size distribution
- **Describe** the state-of-the-art laboratory procedures to measure hydrocarbon phase behavior in nano-scale pores
- **Describe** the state-of-the-art modeling techniques to predict hydrocarbon phase behavior in shale reservoirs

Instructor Information
Name
Hadi Nasrabadi
Telephone number
979-862-6483
Email address
hadi.nasrabadi@tamu.edu
Office hours
TR 10:00-11:00 am
Office location
401Q Richardson Building

Textbook and/or Resource Material
The main source of material for the course will be class notes and related technical papers that will be provided to students. The recorded videos of the lectures will be posted on a shared class site.
Grading Policies

Attendance and Quiz .......................................................... 15%
Homework ............................................................................. 55%
Project ................................................................................. 30%
Total ..................................................................................... 100%

Grading Scale

A .......................................................... 90-100%
B .......................................................... 80-89%
C .......................................................... 70-79%
D .......................................................... 60-69%
F .......................................................... 0-59%

Attendance and Make-up Policies

• Attendance: Texas A&M views class attendance as an individual student responsibility (http://student-rules.tamu.edu/rule07). Attendance in class is essential to complete the course successfully.
• Excused Absences: Rules concerning excused absences may be found at http://student-rules.tamu.edu/rule07. If an illness or other event prevents attendance, the student should notify the instructor before class otherwise it will be considered as unexcused absence.
• Makeup Policy: Work missed due to absences will be excused for only university-approved reasons (see http://studentrules.tamu.edu/rule07). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis.

Course Topics, Calendar of Activities, Major Assignment Dates*

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Introduction and syllabus. Hydrocarbon phase behavior in conventional reservoirs: general definitions, reservoir fluid types, experimental methods</td>
</tr>
<tr>
<td>Week 2</td>
<td>Hydrocarbon Phase Behavior in Conventional Reservoirs: Cubic Equations of State</td>
</tr>
<tr>
<td>Week 3</td>
<td>Shale reservoirs: introduction, pore size distribution, pore materials</td>
</tr>
<tr>
<td>Week 4</td>
<td>Unusual gas-oil-ratio and condensate-gas-ratio trends in shale reservoirs</td>
</tr>
<tr>
<td>Week 5</td>
<td>Confinement effect</td>
</tr>
<tr>
<td>Week 6</td>
<td>Experimental methods: adsorption, NMR spectroscopy</td>
</tr>
<tr>
<td>Week 7</td>
<td>Experimental methods: differential scanning calorimetry, nanofluidic devices</td>
</tr>
<tr>
<td>Week 8</td>
<td>Modeling methods: cubic equation of state + capillary pressure, modified cubic equations of state, non-cubic equations of state, density functional theory, molecular simulation</td>
</tr>
<tr>
<td>Week 9</td>
<td>Possible explanation of the unusual gas-oil-ratio and condensate-gas-ratio trends in shale reservoirs</td>
</tr>
<tr>
<td>Week 10</td>
<td>Fluid Phase Behavior of Gas IOR in Shale Reservoirs</td>
</tr>
</tbody>
</table>

*: The scheduled program is tentative and subject to change

Other Pertinent Course Information

• Homeworks: Homeworks will be assigned to give opportunity to practice and master concepts and calculations needed for the course. Doing them will help you complete the course successfully.
• Grading: Neat, legible, systematic and complete presentation is required in homework assignments and quizzes for full credit. Units (for example, Newton-meters) must be included wherever appropriate for numeric quantities. Work which, while possibly correct, cannot be followed, will be considered incorrect.
• Getting Help: Every effort will be made to help you master the course material. The instructor is available during the office hours shown above. If you are unable to meet with him during these hours, please contact
him by email to find an alternative time. Also note that the instructor does not provide assistance with homework problems, etc. over the telephone.

**Americans with Disabilities Act (ADA)**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit [http://disability.tamu.edu](http://disability.tamu.edu).

**Academic Integrity**

For additional information please visit: [http://aggiehonor.tamu.edu](http://aggiehonor.tamu.edu)

"An Aggie does not lie, cheat, or steal, or tolerate those who do."

**Coursework Copyright Statement: (Texas A&M University Policy Statement)**

The handouts used in this course are copyrighted. The term "handouts" refers to all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, homework problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, **you do not have the right to copy them**, unless you are expressly granted permission.

As commonly defined, plagiarism consists of passing off as one’s own the ideas, words, writing, etc., that belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have any questions about plagiarism and/or copying, please consult the latest issue of the *Texas A&M University Student Rules*, under the section “Scholastic Dishonesty”.
Syllabus

Course Information

Course Number: PETE 689
Course Title: RSRC Resource Shale Petrophysics
Section: 603
Time: Tues & Thurs 2:20 pm – 3:35 pm

Credit Hours: 3

Instructor Details

Instructor: Dr. I. Yucel Akkutlu
Office: RICH 619
Phone: 979-845-4069
E-Mail: akkuttlu@tamu.edu
Office Hours: Tuesday, Wednesday, and Thursday between 1:30 – 2:00 pm

Course Description

Petrophysical properties of resources shale including strength, deformation, fluid flow, thermal and electrical properties as a function of the subsurface temperature, in-situ stress, pore fluid pressure, and chemical environment.

Course Prerequisites

None

Special Course Designation

No Special course designation

Course Learning Outcomes

The following topics will be covered: Pore space properties of rocks, porosity, permeability, Single-phase flow in rocks and Darcy’s equation, Surface tension, interfacial tension and wettability, Capillary pressure, Fluid saturations, Multi-phase flow in rocks and relative permeability, Elastic properties of rocks, rock compressibility, Acoustic properties of rocks, Rock-fluid interactions

Textbook and/or Resource Materials

No textbook needed. A collection of articles will be used throughout the semester.
Grading Policy

(100-90 – A; 89-80 – B; 79-70 – C; 69-60 – D; 59 or lower F)

Homework Assignments: 25%
Term Project: 25%
Midterm Examination: 25%
Final Examination: 25%

Final grade distribution will be based on the curving method but the instructor reserves the right to deviate from this approach at his discretion.

Late Work Policy

- The faculty member may accept late work, but the student must inform the faculty prior to the work due date, explain the reason for the delay and setup a new date.
  When the faculty member accepts late work for evaluation, there is no penalty for late return.

The late work policy should define what constitutes late work (e.g., submitting a deliverable after the established deadline). Work submitted by a student as makeup work for an excused absence is not considered late work and is exempted from the late work policy. (See Student Rule 7.)

Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to unconventional resource. Resource-reservoir duality and the concept of reservoir creation; Shale gas and shale oil reservoir examples from North America</td>
<td>Class Notes</td>
</tr>
<tr>
<td>2</td>
<td>Geological and geochemical considerations for resource shales including depositional environment and petroleum genesis; organic matter content, classification, thermal maturity; kinetics of fluid and pore generation, burial and compaction; kerogen isolation Homework 1</td>
<td>Class notes/Article</td>
</tr>
<tr>
<td>3</td>
<td>Multi-scale pore structure characterization and morphology using scanning and transmission electron microscopy; morphology, genesis and occurrence</td>
<td>Class notes/Article</td>
</tr>
</tbody>
</table>
of nanopores
Homework 2

4 Identification of fluid storage mechanisms; Laboratory methods for porosity estimation and adsorption isotherm; pore compressibility calculations under effective stress; volumetric calculation of shale gas and oil in-place
Homework 3

5 Pore size distribution estimation and characterization using mercury injection porosimetry, nitrogen adsorption porosimetry and NMR; nano-pore confinement effects on fluid properties
Homework 4

6 Single-phase fluid flow and molecular transport calculations; anisotropy in transport properties; low Reynolds number limitations to Darcy law and diffusion effects on transport; laboratory methods for apparent shale permeability estimation; pore-network modeling and REV considerations
Homework 5

7 Single-phase fluid flow in fracture; high Reynolds number limitations to Darcy law and inertial effect on transport; fracture conductivity measurements; effects of stress and proppant embedment on conductivity
Midterm Exam

8 Liquid-gas coexistence and supercritical fluid behavior in nanoporous media; pore pressure anisotropy, IFT and capillary pressure calculations; wettability considerations and fluid phase saturations; saturation measurements using retort and solvent extraction
Homework 6

9 Modeling multi-phase flow in resource shale and its applications to retro-grade condensate and oil reservoirs; key components of multi-phase fracture flow
Homework 7
<table>
<thead>
<tr>
<th>Homework 7</th>
<th>Class Notes/Article</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Elastic properties of resource shales; characteristics of stress-strain diagram for ductile and brittle shales; Griffith’s theory of brittle shale failure; Evolution of fracture network in brittle elastic medium due to fluid generation</td>
</tr>
<tr>
<td>11</td>
<td>Mechanisms of resource shale deformation related to slick-water shale interactions under stress; petrophysical considerations into fluid flow back analysis</td>
</tr>
<tr>
<td>12</td>
<td>Resource shale formation evaluation using logging: gamma ray, resistivity sonic log interpretations; “hot” shale identification; TOC estimation</td>
</tr>
<tr>
<td>13</td>
<td>Project reports due</td>
</tr>
<tr>
<td>14-15</td>
<td>Final exam in December</td>
</tr>
</tbody>
</table>

### University Policies

**Attendance Policy**

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to [Student Rule 7](#) in its entirety for information about excused absences, including definitions, and related documentation and timelines.

**Makeup Work Policy**

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to [Student Rule 7](#) in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor” ([Student Rule 7, Section 7.4.1](#)).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” ([Student Rule 7, Section 7.4.2](#)).
Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

NOTE: Faculty associated with the main campus in College Station should use this Academic Integrity Statement and Policy. Faculty not on the main campus should use the appropriate language and location at their site.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

NOTE: Faculty associated with the main campus in College Station should use this Americans with Disabilities Act Policy statement. Faculty not on the main campus should use the appropriate language and location at their site.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
• The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention—including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

**NOTE:** Faculty associated with the main campus in College Station should use this Title IX and Statement on Limits of Liability. Faculty not on the main campus should use the appropriate language and location at their site.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

**COVID-19 Temporary Amendment to Minimum Syllabus Requirements**

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

**Campus Safety Measures**

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
- **Face Coverings**—Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as
lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the [Face Covering policy](#) and [Frequently Asked Questions (FAQ)](#) available on the [Provost website](#).

- **Physical Distancing**—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- **Classroom Ingress/Egress**—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- **To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the [Student Conduct office](#) for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.**

### Personal Illness and Quarantine

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities.** Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence (See [Student Rule 7, Section 7.2.2.](#)) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, **for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.**
Course title and number  PETE 689 – Physics-based and Data Driven Reduced-Order Modeling in Reservoir Engineering

Term (e.g., Fall 200X)  Spring 2020

Meeting times and location  TBD

Course Description and Prerequisites

This course covers the introduction to surrogate and reduced order modeling to speed up engineering workflows, including, but not limited to, reservoir simulation, production optimization, complex multiphase flow simulation, and other pertinent areas where reduced-order modeling can mitigate many expensive computations. It is intended primarily for graduate students interested in any computational science/engineering application. Model reduction, proxy modeling and surrogate modelling and their variants are becoming an indispensable tool for computational-based design and optimization, statistical analysis, embedded computing, and real-time optimal control. This course will present a survey on physics-based model reduction for large scale dynamical systems and on data-driven modeling based on surrogate and machine learning techniques. The course material described below is complemented by a balanced set of theoretical, algorithmic, and Matlab/Python computer programming homeworks and assignments. Invited lectures from researchers and professionals in model reduction will be given as time permits.

Prerequisites: linear algebra, numerical computation, matrix computation. Basic numerical methods for PDEs and ODEs. Depending on the student’s area, some introductory material in reservoir simulation will be given.

Learning Outcomes

The objectives of the course are for students to:
1. Understand the limitations of current simulation models and why some form of model reduction/approximation is necessary.
2. Develop a basic understanding of current approaches to reduced-order modeling of large-scale systems, and in particular, to problems arising in petroleum engineering.
3. Bridge the gap between theoretical foundations, mathematical modeling, simulation and practical implementations of the algorithms presented in the class to solve real world large-scale problems faced by scientist and petroleum engineers.

Instructor Information

Name  Dr. Eduardo Gildin
Telephone number  (979) 862-4578
Email address  egildin@tamu.edu
Office hours  TBD
Office location  RICH 401J

Textbook and/or Resource Material

The main source of material for the course will be a series of notes and slides handed out to the students ([GIL] notes). Complementary textbooks are:

1. [GIL] Eduardo Gildin. Lecture Notes


**5. [MOR1]** Model Reduction and Approximation: Theory and Algorithms edited by Peter Benner, Albert Cohen, Mario Ohlberger, Karen Willcox. SIAM 2017


**14. [DD_SUR2]** Andy Keane, Prasanth Nair. *Computational Approaches for Aerospace Design: The Pursuit of Excellence*

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**Grading Policies**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90-100%</td>
</tr>
<tr>
<td>B</td>
<td>80-89%</td>
</tr>
<tr>
<td>C</td>
<td>70-79%</td>
</tr>
<tr>
<td>D</td>
<td>60-69%</td>
</tr>
<tr>
<td>F</td>
<td>0-59%</td>
</tr>
</tbody>
</table>

Grading is based on:

- **Homework** ........................................... (50%)
- **Final Project Presentation** ............... (15%)
- **Final Project Report** .................................. (35%)
- **Total** ........................................... (100%)

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**Course Topics, Calendar of Activities, Major Assignment Dates**

**Topics are:**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Suggested Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course Introduction; Large scale dynamical systems and Reservoir Simulation</td>
<td>GIL, PYT1, PY2, MAT1</td>
</tr>
<tr>
<td>2</td>
<td>Python/Matlab for numerical computing and machine learning</td>
<td>PYT1, PY2, MAT1</td>
</tr>
<tr>
<td>3</td>
<td>General Approximation methods and surrogate modeling (kriging, response surface)</td>
<td>DD_SUR1, SS_SUR2, DD_SUR3</td>
</tr>
<tr>
<td>4</td>
<td>Dimensionality reduction (SVD, Fourier, Wavelets, Sparsity)</td>
<td>GIL, MOR1, MOR2</td>
</tr>
<tr>
<td>6-7</td>
<td>Machine Learning/Neural Nets</td>
<td>GIL, MOR6</td>
</tr>
<tr>
<td>7-8</td>
<td>Dynamical Systems. Controllability/Observability</td>
<td>MOR1, MOR2, MOR6</td>
</tr>
<tr>
<td>9-10</td>
<td>Model Reduction Concepts/System Theory – Balanced Truncation</td>
<td>MOR1 through MOR6</td>
</tr>
<tr>
<td>11</td>
<td>Nonlinear MOR – POD-based methods</td>
<td>GIL, MOR1, MOR2</td>
</tr>
</tbody>
</table>
Other Pertinent Course Information

Students may refer to Students Rule 07 for attendance policies: http://student-rules.tamu.edu/rule07.

Americans with Disabilities Act (ADA)

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Academic Integrity

For additional information please visit: http://aggiehonor.tamu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number
PETE 489/689: Petroleum Data Analytics and Machine Learning

Term
Summer 2020

Meeting times and location
WF 2:00 pm to 3:50 pm

Course Description and Prerequisites

This course will provide working knowledge about data analytics suitable for petroleum engineers/geoscientists. Students will assemble data-driven workflows and apply them on various types of the data generated during petroleum engineering operations. Students will get to work on case studies that integrate various domains of petroleum engineering and geoscience. Emphasis will be on the use of supervised learning, classification, clustering, regression, transformations, and neural networks using open-source Python computational platform. The hands-on nature of the course facilitates understanding the basics of machine learning, data science, and data analysis and their applications to petroleum engineering and geoscience.

Prerequisites: PETE 301 or Approval of instructor or Graduate standing

Learning Outcomes

- Students will be able to assemble open-source machine learning and data mining workflows in Python to solve complex data science problems related to petroleum engineering and petroleum geosciences.
- Students will be proficient in exploratory data analysis on datasets containing numerical, time-series, and categorical data generated during petroleum engineering and subsurface characterization operations.
- Students will be skilled in supervised regression using ElasticNet, Support Vector, Nearest Neighbor, Neural Network, and LASSO regressors on petroleum engineering/geoscience datasets.
- Students will be proficient in using Decision Tree, Nearest Neighbor, Random Forest, Gradient Boosting, and Support Vector Machine classification techniques on petroleum engineering/geoscience datasets.
- Students will be proficient in using K-Means, DBSCAN, Hierarchical, Gaussian Mixture, and Self Organizing Map clustering techniques on petroleum engineering/geoscience datasets.
- Students will be able to apply training, testing, cross validation, feature elimination, feature ranking, parameter selection, and anomaly detection on petroleum engineering/geoscience datasets.
- Students will be proficient in working on well logs, hydrocarbon-bearing geological images, sonic waveforms, and production data, to name a few.

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Assignments</td>
<td>25</td>
</tr>
<tr>
<td>Midterm Project</td>
<td>10</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>15</td>
</tr>
<tr>
<td>Final Project</td>
<td>25</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20</td>
</tr>
<tr>
<td>Attendance &amp; Participation</td>
<td>5</td>
</tr>
<tr>
<td>Week</td>
<td>Topic</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>May 27 &amp; 29</td>
<td>Introduction, getting started with python, pandas, scikit-learn, and matplotlib</td>
</tr>
<tr>
<td></td>
<td>Overview of data analytics and machine learning applications in petroleum engineering and geoscience</td>
</tr>
<tr>
<td>June 3 &amp; 5</td>
<td>Basics of statistics and probability used in petroleum engineering and geosciences</td>
</tr>
<tr>
<td></td>
<td>Exploratory data analysis, handling missing data, handling categorical data</td>
</tr>
<tr>
<td></td>
<td>Big-data visualization – Pandas, Matplotlib, dimensionality reduction - PCA and t-SNE</td>
</tr>
<tr>
<td>June 10 &amp; 12</td>
<td><strong>Midterm Project Assigned</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Petroleum Case Study #1</strong>: Importing large petroleum datasets and visualization</td>
</tr>
<tr>
<td></td>
<td>Transformations: standardization, scaling, normalization; dimensionality reduction (PCA, LDA)</td>
</tr>
<tr>
<td></td>
<td>Outlier detection</td>
</tr>
<tr>
<td>June 17 &amp; 19</td>
<td><strong>Petroleum Case Study #2</strong>: Anomaly detection and data quality check</td>
</tr>
<tr>
<td></td>
<td>Feature selection, feature ranking, and feature elimination</td>
</tr>
<tr>
<td></td>
<td>Linear Regression, Lasso, Ridge, Non-parametric regression</td>
</tr>
<tr>
<td></td>
<td>Model evaluation and metrics, cross validation, regularization, and hyperparameter optimization</td>
</tr>
<tr>
<td>June 24 &amp; 26</td>
<td><strong>Petroleum Case Study #3</strong>: Completion optimization</td>
</tr>
<tr>
<td></td>
<td>Scoping and delivering O&amp;G data-analytics projects</td>
</tr>
<tr>
<td></td>
<td><strong>Midterm Project Due; Final Project Assigned</strong></td>
</tr>
<tr>
<td>July 1 &amp; 3</td>
<td><strong>Petroleum Case Study #4</strong>: Estimation of brittleness and permeability;</td>
</tr>
<tr>
<td></td>
<td>Supervised classifier: Logistic regression, decision trees, kNN</td>
</tr>
<tr>
<td></td>
<td>Advanced supervised regressors and classifiers: kernels, ensemble, voting, boosting, bagging, random forests, support vector machine</td>
</tr>
<tr>
<td></td>
<td><strong>Midterm Exam</strong></td>
</tr>
<tr>
<td>July 8 &amp; 10</td>
<td><strong>Petroleum Case Study #5</strong>: Rock facies and sweet spot identification #1</td>
</tr>
<tr>
<td></td>
<td>Advanced supervised regressors and classifiers: artificial neural networks, Bayesian classifiers and regressors</td>
</tr>
<tr>
<td></td>
<td><strong>Petroleum Case Study #6</strong>: Image analysis #1</td>
</tr>
</tbody>
</table>
July 15 & 17  Unsupervised learning: K-means clustering, hierarchical trees, density-based methods, self-organizing maps

July 22  Petroleum Case Study #7: Fracture characterization and acoustic emission analysis

Petroleum Case Study #8: Rock facies and sweet spot identification #2

July 24, 29 & 31  Petroleum Case Study #9: Noise removal and data quality enhancement

Petroleum Case Study #10: Production forecasting

Petroleum Case Study #11: Drilling data analysis

Aug 4  Final Project Due

Final Exam
Course title and number: Application of water-soluble polymers in the oil industry
Term (e.g., Summer 2020): Summer 2020
Meeting times and location: Our building

Course Description and Prerequisites

(Prerequisites, even if none should be given and must match course form and catalog. In addition to material chosen by instructor, the course description should closely follow the catalog description for the course. In some instances, the course description may include a rationale or context for the subject matter within the discipline.

The role of water-soluble polymers in polymer flooding, water shut-off treatments, scale mitigation, drag reduction, preparation of drilling fluids, fracturing fluids, mitigation of fines migration in sandstone and shale reservoirs, and water treatment. Impact of these polymers on various aspects of formation damage will be also addressed.

Learning Outcomes

(A learning outcome is defined as a statement of what the student will know or be able to do upon successfully completing the course. It must be both observable and measureable. The outcomes may include competencies developed in the course. Learning outcomes define what students need to do to show mastery of course materials. Additional assistance with learning outcomes is available through the Center for Teaching Excellence http://cte.tamu.edu and the Office of Institutional Assessment https://assessment.tamu.edu/.)

The student will learn how to characterize various polymers, how to select polymers for various applications and how to assess their side effects.

Instructor Information

Name: Hisham Nasr-El-Din
Telephone number: 979 862 1473
Email address: Hisham.nasreldin@tamu.edu
Office hours: TBD
Office location: 710 Richardson

Textbook and/or Resource Material

Several textbooks will be used, including, but not limited to:

Oil Field Chemicals and Fluids, J. Fink, 2015
Chemistry for Enhancing the Production of Oil and Gas, W. Frenier and M. Ziauddin, 2014
Production Chemicals for the Oil and Gas Industry, M. Kelland, 2009
Technology for Cleaning Industrial Equipment, W. W. Frenier, 2001
Well Treatments and Water Shut-off by Polymer Gels, L.J. Zitha, 2000
Corrosion and Scale Handbook, J.R. Becker, 1998

Grading Policies

(Must include a grading scale (A=90-100%, B=80-89%, etc.). Include weights as applicable to exams, laboratory assignments, field student work, projects, papers, homework, class attendance and
participation, and other graded activities in the calculation of the course grade. If more than 10% of grade is based on participation, syllabus should explicitly define and outline how grade is determined. Stacked courses – syllabus must clearly indicate additional work required for graduate students. Changing grading policies should occur only under extraordinary circumstances.

**Grading Policies**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>(30%)</td>
</tr>
<tr>
<td>Two mid-term exams</td>
<td>(40%)</td>
</tr>
<tr>
<td>Final Exam</td>
<td>(30%)</td>
</tr>
</tbody>
</table>

**Grading Scale**

- A ................................................................. 90-100%
- B ................................................................. 80-89%
- C ................................................................. 70-79%
- D ................................................................. 60-69%
- F ................................................................. 0-59%

(Include website link to student rule 7 [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07). Must include attendance and make-up policy, especially if attendance/class participation will count as a grade. Policies should detail excused absences, unexcused absences, and make-up policies. Attendance and make-up policies should not contradict student rules.

TBD

**Course Topics, Calendar of Activities, Major Assignment Dates**

(14 weeks - 15th week is first week of finals. Include lab hours. Must include dates on which major exams will be given and assignments will be due and should not be changed without notification of all students in the course.

One assignment per week. Two mid exams and a final exam.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Introduction and types of polymers</td>
<td></td>
</tr>
<tr>
<td>3-4</td>
<td>Characterization of polymers</td>
<td></td>
</tr>
<tr>
<td>5-6</td>
<td>Rheology of polymer solutions</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Application in drilling</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Application as clay stabilizers</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Application in acidizing</td>
<td></td>
</tr>
<tr>
<td>10-11</td>
<td>Application in EOR</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Application in drag reduction</td>
<td></td>
</tr>
<tr>
<td>13-14</td>
<td>Application in fracturing</td>
<td></td>
</tr>
</tbody>
</table>
Other Pertinent Course Information

Americans with Disabilities Act (ADA)
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.

Academic Integrity
For additional information please visit: http://aggiehonor.tamu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course title and number: PETE 689- Reservoir Geomechanics
Term (e.g., Fall 200X): Fall 2020
Meeting times and location: TR- 1:30- 2:45

Course Description and Prerequisites

Basic concepts of rock mechanics, state of stress, strain and pore pressure, rock deformation mechanism, strength and failure criteria, wellbore stability, depletion induced deformation, and hydraulic fracturing. This course embraces fields of rock mechanics and petroleum engineering to tackle fundamental geomechanical problems that emerge through the exploitation of oil and gas reservoirs.

Learning Outcomes or Course Objectives

By the end of the course, students will be familiar with necessary fundamentals of reservoir rock properties, structural geology, stress and strain analysis, prediction of pore pressure, determination of rock strength, wellbore failure and wellbore design, static and dynamic laboratory tests, reservoir depletion, and rock fracture analysis.

Instructor Information

Name: Sara Abedi
Telephone number: 979.845.2920
Email address: sara.abedi@tamu.edu
Office hours: TBD
Office location: Rich 401L

Textbook and/or Resource Material


Grading Policies

Grading is based on

- Quizzes: 20% (We will have a quiz every other week on Thursdays starting from the second week of the semester)
- Project: 20%
- Midterm Examination: 30% (10/8/2020)
- Final Examination: 30% (12/8/2020)

Grading Scale

*Standard Letter Grading Scale:*
A = 90-100%
B = 80-89%
C = 70-79%
D = 60-69%
F = <60%

Attendance / Make-up Work Policies

Absences: Work missed due to absences will be excused for only University-approved reasons in accordance with Texas A&M University Student Rules (see http://student-rules.tamu.edu/rule07). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis, in accordance with Student Rule 7. In accordance with Rule 7, any "personal injury or illness that is too severe or contagious for the student to attend class" will require “a medical confirmation note from the student’s medical provider” regardless of the length of the absence (see 7.3.2.1).

Course Topics, Calendar of Activities, Major Assignment Dates

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Required Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to reservoir rock properties, rock mass structure, discontinuities</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>2</td>
<td>Stress and strain tensors, rock deformation, pore pressure</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>3</td>
<td>Stress and strain tensors, rock deformation, pore pressure</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>4</td>
<td>Constitutive laws</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>5</td>
<td>Determination of rock strength; static &amp; dynamic laboratory tests</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>6</td>
<td>Determination of rock strength; static &amp; dynamic laboratory tests</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>7</td>
<td>Rock failure and Wellbore stability</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>8</td>
<td>Rock failure and Wellbore stability</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>9</td>
<td>Depletion induced deformation</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>10</td>
<td>Depletion induced deformation and induced seismicity</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>11</td>
<td>Induced seismicity</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>12</td>
<td>Fracture Modes, Stress Intensity, Factors and Toughness</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>13</td>
<td>Fracture Modes, Stress Intensity, Factors and Toughness</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
<tr>
<td>14</td>
<td>Hydraulic Fracturing</td>
<td>Class slides, notes, Jaeger and Zoback book</td>
</tr>
</tbody>
</table>

Americans with Disabilities Act (ADA)

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit http://disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Academic Integrity
For additional information please visit: http://aggiehonor.tamu.edu

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
Course Objectives: This course focuses on (1) coupling between flow and geomechanics for poromechanics problems, (2) computational methods and code development, (3) numerical stability of sequential methods, (4) hydraulic fracturing, and (5) fault activation. The seed codes will be given to the students.

Prerequisite(s): Reservoir simulation, geomechanics or applied mathematics courses recommended.

Instructor: Dr. Jihoon Kim, Assistant Professor
501L Richardson, 845-2205, jihoon.kim@tamu.edu
Office hours: TBD
Class hours: MW 10:45 am-12:00 pm

References:
Course slides will be provided. Recommended references are as follows.

Lecture Topics Covered:
1. Introduction to coupled flow and geomechanics
2. Fundamentals of poromechanics
   a. Governing equations
   b. Constitutive relations
3. Numerical simulation for single phase flow
   a. Finite volume method
   b. 1D & 2D flow
4. Numerical simulation in geomechanics
   a. Finite element methods
   b. 1D & 2D geomechanics
5. Coupling between flow and geomechanics by using sequential methods
   a. Solution strategies
   b. Stability analysis
   c. Coupled simulation
6. Hydraulic fracturing
   a. Fundamental concepts
   b. Analytical solution: KGD and PKN fractures
   c. 1D numerical simulation by using the coupled codes
d. Discussion about current simulation methods

7. Fault activation
   a. Basics of fault activation
   b. Extended Finite element method
   c. Constrained geomechanics
   d. Fault slip & Induced seismicity

Grading Policies

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>40%</td>
</tr>
<tr>
<td>Midterm</td>
<td>20%</td>
</tr>
<tr>
<td>Final Examination</td>
<td>40%</td>
</tr>
<tr>
<td>Participation &amp; Professionalism</td>
<td>Pass or Fail</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

- **Examinations Absences:** Make-up for major examinations will be given for university-excused absences only.

Grading Scale

- A = 90-100%
- B = 80-89%
- C = 70-79%
- D = 60-69%
- F = <60%

Attendance / Make-up Work Policies

- **Attendance:** Attendance and active participation in class is expected. Students should read assigned reference material in advance and be prepared for class discussions. Please turn off and stow cell phones while class is in session.
- **Absences:** Work missed due to absences will be excused for only University-approved reasons in accordance with Texas A&M University Student Rules (see [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07)). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis. In accordance with recent changes to Rule 7, please be aware that in this class any “injury or illness that is serious enough for a student to be absent from class” will require “a medical confirmation note from his or her medical provider” even if the absence is for less than three days (see 7.1.6.2 Injury or illness less than three days).

Course Topics, Calendar of Activities, Major Assignment Dates

Tentative Course Schedule
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>DOW</th>
<th>Topics</th>
<th>Homework</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8/19/2020</td>
<td>Wed</td>
<td>Course Introduction</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8/24/2020</td>
<td>Mon</td>
<td>Basic concepts, Governing equations</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8/26/2020</td>
<td>Wed</td>
<td>Numerical discretization (Flow-FVM) 1D</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>8/31/2020</td>
<td>Mon</td>
<td>Numerical discretization (Flow-FVM) 2D</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9/2/2020</td>
<td>Wed</td>
<td>Numerical discretization (Flow-FVM) 2D</td>
<td>Hw1: Test of 2D FVM flow</td>
</tr>
<tr>
<td>6</td>
<td>9/7/2020</td>
<td>Mon</td>
<td>Pore-volume coupling</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>9/9/2020</td>
<td>Wed</td>
<td>Coupled system</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>9/14/2020</td>
<td>Mon</td>
<td>Numerical discretization (Geomechanics-1D FEM)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9/16/2020</td>
<td>Wed</td>
<td>Numerical discretization (Geomechanics-1D FEM)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>9/21/2020</td>
<td>Mon</td>
<td>Coupled system (Residual form)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>9/23/2020</td>
<td>Wed</td>
<td>Numerical discretization (Geomechanics-2D FEM)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>9/28/2020</td>
<td>Mon</td>
<td>Numerical discretization (Geomechanics-2D FEM)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>9/30/2020</td>
<td>Wed</td>
<td>Numerical discretization (Geomechanics-2D FEM)</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>9/5/2020</td>
<td>Mon</td>
<td>Solution strategies</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>9/7/2020</td>
<td>Wed</td>
<td>Stability in time</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>9/9/2020</td>
<td>Mon</td>
<td>Mixed finite element method (FVM-FEM)</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>9/14/2020</td>
<td>Wed</td>
<td>Midterm (No class), Take-home exam</td>
<td>Midterm: 2D coupling</td>
</tr>
<tr>
<td>18</td>
<td>9/19/2020</td>
<td>Mon</td>
<td>Basics of hydraulic fracturing (HF)</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>9/21/2020</td>
<td>Wed</td>
<td>Derivation of analytical solution (KGD &amp; PKN)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>9/26/2020</td>
<td>Mon</td>
<td>1D planar fracture numerical simulation</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>9/28/2020</td>
<td>Wed</td>
<td>1D planar fracture numerical simulation</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>10/2/2020</td>
<td>Mon</td>
<td>HF simulation methods in reservoir simulation</td>
<td>Hw3: 1D planar fracture</td>
</tr>
<tr>
<td>23</td>
<td>10/4/2020</td>
<td>Wed</td>
<td>Background of fault activation</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>10/9/2020</td>
<td>Mon</td>
<td>Constrained geomechanics, formulation</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>10/11/2020</td>
<td>Wed</td>
<td>Extended FEM (XFEM)</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>10/16/2020</td>
<td>Mon</td>
<td>Extended FEM (XFEM)</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>10/18/2020</td>
<td>Wed</td>
<td>Fault activation numerical simulation</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>10/23/2020</td>
<td>Mon</td>
<td>Revisit to HF simulation methods</td>
<td>Hw4: Constrained geomechanics, XFEM</td>
</tr>
<tr>
<td>29</td>
<td>10/25/2020</td>
<td>Wed</td>
<td>Reading day (no class)</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>11/3/2020</td>
<td>Mon</td>
<td>Reading day (no class)</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>11/4/2020</td>
<td>Wed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>12/7/2020</td>
<td>Mon</td>
<td>Final, Take-home exam</td>
<td>Final: TBD</td>
</tr>
</tbody>
</table>

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"An Aggie does not lie, cheat, or steal, or tolerate those who do."
Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- **Self-monitoring**—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**

- **Face Coverings**—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.

- **Physical Distancing**—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

- **Classroom Ingress/Egress**—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.

- To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

**Personal Illness and Quarantine**

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities.** Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student’s medical provider is preferred, **for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.**

**Operational Details for Fall 2020 Courses**

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.
College and Department Policies

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.
Course Information

Course Number: PETE 489 or PETE 689
Course Title: Unconventional Reservoir Methods and Analysis
Section: Fall 2020
Time: Friday 9:20am – 12:10pm
Location: Richardson 208
Credit Hours: Three (3)

Instructor Details

Instructor: William D. Von Gonten, Jr. “Bill”
Office: Richardson 901L
Phone: 713-224-6333 (ask for Leslie Davis – Executive Assistant)
E-Mail: bill@wdvgco.com
Office Hours: Friday, 8:00 – 9:00am

Course Description

This course will cover unconventional reservoirs and the latest practices of reservoir characterization, horizontal drilling and completion optimization methodologies, reservoir engineering and production analysis techniques.

Course Prerequisites

None

Course Learning Outcomes

Course objective is to provide students a practical understanding of unconventional reservoirs and the current methodologies to evaluate and exploit these complex systems. The course provides a general overview of major unconventional basins including latest activity trends then will focus on current and innovative approaches being implemented within the following technical domains: reservoir characterization, targeting pay zones with horizontal drilling, the role of geomechanics, hydraulic fracturing and completion optimization methods. In addition, production performance and analysis techniques will be reviewed accompanied by the present-day usage of data analytics. Development challenges and industry trends will conclude the course. Thus, the course is designed to provide a realistic view of current practices, innovative approaches of targeting and optimization, and then conclude with an overview of development challenges and overall industry trends.

Textbook and/or Resource Materials

No textbook required. Course materials will be provided.
Grading Policy

Grading is based on
Homework ........................................................................... (50%)
Mid-Term ............................................................................ (25%)
Final Exam ........................................................................... (25%)
Total.................................................................................. (100%)

Homework Assignments: 50%
Midterm Examination: 25% (October 2)
Final Examination: 25% (November 20)

Grading Scale - Standard Letter Grading Scale:
A = 90-100
B = 80-89
C = 70-79
D = 60-69
F = <60

Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21-Aug</td>
<td>Introduction to Unconventional Reservoirs</td>
</tr>
<tr>
<td>2</td>
<td>28-Aug</td>
<td>Reservoir Characterization Part 1</td>
</tr>
<tr>
<td>3</td>
<td>4-Sep</td>
<td>Reservoir Characterization Part 2</td>
</tr>
<tr>
<td>4</td>
<td>11-Sep</td>
<td>Drilling Methodologies &amp; Trends</td>
</tr>
<tr>
<td>5</td>
<td>18-Sep</td>
<td>Rock Mechanics Introduction</td>
</tr>
<tr>
<td>6</td>
<td>25-Sep</td>
<td>Horizontal Completion Introduction</td>
</tr>
<tr>
<td>7</td>
<td>2-Oct</td>
<td>Mid-Term</td>
</tr>
<tr>
<td>8</td>
<td>9-Oct</td>
<td>Hydraulic Fracture Modeling</td>
</tr>
<tr>
<td>9</td>
<td>16-Oct</td>
<td>Hydraulic Fracture Modeling Diagnostics</td>
</tr>
<tr>
<td>10</td>
<td>23-Oct</td>
<td>Well Production Performance Trends</td>
</tr>
<tr>
<td>11</td>
<td>30-Oct</td>
<td>Well Production Performance Trends</td>
</tr>
<tr>
<td>12</td>
<td>6-Nov</td>
<td>Acreage Development</td>
</tr>
<tr>
<td>13</td>
<td>13-Nov</td>
<td>Industry Trends and Challenges in Unconventional Development</td>
</tr>
<tr>
<td>14</td>
<td>20-Nov</td>
<td>Final Exam</td>
</tr>
</tbody>
</table>
University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student’s grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor” (Student Rule 7, Section 7.4.1).

“The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence” (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

“An Aggie does not lie, cheat or steal, or tolerate those who do.”

“Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one’s work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case” (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.
Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.
COVID-19 Temporary Amendment to Minimum Syllabus Requirements

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university’s COVID-19 response.

Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- Self-monitoring—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**

- Face Coverings—**Face coverings** (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.

- Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.

- Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.

- To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day’s class remotely for all students.

Personal Illness and Quarantine

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities.** Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence (See **Student Rule 7, Section 7.2.2.**) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While **Student Rule 7, Section 7.3.2.1,** indicates a medical confirmation note from the student’s medical
provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.

Operational Details for Fall 2020 Courses

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.

College and Department Policies

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.
Appendix C

Graduate Program Forms
PhD Qualifying Examination
Petroleum Engineering – Texas A&M University

The purpose of the PhD Qualifying Examination is to ensure that doctoral candidates in the Department of Petroleum Engineering can demonstrate proficiency in the primary areas of petroleum engineering (drilling, production, and reservoir). As policy, all doctoral students admitted to the Department of Petroleum Engineering are required to take the PhD Qualifying Examination at the conclusion of their first semester. A Master of Science student in the Department of Petroleum Engineering (with a GPA of 3.5 or better) who has not been admitted to the PhD program can petition to take the PhD Qualifying Examination after completing two long semesters. The petition must be approved by their advisor and the graduate advisor. For a MS student, passing the PhD Qualifying Examination does not guarantee admission to the PhD program. The student will still have to file a letter of intent, be reviewed by the Graduate Committee and be officially admitted.

Format of Examination and Timing:

The Qualifying Examination consists of three written exams, in the areas of Reservoir Engineering, Production Engineering, and Drilling Engineering. The written exams will be offered twice in an academic year, in January and May. A PhD student who has been admitted in a fall semester takes the exam in January, and a student admitted in spring takes the exam in May. The written exams are closed book (i.e., no materials are permitted in the examination). The exams will be on two consecutive days for the three subjects, and each subject exam is 2 hours.

Exam Preparation:

The suggested books to study to prepare for the examination are:


If additional preparation is desired, candidates are encouraged to take the courses PETE 661 for Drilling, PETE 662 for Production, and PETE 665 for Reservoir. However, taking these courses and completing them successfully are neither required for the written exams, nor guaranteed for passing written exams.
**Administration of the Examination:**

All new PhD students will be assigned a QE registration number. The candidates will use the registration number throughout the exam. The candidate must not write his/her name on any exam-related papers.

**Exam Outcomes:**

The results of the Qualifying Examination will be reported back from the Examination Committee to the Graduate Advisor and announced before the beginning of the following semester. The candidate’s continuation in the program will be based on the following rules:

- **Pass:** A student receiving a pass in all three subject areas may continue in the doctoral program. If the student is serving as a GAR or GAT they may have their stipend increased to the PhD level with approval of their supervisor.

- **Conditional Pass:** A student receiving a conditional pass in any of the three subject areas must take a course in the subject area in the following Spring or Fall semester and receive a grade of A or B. Upon successful completion of the course, the student will be issued a pass for that subject area. A course used for the conditional pass cannot be used for graduate degree-plan credits. A grade of C or below will be considered a failure for the subject area.

- **Failure:** A student failing any of the three subject areas will be allowed a second attempt in the failed subject area(s) when the next Qualifying Examination is offered. If a student fails any subject area after the second attempt, he/she will be dismissed from the PhD program. No-shows for the exam will be treated as a failure.

**The exam schedule for January 2021 is set as follows:**

- **Monday, January 11th, 2021:** 9:00-11:00am – Reservoir
- **Monday, January 11th, 2021:** 2:00-4:00pm – Drilling
- **Tuesday, January 12th, 2021:** 9:00am-11:00am – Production

*Revised August 2020*
Petroleum Engineering Annual PhD Student Review System

Summary:

- Reviewing graduate students progress once, a year provides an opportunity to assess performance and clarify expectations.

- Annual assessment of student progress includes goal setting, identifying milestones for the coming year.

- Requires students to prepare a progress report each year.

- Annual review can function as an early warning system. It encourages the student and faculty to identify issues early on and provides an opportunity for students to share any underlying personal problems that may be affecting their research/course work.

- Provides the student with a written version of the review that indicates progress to date and clearly sets out expectations for the coming year. Student's value knowing more than just their grades.

- Provides the student the ability to discuss any critique in a constructive fashion.
Annual PhD Students Review System Procedure

1. Department graduate office completes the student information portion.
2. Student completes his/her portion by attaching a CV / One-page progress / PowerPoint.
3. Student's PhD committee members review the documents and provide some feedback to the committee chair, who summarizes the review and then gives to the student.
4. Department graduate office will complete ALL PhD student annual reviews by May 31st of each year.
 Annual PhD Student Progress Form

Student Name: ___________________ ID Number: ___________________
Email Address: ___________________ Phone: _______________________
Date of First Enrollment in the PhD Program (semester/year) ____________
Expected Graduation / Completion Date (semester/year) _______________
Graduate Credit Hours completed during PhD study at Texas A&M: _____ GPA: _____
Name of your Advisor: ____________________________________________

Qualifying Exam
Date Taken _______________ Passed ___ Failed ___ (First try)
Date Taken _______________ Passed ___ Failed ___ (Second try if necessary)
Dissertation/Advisory Committee Formed ___________________ (date)
Members: ___________________________________, Chair
__________________________________________________________
__________________________________________________________
__________________________________________________________
__________________________________________________________

Dissertation Proposal Title:______________________________________

Oral Prelim Exam
Date Taken _______________ Passed ___ Failed ___ (First try)

Advanced to Candidacy (Date) ___________________________________
(To be completed by the student)

Main Area of Research / Interest: _____________________________

Progress Summary
Please write a short summary of your progress in the PhD Program over the past 12 months. Include accomplishments such as papers submitted or accepted, conferences attended, honors and awards, or any other significant event. You should also mention any problems in making progress on your degree that we should be aware of.

Support
How are you currently supporting yourself while working on your PhD?

_____ Teaching Assistantship in (Department) _______________________

_____ Research Assistantship with (Faculty member) _______________________

_____ Other job for the University _____________________________

_____ Job Outside the University _____________________________

_____ Other _____________________________
(To be completed by Advisor of the student’s dissertation committee)

<table>
<thead>
<tr>
<th>Item</th>
<th>Satisfactory</th>
<th>Needs Improvement</th>
<th>Unsatisfactory</th>
<th>Comments</th>
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<td>Develops a clear research plans, conduct valid, data-supported,</td>
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<td>theoretically consistent, and institutionally appropriate research</td>
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<td>and effectively disseminate the results of the research in</td>
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<td>appropriate venues to a range of audiences</td>
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<td>Applies a variety of strategies and tools. Uses a variety of</td>
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<td>sources and evaluate multiple points of view to analyze and</td>
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<td>integrate information and put forth critical, reasoned arguments.</td>
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<td>Applies subject matter knowledge to solve problems and make</td>
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<td>decisions.</td>
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<td>Develops a coherent understanding of the subject matter through</td>
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<td>synthesis across courses and experiences</td>
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<td>Communicates effectively.</td>
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<td>Uses appropriate technologies to communicate, collaborate, conduct</td>
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<tr>
<td>research and solve problems.</td>
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<td>Chooses ethical courses of action in research and practice.</td>
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(Advisor name / signature / date)
Plan to Pursue Graduate Studies in Petroleum Engineering?

With Fast Track, you begin taking graduate courses at the start of your junior year, which speeds up the process of earning a master's degree in petroleum engineering from the Harold Vance Department of Petroleum Engineering at Texas A&M University.

How Fast Track Works

Our department has streamlined its program for Fast Track participants by substituting specific graduate courses for selected undergraduate course offerings. You will take 600-level courses starting your junior year, earning graduate credit while fulfilling undergraduate requirements through “credit-by-exam.”

Advantages

- Participate earlier in graduate studies
- Identify research opportunities in your chosen discipline sooner
- Receive dual credits for B.S. and M.S./M.E. degrees on up to four courses

Requirements

- Apply to Fast Track during the last semester of your sophomore year
- Obtain approval from your undergraduate advisor
- Take the GRE before the start of your senior year
- Begin research your senior year and continue through your graduate year
- Maintain a cumulative GPA of 3.5 or above during your sophomore year
- Apply with EngineeringCAS for admission to the graduate program
- Take no more than two graduate courses per semester in your junior and senior year

Hours Needed

Estimated time required to receive a master's degree after completing the bachelor's portion:

- M.E. - nine months or two semesters
- M.S. - one year, depending on thesis completion

Note: Texas A&M has a residency requirement of nine hours for an M.S. degree. There is no residency requirement for an M.E. degree.

Need more information?
Set up an appointment with our undergraduate program director:
Catherine Silva  |  cathy.silva@tamu.edu
PETE GRADUATE STUDENT EVALUATION

Student Name: ____________________________________________  Faculty Name: ________________________________

Degree: MEng (Online)________  Committee Role: Chair___ Co-chair___ Member___ External___

1. How well does the student meet your expectations in the following areas?

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<thead>
<tr>
<th></th>
<th>Above Expectations</th>
<th>Meets Expectations</th>
<th>Below Expectations</th>
<th>Not Observable</th>
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<tbody>
<tr>
<td>A</td>
<td>Exhibits a coherent understanding of discipline-specific knowledge, including concepts, principles, and the theories</td>
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<tr>
<td>B</td>
<td>Applies discipline-specific knowledge to solve problems, make decisions</td>
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<td>E</td>
<td>For IPM certificate students: Ability to communicate ideas, constraints, problems, and potential solutions related with current issues in international petroleum management.</td>
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2. How well does the student meet your expectations in the following areas?

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<tr>
<td>I</td>
<td>Understands responsibility</td>
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</table>

3. If this is MS student, would you recommend the student go on to a Ph.D. program?  Yes___ No___

General Comments and Evaluation Process: At the time of the project defense, faculty members of the student’s graduate committee will use this form to evaluate how well the student meets the expectations listed above. The Department Graduate Committee will tabulate/discuss the results to measure the effectiveness of the MEN program.
# PETE GRADUATE STUDENT EVALUATION

**Student Name:**

**Degree:** MS  MEng

**Faculty Name:**

**Committee Role:** Chair  Co-chair  Member  External

1. How well does the student meet your expectations in the following areas?

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2. How well does the MS student meet your expectations in the following areas?

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</table>

3. If this is MS student, would you recommend the student go on to a Ph.D. program?  

   Yes  No

**General Comments and Evaluation Process:** At the time of the thesis defense, faculty members of the student’s graduate committee will use this form to evaluate how well the student meets the expectations listed above. The Department Graduate Committee will tabulate/discuss the results to measure the effectiveness of the master’s program.
# PETE GRADUATE STUDENT EVALUATION

**Student Name:**

**Faculty Name:**

**Degree:** PhD

**Committee Role:** Chair ___ Co-chair ___ Member ___ External ___

1. **How well does the student meet your expectations in the following areas?**

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2. **How well does the PhD student meet your expectations in the following areas?**

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<td>Understands responsibility</td>
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</table>

1. If this is a PhD student, would you recommend the student go on to a post-doc or faculty position? **Yes** ___ **No** ___

**General Comments and Evaluation Process:** At the time of the dissertation defense, faculty members of the student’s graduate committee will use this form to evaluate how well the student meets the expectations listed above. The Department Graduate Committee will tabulate/discuss the results to measure the effectiveness of the PHD program.
Appendix D

Institutional Profile
November 18, 2019

TO: External Program Reviewers and Program Accreditors

FROM: Michael T. Stephenson
Vice Provost for Academic Affairs & Strategic Initiatives

RE: Information required for USDOE Accrediting Bodies

Texas A&M University is accredited by the Southern Association of Colleges and Schools Commission on Colleges to award baccalaureate, master's, and doctoral degrees. Consistent with standard 14.4, the following provides the institution’s official position on its purpose, governance, programs, degrees, diplomas, certificates, personnel, finances, and constituencies and is published in official university documents as noted.

Purpose

 Classified by the Carnegie Foundation as a Research Doctoral University (Highest Research Activity), Texas A&M embraces its mission of the advancement of knowledge and human achievement in all its dimensions. The research mission is a key to advancing economic development in both public and private sectors. Integration of research with teaching prepares students to compete in a knowledge-based society and to continue developing their own creativity, learning, and skills beyond graduation.

The institution’s official mission statement, published both on the institution’s web page as well as in its annual university catalog, is:

Texas A&M University (Texas A&M) is dedicated to the discovery, development, communication and application of knowledge in a wide range of academic and professional fields. Its mission of providing the highest quality undergraduate and graduate programs is inseparable from its mission of developing new understandings through research and creativity. It prepares students to assume roles in leadership, responsibility and service to society. Texas A&M assumes as its historic trust the maintenance of freedom of inquiry and an intellectual environment nurturing the human mind and spirit. It welcomes and seeks to serve persons of all racial, ethnic and geographic groups, women and men alike, as it addresses the needs of an increasingly diverse population and a global economy. In the twenty-first century, Texas A&M University seeks to assume a place of preeminence among public universities while respecting its history and traditions.

Governance

The governance of the institution was described in the 2012 certification of compliance submitted to SACSCOC.
Texas A&M University at College Station, the flagship institution of the Texas A&M University System, has branch campuses located in Galveston, Texas and Doha, Qatar. A ten-member Board of Regents, appointed by the Governor, directs the Texas A&M University System. The appointment of each Regent follows Texas Education Code (TEC, Chapter 85, Section 21).

TEC outlines the duties and responsibilities of the Board of Regents. These responsibilities are also defined in System Policy 02.01 Board of Regents and TEC 51.352. The Board elects two officers: Chair and Vice Chair. There are four standing committees: Audit, Academic & Student Affairs, Finance, and Buildings & Physical Plant. Special committees may be appointed by the Chair with Board approval.

At Texas A&M University the President is the chief executive officer; the President is not the presiding officer of the Board of Regents. The President reports to the state-appointed Board of Regents through the Chancellor of the Texas A&M University System. System Policy 2.05 Presidents of System Member Universities defines the duties of the President. The appointment of the President follows conditions set forth in System Policy 01.03 Appointing Power and Terms and Conditions of Employment, section 2.2.

**Personnel**

The institution is led by the President and members of his cabinet:

- Michael K. Young, President
- Carol A. Fierke, Provost and Executive Vice President, Chief Academic Officer
- Jerry R. Strawser, Executive Vice President and Chief Financial Officer
- Michael Benedik, Vice Provost and Chief International Officer
- Michael T. Stephenson, Vice Provost for Academic Affairs & Strategic Initiatives
- M. Dee Childs, Vice President for Information Technology and CIO
- Michael G. O’Quinn, Vice President for Government Relations & Strategic Initiatives
- Col. Michael E. Fossum, Chief Operating Officer, TAMU-Galveston
- Jeff Risinger, Vice President for HR & Organizational Effectiveness
- Robin Means Coleman, Vice President and Associate Provost for Diversity
- Mark Barteau, Vice President for Research
- Greg Hartman, Vice Chancellor for Strategic Initiatives, TAMU & Interim Senior Vice President, TAMU-HSC
- Daniel J. Pugh, Sr., Vice President for Student Affairs
- Joseph P. Pettibon, II, Vice President for Enrollment and Academic Services
- Gen Joe E. Ramirez, Jr., Commandant, Corps of Cadets
- Amy B. Smith, Senior Vice President and Chief Marketing and Communications Officer
- Ross Bjork, Athletics Director
- Jonathan Bowling, Sr. Associate Athletics Director, Athletics Compliance
- Shane Hinckley, Vice President for Brand Development
- Andrew P. Morris, VP of Entrepreneurship & Economic Development, Dean of the I-School
- C.J. Woods, Associate Vice President and Chief of Staff
- Kevin McGinnis, Chief Compliance Officer

**Programs, Degrees, Diplomas, and Certificates**

See the appended Degrees and Programs Offered tables.

**Finances**

See the 2019 SACSCOC Financial Profile and Indicators
INSTITUTIONAL SUMMARY FORM
PREPARED FOR COMMISSION REVIEWS

GENERAL INFORMATION

Name of Institution  Texas A&M University

Name, Title, Phone number, and email address of Accreditation Liaison
Michael T. Stephenson
Vice Provost for Academic Affairs and Strategic Initiatives, and SACSCOC Accreditation Liaison
979.845.4016
mstephenson@tamu.edu

Name, Title, Phone number, and email address of Technical Support person for the Compliance Certification
Alicia M. Dorsey
Assistant Provost for Institutional Effectiveness
979.862.2918
amdorsey@tamu.edu

IMPORTANT:

Accreditation Activity (check one):

x  Submitted at the time of Reaffirmation Orientation
☐  Submitted with Compliance Certification for Reaffirmation
☐  Submitted with Materials for an On-Site Reaffirmation Review
☐  Submitted with Compliance Certification for Fifth-Year Interim Report
☐  Submitted with Compliance Certification for Initial Candidacy/Accreditation Review
☐  Submitted with Merger/Consolidations/Acquisitions
☐  Submitted with Application for Level Change

Submission date of this completed document:  November 13, 2019
EDUCATIONAL PROGRAMS

1. Level of offerings (Check all that apply)

   X Diploma or certificate program(s) requiring less than one year beyond Grade 12
   X Diploma or certificate program(s) of at least two but fewer than four years of work beyond Grade 12
   ☐ Associate degree program(s) requiring a minimum of 60 semester hours or the equivalent designed for transfer to a baccalaureate institution
   ☐ Associate degree program(s) requiring a minimum of 60 semester hours or the equivalent not designed for transfer
   X Four or five-year baccalaureate degree program(s) requiring a minimum of 120 semester hours or the equivalent
   X Professional degree program(s)
   X Master's degree program(s)
   ☐ Work beyond the master's level but not at the doctoral level (such as Specialist in Education)
   X Doctoral degree program(s)
   ☐ Other (Specify)

2. Types of Undergraduate Programs (Check all that apply)

   ☐ Occupational certificate or diploma program(s)
   ☐ Occupational degree program(s)
   ☐ Two-year programs designed for transfer to a baccalaureate institution
   X Liberal Arts and General
   X Teacher Preparatory
   X Professional
   ☐ Other (Specify)

GOVERNANCE CONTROL

Check the appropriate governance control for the institution:

☐ Private (check one)
   ☐ Independent, not-for-profit
   Name of corporation OR
   Name of religious affiliation and control:
   ☐ Independent, for-profit *
   If publicly traded, name of parent company:

X Public state * (check one)
   ☐ Not part of a state system, institution has own independent board
   X Part of a state system, system board serves as governing board
   ☐ Part of a state system, system board is super governing board, local governing board has delegated authority
   ☐ Part of a state system, institution has own independent board

* If an institution is part of a state system or a corporate structure, a description of the system operation must be submitted as part of the Compliance Certification for the decennial review. See Commission policy “Reaffirmation of Accreditation and Subsequent Reports” for additional direction.
INSTITUTIONAL INFORMATION FOR REVIEWERS

Directions:

Please address the following and attach the information to this form.

1. History and Characteristics

Provide a brief history of the institution, a description of its current mission, an indication of its geographic service area, and a description of the composition of the student population. Include a description of any unusual or distinctive features of the institution and a description of the admissions policies (open, selective, etc.). If appropriate, indicate those institutions that are considered peers. Please limit this section to one-half page.

History. Texas A&M University (TAMU) opened in 1876 as the state's first public institution of higher education. TAMU is one of a select few institutions in the nation to hold land grant, sea grant (1971) and space grant (1989) designations. A mandatory military component was a part of the land grant designation until 1965; currently, it is one of only three institutions with a full-time Corps of Cadets, leading to commissions in all branches of service. TAMU has two branch campuses, one in Galveston, Texas, (established in 1962, officially merged with TAMU in 1991) and one in Doha, Qatar (established in 2003) and 16 approved off-campus instructional locations. In 2013, the Texas A&M University System Health Science Center merged with TAMU. This same year, TAMU acquired the School of Law from Texas Wesleyan University. Finally, TAMU is classified by the Carnegie Foundation as a Research University (very high research activity).

Mission. Texas A&M University is dedicated to the discovery, development, communication, and application of knowledge in a wide range of academic and professional fields. Its mission of providing the highest quality undergraduate and graduate programs is inseparable from its mission of developing new understandings through research and creativity. It prepares students to assume roles in leadership, responsibility and service to society. Texas A&M assumes as its historic trust the maintenance of freedom of inquiry and an intellectual environment nurturing the human mind and spirit. It welcomes and seeks to serve persons of all racial, ethnic and geographic groups as it addresses the needs of an increasingly diverse population and a global economy. In the 21st century, Texas A&M University seeks to assume a place of preeminence among public universities while respecting its history and traditions.

Enrollment Profile. Fall 2018 total enrollment was 69,367 students (across all campuses and locations), with 64,126 (92.4%) located on the main campus in College Station. Undergraduate enrollment made up 78.3% of the total student body, with Hispanic, Black, and American Indian students making up 24.9% of the total student body. TAMU Galveston enrolled 1,815 students as of Fall, 2018, with TAMU Qatar enrolling 549 students.

Admissions Process. Automatic admission is available in two ways: (1) for Texas resident applicants in the top 10% of their high school graduating class; and, (2) for applicants who rank in the top 25% of their high school graduating class and achieve a combined SAT math and SAT critical reading score of at least 1300, with a test score of at least 600 in each component or 30 composite on the ACT with a 27 in the math and English components. The review of all other applicants is based on academic potential, distinguishing characteristics, exceptional circumstances, and personal achievements.

Peer Institutions. Georgia Institution of Technology; The Ohio State University; Pennsylvania State University; Purdue University; University of California at Berkeley, Davis, Los Angeles, and San Diego; University of Florida; University of Illinois at Urbana-Champaign; University of Michigan; University of Minnesota; University of North Carolina at Chapel Hill; University of Texas at Austin; and University of Wisconsin – Madison.

2. List of Degrees

List all degrees currently offered (A. S., B.A., B.S., M.A., Ph.D., for examples) and the majors or concentrations within those degrees, as well as all certificates and diplomas. For each credential offered, indicate the number of graduates in the academic year previous to submitting this report. Indicate term dates.

Does the institution offer any credit, non-credit, or pathways English as a Second Language (ESL) programs? If yes, list the programs.
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<td>VETERINARY MEDICINE &amp; BIOMEDICAL SCIENCES</td>
<td>VETERINARY PUBLIC HEALTH - EPIDEMIOLOGY</td>
<td>MS</td>
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*Major dependent certificates
### 3. Off-Campus Instructional Locations and Branch Campuses

List all approved off-campus instructional locations where 25% or more credit hours toward a degree, diploma, or certificate can be obtained primarily through traditional classroom instruction. Report those locations in accord with the Commission’s definitions and the directions as specified below.

*Table 1: Off-campus instructional sites*—a site located geographically apart from the main campus at which the institution offers *50% or more* of its credit hours for a diploma, certificate, or degree. This includes high schools where courses are offered as part of dual enrollment. For each site, provide the information below. The list should include only those sites reported to and approved by SACSCOC. Listing unapproved sites below does not constitute reporting them to SACSCOC. In such cases when an institution has initiated an off-campus instructional site as described above without prior approval by SACSCOC, a prospectus for approval should be submitted immediately to SACSCOC.

<table>
<thead>
<tr>
<th>Name of Site</th>
<th>Physical Address (street, city, state, country)</th>
<th>Date Approved by SACSCOC</th>
<th>Date Implemented by the institution</th>
<th>Educational programs offered (specific degrees, certificates, diplomas) with 50% or more credits hours offered at each site</th>
<th>Is the site currently active? (At any time during the past 5 years, have students been enrolled and courses offered? If not, indicate the date of most recent activity.)</th>
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<tbody>
<tr>
<td>Texas A&amp;M Health Science Center</td>
<td>8441 State Highway 47 Clinical Building 1, Suite 3100 Bryan, TX 77807</td>
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<td>2000</td>
<td>MEDICAL SCIENCES MS&lt;br&gt;MEDICAL SCIENCES PHD&lt;br&gt;MEDICINE MD&lt;br&gt;NURSING BSN</td>
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<tr>
<td>Baylor University Medical Center</td>
<td>3500 Gaston Avenue, Dallas, TX 75246</td>
<td>2012</td>
<td>2011</td>
<td>MEDICINE MD</td>
<td>Yes</td>
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<tr>
<td>College of Dentistry</td>
<td>3302 Gaston Ave, Dallas, TX 75246</td>
<td>2001</td>
<td>2000</td>
<td>ADVANCED EDUCATION IN GENERAL DENTISTRY CERT-G&lt;br&gt;DENTAL HYGIENE BS&lt;br&gt;DENTAL PUBLIC HEALTH CERT-G&lt;br&gt;DENTISTRY DDS&lt;br-ENDODONTICS CERT-G&lt;br&gt;ORAL AND MAXILLOFACIAL SURGERY CERT-G&lt;br&gt;ORAL AND MAXILLOFACIAL PATHOLOGY CERT-G&lt;br&gt;ORAL AND MAXILLOFACIAL RADIOLOGY CERT-G&lt;br&gt;ORAL BIOLOGY MS&lt;br&gt;ORAL BIOLOGY PHD&lt;br&gt;ORTHODONTICS CERT-G&lt;br&gt;PEDiatric DENTISTRY CERT-G&lt;br&gt;PERIODONTICS CERT-G&lt;br&gt;PROSTHODONTICS CERT-G</td>
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<td>Institution</td>
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<td>End Year</td>
<td>Programs Offered</td>
<td>Degree</td>
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<td>Texas A&amp;M University School of Law</td>
<td>1515 Commerce St Fort Worth, TX 76102</td>
<td>2013</td>
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<td>HEALTH CARE LAW</td>
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<td>City Centre</td>
<td>800 West Sam Houston Parkway North, Suite 200 Houston, TX 77024-3920</td>
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<tr>
<td>Houston Methodist Hospital</td>
<td>6670 Bertner Avenue, R2-216 Houston, TX 77030</td>
<td>2015</td>
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<td>MEDICINE</td>
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<td>Institute of Biosciences and Technology</td>
<td>2121 W. Holcombe Blvd. Houston, TX 77030</td>
<td>2000</td>
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<td>Rangel College of Pharmacy</td>
<td>1010 W. Avenue B. Kingsville, TX 78363</td>
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<td>PHARMACY</td>
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<td>Lawrence Livermore National Laboratory</td>
<td>7000 East Avenue Livermore, CA 94550</td>
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<td>CERT-G</td>
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<td>Sandia National Laboratories, California</td>
<td>7011 East Avenue Livermore, CA 94550</td>
<td>2018</td>
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<td>Sandia National Laboratories, New Mexico</td>
<td>1515 Eubank S.E. Albuquerque, NM 87123</td>
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<td>School of Public Health - McAllen Teaching Site</td>
<td>2101 South McColl Road McAllen, TX 78503</td>
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<td>HEALTH PROMOTION AND COMMUNITY HEALTH SCIENCES</td>
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<td>Texas A&amp;M Higher Education Center at McAllen</td>
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<td>Clinical Learning Resource Center</td>
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<td>Name of Site</td>
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<td>Date of SACSCOC letter accepting notification</td>
<td>Date Implemented by the institution</td>
<td>Educational programs offered (specific degrees, certificates, diplomas) with 25-49% credit hours offered at each site</td>
<td>Is the site currently active? (At any time during the past 5 years, have students been enrolled and courses offered? If not, indicate the date of most recent activity.)</td>
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<td>Travis Park Plaza</td>
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**Table 2: Off-campus instructional sites** at which the institution offers 25-49% of its credit hours for a diploma, certificate, or degree—including high schools where courses are offered as dual enrollment. *Note: institutions are required to notify SACSCOC in advance of initiating coursework at the site.* For each site, provide the information below.

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<th>Date Approved by SACSCOC</th>
<th>Date Implemented by the institution</th>
<th>Educational programs offered (specific degrees, certificates, diplomas) with 50% or more credits hours offered at the branch campus</th>
<th>Is the campus currently active? (At any time during the past 5 years, have students been enrolled and courses offered? If not, indicate the date of most recent activity.)</th>
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### Credit Bearing Degree Programs

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<th>Synchronous, Asynchronous, or Both</th>
<th>Site</th>
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<td>Advance International Affairs</td>
<td>CERT-G</td>
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<tr>
<td>Aerospace Engineering</td>
<td>MENGGR</td>
<td>Asynchronous</td>
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<tr>
<td>Agricultural Development</td>
<td>MAGR</td>
<td>Asynchronous</td>
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<tr>
<td>Agricultural Education</td>
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<td>Agricultural Systems Management</td>
<td>MS</td>
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<td>Agriculture eLearning Development</td>
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<tr>
<td>Analytics</td>
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<td>Synchronous</td>
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<td>Applied Behavior Analysis</td>
<td>CERT-G</td>
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<td>Applied Statistics</td>
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<td>Bilingual Education</td>
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<td>Bilingual Education</td>
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<td>Asynchronous</td>
</tr>
<tr>
<td>Biological &amp; Agricultural Engineering</td>
<td>MENGGR</td>
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<tr>
<td>Computer Engineering</td>
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<td>Curriculum &amp; Instruction</td>
<td>EDD</td>
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<td>Curriculum &amp; Instruction</td>
<td>MED</td>
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<td>Education for Health Care Professionals</td>
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<td>Education for Health Care Professionals</td>
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<td>Educational Human Resource Development</td>
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</table>

### 4. Distance and Correspondence Education

Provide an initial date of approval for your institution to offer distance education. Provide a list of credit-bearing educational programs (degrees, certificates, and diplomas) where 50% or more of the credit hours are delivered through distance education modes. For each educational program, indicate whether the program is delivered using synchronous or asynchronous technology, or both. For each educational program that uses distance education technology to deliver the program at a specific site (e.g., a synchronous program using interactive videoconferencing), indicate the program offered at each location where students receive the transmitted program. Please limit this description to one page, if possible.
<table>
<thead>
<tr>
<th>Program</th>
<th>Degree</th>
<th>Delivery Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Technology</td>
<td>MED</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>MENGR</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Energy</td>
<td>CERT-G</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Energy</td>
<td>MS</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Engineering</td>
<td>MENGR</td>
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</tr>
<tr>
<td>Engineering Systems Management</td>
<td>MS</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Epidemiology</td>
<td>MPH</td>
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</tr>
<tr>
<td>Extension Education</td>
<td>CERT-G</td>
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<tr>
<td>Family Nurse Practitioner</td>
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<td>Asynchronous</td>
</tr>
<tr>
<td>Forensic Healthcare</td>
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</tr>
<tr>
<td>Forensic Nursing</td>
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<td>Asynchronous</td>
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<tr>
<td>Geoscience</td>
<td>MGS</td>
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<tr>
<td>Health Coaching for Chronic Disease Prevention and Management</td>
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<tr>
<td>Health Education</td>
<td>MS</td>
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<tr>
<td>Hispanic Bilingual Education</td>
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<td>Homeland Security Certificate</td>
<td>CERT-G</td>
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<td>Hospitality Management</td>
<td>CERT-U</td>
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<tr>
<td>Industrial Data Analytics</td>
<td>CERT-G</td>
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<td>Industrial Distribution</td>
<td>MID</td>
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<tr>
<td>Industrial Engineering</td>
<td>MENGR</td>
<td>Asynchronous</td>
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<tr>
<td>International Agriculture &amp; Resource Management</td>
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<tr>
<td>Jurisprudence</td>
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<td>Laws</td>
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<tr>
<td>Mathematics</td>
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<td>Mechanical Engineering</td>
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<td>Medical Science</td>
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<tr>
<td>Medical Science</td>
<td>PHD</td>
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<tr>
<td>Military Land Sustainability</td>
<td>CERT-G</td>
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</tr>
<tr>
<td>National Security Affairs</td>
<td>CERT-G</td>
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<tr>
<td>Natural Resources Development</td>
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<tr>
<td>Non-Profit Management</td>
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<tr>
<td>Nuclear Security</td>
<td>CERT-G</td>
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<tr>
<td>Nursing</td>
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<td>Nursing Education</td>
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<td>Petroleum Engineering</td>
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<td>Asynchronous</td>
</tr>
<tr>
<td>Plant Breeding</td>
<td>MS</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Program</td>
<td>Degree</td>
<td>Format</td>
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<tr>
<td>---------------------------------------------</td>
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</tr>
<tr>
<td>Plant Breeding</td>
<td>PHD</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Poultry Science</td>
<td>MAGR</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Public Health</td>
<td>CERT-G</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Public Management</td>
<td>CERT-G</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Public Service &amp; Administration</td>
<td>MPSA</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Recreation &amp; Resources Development</td>
<td>MRRD</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Regulatory Science in Food Systems</td>
<td>CERT-G</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Safety Engineering</td>
<td>CERT-G</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Safety Engineering</td>
<td>MS</td>
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<tr>
<td>Science, Technology, Engineering and Mathematics Education</td>
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<td>Special Education</td>
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<tr>
<td>Special Education</td>
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<td>Asynchronous</td>
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<tr>
<td>Sport Management</td>
<td>MS</td>
<td>Asynchronous</td>
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<tr>
<td>Statistics</td>
<td>MS</td>
<td>Asynchronous</td>
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<tr>
<td>Technical Management</td>
<td>METM</td>
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<tr>
<td>Tourism Management*</td>
<td>CERT-UG</td>
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</tr>
<tr>
<td>Wildlife Science</td>
<td>MWSC</td>
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</tbody>
</table>

*Major dependent certificates

5. Accreditation

(1) List all agencies that currently accredit the institution and any of its programs and indicate the date of the last review by each.

<table>
<thead>
<tr>
<th>Accrediting Agency</th>
<th>Program</th>
<th>Last Reviewed</th>
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<tbody>
<tr>
<td>Accreditation Council for Pharmacy Education</td>
<td>Irma Lerma Rangel College of Pharmacy</td>
<td>April 2014</td>
</tr>
<tr>
<td>American Bar Association</td>
<td>Texas A&amp;M University School of Law</td>
<td>October 2016</td>
</tr>
<tr>
<td>American Chemical Society</td>
<td>Chemistry</td>
<td>May 2013</td>
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<tr>
<td>American Council for Construction Education</td>
<td>Construction Management</td>
<td>October 2017</td>
</tr>
<tr>
<td>American Psychological Association</td>
<td>Construction Science</td>
<td>October 2017</td>
</tr>
<tr>
<td>American Psychological Association</td>
<td>Clinical Psychology</td>
<td>May 2015</td>
</tr>
<tr>
<td>American Psychological Association</td>
<td>Counseling Psychology</td>
<td>May 2015</td>
</tr>
<tr>
<td>American Psychological Association</td>
<td>School Psychology</td>
<td>October 2017</td>
</tr>
<tr>
<td>American Society of Agricultural and Biological Engineers</td>
<td>Agricultural Systems Management</td>
<td>September 2015</td>
</tr>
<tr>
<td>American Veterinary Medical Association Council on Education</td>
<td>Veterinary Medicine</td>
<td>December 2015</td>
</tr>
<tr>
<td>Association to Advance Collegiate Schools of Business</td>
<td>The business baccalaureate, master’s, and doctoral programs in Mays Business School</td>
<td>January 2017</td>
</tr>
<tr>
<td>Commission on Accreditation for Dietetics Education</td>
<td>Didactic Program in Dietetics</td>
<td>January 2015</td>
</tr>
<tr>
<td>Commission on Accreditation of Athletic Training Education</td>
<td>Athletic Training</td>
<td>April 2018</td>
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<tr>
<td>Commission on Accreditation of Healthcare Management Education</td>
<td>The Master of Health Administration</td>
<td>November 2019</td>
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<tr>
<td>Commission on Collegiate Nursing Education</td>
<td>Nursing – Baccalaureate&lt;br&gt;Nursing – Master’s</td>
<td>March 2014&lt;br&gt;February 2015</td>
</tr>
<tr>
<td>Commission on Dental Accreditation</td>
<td>Dental Public Health&lt;br&gt;Oral &amp; Maxillofacial Surgery&lt;br&gt;Oral &amp; Maxillofacial Radiology&lt;br&gt;Dental Hygiene Predoctoral Dental Education&lt;br&gt;Advanced Clinical Certificates:&lt;br&gt;• Advanced Education in General Dentistry&lt;br&gt;• Endodontics&lt;br&gt;• Oral Maxillofacial Pathology&lt;br&gt;• Orthodontics &amp; Dentofacial Orthopedics&lt;br&gt;• Pediatric Dentistry&lt;br&gt;• Periodontics&lt;br&gt;• Prosthodontics</td>
<td>October 2016&lt;br&gt;September 2019&lt;br&gt;March 2017&lt;br&gt;October 2018</td>
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<tr>
<td>Computing Accreditation Commission of ABET</td>
<td>Computer Science</td>
<td>August 2017</td>
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<tr>
<td>Council on Education for Public Health</td>
<td>School of Public Health</td>
<td>October 2018</td>
</tr>
<tr>
<td>Engineering Accreditation Commission of ABET</td>
<td>College Station Undergraduate Programs in:&lt;br&gt;• Aerospace Engineering&lt;br&gt;• Agricultural Engineering&lt;br&gt;• Bioengineering&lt;br&gt;• Biological &amp; Agricultural Engineering&lt;br&gt;• Biological Systems Engineering&lt;br&gt;• Biomedical Engineering&lt;br&gt;• Chemical Engineering&lt;br&gt;• Civil Engineering&lt;br&gt;• Computer Engineering&lt;br&gt;• Electrical Engineering&lt;br&gt;• Industrial Engineering&lt;br&gt;• Mechanical Engineering&lt;br&gt;• Nuclear Engineering&lt;br&gt;• Ocean Engineering&lt;br&gt;• Petroleum Engineering&lt;br&gt;• Radiological Health Engineering&lt;br&gt;TAMU at Qatar Undergraduate Programs in:&lt;br&gt;• Chemical Engineering&lt;br&gt;• Electrical Engineering&lt;br&gt;• Mechanical Engineering&lt;br&gt;• Petroleum Engineering&lt;br&gt;TAMU at Galveston Undergraduate Programs in:&lt;br&gt;• Marine Engineering&lt;br&gt;• Maritime Systems Engineering&lt;br&gt;• Offshore and Coastal Systems Engineering</td>
<td>September 2016&lt;br&gt;October 2014&lt;br&gt;October 2016</td>
</tr>
<tr>
<td>Accrediting Body</td>
<td>Program</td>
<td>Date</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Engineering Technology Accreditation Commission of ABET</td>
<td>College Station Undergraduate Programs in:</td>
<td>October 2013</td>
</tr>
<tr>
<td></td>
<td>• Electronic Systems Engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Electronic(s) Engineering Technology</td>
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<tr>
<td></td>
<td>• Manufacturing &amp; Mechanical Engineering Technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Manufacturing Engineering Technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Mechanical Engineering Technology</td>
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<tr>
<td></td>
<td>• Telecommunications Engineering Technology</td>
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<tr>
<td></td>
<td>Galveston Undergraduate Programs in:</td>
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<tr>
<td></td>
<td>• Marine Engineering Technology</td>
<td></td>
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<tr>
<td>Forensic Science Education Programs Accreditation Commission (FEPAC)</td>
<td>Forensics &amp; Investigative Sciences Program</td>
<td>September 2016</td>
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<tr>
<td>Institute of Food Technologists</td>
<td>Food Science &amp; Technology</td>
<td>December 2016</td>
</tr>
<tr>
<td>Landscape Architectural Accreditation Board</td>
<td>Bachelor – Landscape Architecture</td>
<td>February 2015</td>
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<td></td>
<td>Master – Landscape Architecture</td>
<td>September 2017</td>
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<tr>
<td>Liaison Committee on Medical Education</td>
<td>Medical Education Degree Program</td>
<td>August 2012</td>
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<tr>
<td>National Architectural Accrediting Board</td>
<td>Architecture</td>
<td>March 2017</td>
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<tr>
<td>Network of Schools of Public Policy, Affairs, and Administration</td>
<td>The Master of Public Service and Administration degree in the Bush School of Government and Public Service</td>
<td>April 2014</td>
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<tr>
<td>National Recreation and Park Association</td>
<td>Recreation, Park and Tourism Sciences</td>
<td>January 2016</td>
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<tr>
<td>Planning Accreditation Board</td>
<td>Urban and Regional Planning</td>
<td>March 2013</td>
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<tr>
<td>Society for Range Management</td>
<td>Rangeland Ecology and Management</td>
<td>April 2017</td>
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<tr>
<td>Society of American Foresters</td>
<td>Forestry</td>
<td>March 2013</td>
</tr>
<tr>
<td>Texas Education Agency</td>
<td>Programs in professional education</td>
<td>March 2011</td>
</tr>
</tbody>
</table>

(2) If SACS Commission on Colleges is not your primary accreditor for access to USDOE Title IV funding, identify which accrediting agency serves that purpose.

Not applicable.

(3) List any USDOE-recognized agency (national and programmatic) that has terminated the institution’s accreditation (include the date, reason, and copy of the letter of termination) or list any agency from which the institution has voluntarily withdrawn (include copy of letter to agency from institution).

1. COMMISSION ON ENGLISH LANGUAGE PROGRAM ACCREDITATION (CEA) – The English Language Institute at Texas A&M University voluntarily withdrew from CEA. The English Language Institute was accredited in good standing through August, 2018, at the time of the voluntary withdrawal (with no history of adverse action). The university made the decision to close the English Language Institute as an administrative unit on May 31, 2017. Please see attached correspondence.
(4) Describe any sanctions applied or negative actions taken by any USDOE-recognized accrediting agency (national, programmatic, SACSCOC) during the two years previous to the submission of this report. Include a copy of the letter from the USDOE-recognized agency to the institution.

None.

6. **Relationship to the U.S. Department of Education**

Indicate any limitations, suspensions, or termination by the U.S. Department of Education in regard to student financial aid or other financial aid programs during the previous three years. Report if on reimbursement or any other exceptional status in regard to federal or state financial aid.

None.

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**Document History**

- Adopted: September 2004
- Revised: March 2011
- Revised: January 2014
- Revised: January 2018
2019 SACSCOC Financial Profile and Indicators

Institution Name Address: Texas A&M University, College Station, TX

Thank you for completing the 2019 Financial Profile and Indicators:

The Profile was submitted by Michael T. Stephenson on 7/8/2019 and approved by Michael K. Young on 7/12/2019.

### FINAL SUBMISSION

<table>
<thead>
<tr>
<th>Fields:</th>
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<td>Instruction:</td>
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<td>Total Liabilities (add Deferred Inflows):</td>
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<td>Long-term Debt:</td>
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