PETE - PETROLEUM ENGINEERING

PETE 602 Well Stimulation

Credits 3. 3 Lecture Hours. Design and analysis of well stimulation methods, including acidizing and hydraulic fracturing; causes and solutions to low well productivity.

PETE 603 Advanced Reservoir Engineering I

Credits 3. 3 Lecture Hours. Petroleum reservoir simulation basics including solution techniques for explicit problems.

PETE 605 Phase Behavior of Petroleum Reservoir Fluids

Credits 3. 3 Lecture Hours. Pressure, volume, temperature, composition relationships of petroleum reservoir fluids.

PETE 606 EOR Methods--Thermal

Credits 3. 3 Lecture Hours. Fundamentals of enhanced oil recovery (EOR) methods and applications of thermal recovery methods. **Prerequisite:** PETE 323.

PETE 608 Well Logging Methods

Credits 3. 3 Lecture Hours. Well logging methods for determining nature and fluid content of formations penetrated by drilling; development of computer models for log analysis.

PETE 609 Enhanced Oil Recovery Processes

Credits 3. 3 Lecture Hours. 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. **Prerequisite:** PETE 323.

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.

PETE 612 Unconventional Oil and Gas Reservoirs

Credits 3. 3 Lecture Hours. As conventional oil and gas resources are depleted, unconventional resources, including heavy oil and gas from low-permeability sandstones, fractured shales, coal bed, 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. **Prerequisite:** Graduate classification in petroleum engineering, geology or geophysics.

PETE 613 Natural Gas Engineering

Credits 3. 3 Lecture Hours. Flow of natural gas in reservoirs and in wellbores and gathering systems; deliverability testing; production forecasting and decline curves; flow measurement and compressor sizing. **Prerequisites:** PETE 323 and PETE 324.

PETE 614 Master Graduate Student Paper Contest

Credits 0. 0 Lecture Hours. No Credit. Presentation of a technical petroleum engineering topic judged by petroleum professionals at the master graduate level department student paper contest. **Prerequisite:** Master level graduate classification.

PETE 615 Doctoral Student Paper Contest

Credits 0. 0 Lecture Hours. No Credit. Presentation of a technical petroleum engineering topic judged by petroleum professionals at the PhD graduate level department student paper contest. **Prerequisite:** PhD graduate classification.

PETE 616 Engineering Near-Critical Reservoirs

Credits 3. 3 Lecture Hours. 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. **Prerequisites:** PETE 323, PETE 400, PETE 401.

PETE 617 Petroleum Reservoir Management

Credits 3. 3 Lecture Hours. The principles of reservoir management and application to specific reservoirs based on case studies presented in the petroleum literature.

PETE 618 Modern Petroleum Production

Credits 3. 3 Lecture Hours. An advanced treatment of modern petroleum production engineering encompassing well deliverability from vertical, horizontal and multilateral/multibranch wells; diagnosis of well performance includes elements of well testing and production logging; in this course the function of the production engineer is envisioned in the context of well design, stimulation and artificial lift.

PETE 620 Fluid Flow in Petroleum Reservoirs

Credits 3. 3 Lecture Hours. Analysis of fluid flow in bounded and unbounded reservoirs, wellbore storage, phase redistribution, finite and infinite conductivity fractures; dual-porosity systems. **Prerequisite:** PETE 323.

PETE 621 Petroleum Development Strategy

Credits 3. 3 Lecture Hours. 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; both commercial and student-prepared computer software used during the lab sessions to practice methods.

PETE 622 Exploration and Production Evaluation

Credits 3. 3 Lecture Hours. 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.

PETE 623 Waterflooding

Credits 3. 3 Lecture Hours. Design, surveillance and project management of waterfloods in reservoirs. **Prerequisite:** PETE 323.

PETE 624 Rock Mechanic Aspects of Petroleum Reservoir Response

Credits 3. 3 Lecture Hours. Reservoir rocks and their physical behavior; porous media and fracture flow models; influence of rock deformability, stress, fluid pressure and temperature. **Prerequisite:** PETE 604.

PETE 625 Well Control

Credits 3. 3 Lecture Hours. 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 simulators. **Prerequisites:** PETE 411.

PETE 626 Offshore Drilling

Credits 3. 3 Lecture Hours. Offshore drilling from fixed and floating drilling structures; directional drilling including horizontal drilling; theory of deviation monitoring and control. **Prerequisite:** PETE 411.

PETE 627 Well Completion and Workover

Credits 3. 3 Lecture Hours. Development of design options, systems and procedures to meet deliverability, safety and integrity requirements for completions and workover equipment; overview of methods in the oil and gas industry; function and design criteria of well components. **Prerequisite:** Graduate classification.

PETE 628 Horizontal Drilling

Credits 3. 3 Lecture Hours. Changing a wellbore from vertical to horizontal; long- and short-radius horizontal wells; bottomhole assemblies for achieving and maintaining control of inclination and direction; drilling fluids; torque and drag calculations; transport of drilled solids. **Prerequisite:** PETE 411 or approval of instructor.

PETE 629 Advanced Hydraulic Fracturing

Credits 3. 3 Lecture Hours. Physical principles and engineering methods involved in hydraulic fracturing; an advanced treatise integrating the necessary fundamentals from elasticity theory, fracture mechanics and fluid mechanics to understand designs, optimization and evaluate hydraulic fracturing treatments including special topics such as high permeability fracturing and deviated well fracturing.

PETE 630 Geostatistics and Data Analytics

Credits 3. 3 Lecture Hours. 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 include: data partitioning (classification), data correlation (parametric, non-parametric regression), variograms and spatial data analysis, kriging and cokriging, conditional simulation, non-Gaussian approaches (indicator methods, simulated annealing, genetic algorithms) and data driven methods (RF, SVM and GBM). **Prerequisite:** Introductory course in statistics or approval of instructor.

PETE 633 Data Integration for Petroleum Reservoirs

Credits 3. 3 Lecture Hours. Introduction and application of techniques that can be used to incorporate dynamic reservoir behavior into stochastic reservoir characterizations; dynamic data in the form of pressure transient tests, tracer tests, multiphase production histories or interpreted 4-D seismic information. **Prerequisites:** PETE 620; STAT 601.

PETE 635 Underbalanced and Managed Pressure Drilling

Credits 3. 3 Lecture Hours. Introduction and application of techniques utilized in underbalanced and managed pressure drilling; includes equipment, types of drilling fluids used (air, mist foam, etc.), flow drilling, mud cap drilling and hydraulics calculations. **Prerequisite:** Graduate classification.

PETE 636 Horizontal, Multilateral and Intelligent Wells

Credits 3. 3 Lecture Hours. Advanced well architectures, primarily horizontal, multilateral and intelligent wells, all aspects of these types of wells, including well completions, reservoir flow, and wellbore flow conditions, and well deliverability; optimization of well design and field applications will be demonstrated with field cases. **Prerequisites:** PETE 662; graduate classification.

PETE 637 Streamline Simulation

Credits 3. 3 Lecture Hours. Introductory and advanced concepts in streamline simulation and its applications; theory of streamlines/streamtubes in multidimensions; 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. **Prerequisite:** Graduate classification.

PETE 638 Production Logging

Credits 3. 3 Lecture Hours. Well logging methods concerned with problem well diagnosis and reservoir surveillance; includes fluid flow in pipes, understanding fluid dynamics in a wellbore, theoretical basis of production logging techniques, production log interpretation techniques, and operational considerations. **Prerequisite:** Graduate classification.

PETE 639 High Performance Drilling Design and Operational Practices

Credits 3. 3 Lecture Hours. Achieving differentiating drilling performance in most complex wells; includes physics of each type of performance limiter, real time operational practices, engineering redesign practices, and effective workflows to achieve the required change in engineering and operational practices. **Prerequisites:** Graduate classification, PETE 355 or PETE 661 or approval of instructor.

PETE 640 Models for Simulation of Flow and Transport of Fluids and Heat in Porous Media

Credits 4. 3 Lecture Hours. 3 Lab Hours. Design and develop numerical simulators that describe flow of reservoir fluids and transport of heat through porous media; develop multi-dimensional models capable of handling single mass components (gas, oil or water) in single phases (liquid or vapor). **Prerequisites:** PETE 603 or approval of instructor; experience in FORTRAN or another programming language; solid understanding of physical processes of flow and transport through porous media, numerical analysis and linear algebra; graduate classification.

PETE 641 Models for Simulation of Advanced Coupled Processes in Geologic Media

Credits 4. 3 Lecture Hours. 3 Lab Hours. 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. **Prerequisites:** PETE 640 and graduate classification; experience in FORTRAN95, C, C++ or another programming language; solid understanding of physical processes of flow and transport through porous media, numerical analysis and linear algebra.

PETE 642 Formation Damage: Mechanisms and Remediation

Credits 3. 3 Lecture Hours. Identification and development of solutions for mechanisms of formation damage that can occur during drilling, completion, and following chemical treatments; includes interaction of cleaning fluids with the formation brines, rock and oil. **Prerequisites:** Graduate classification.

PETE 643 Oil Field Chemistry

Credits 3. 3 Lecture Hours. The role of chemistry in well stimulation, water shut-off treatments, scale removal, mitigation, downhole corrosion issues, organic deposition, dementing, drilling fluids and various aspects of formation damage; includes problem identification as the first step in designing chemical treatment to remove formation damage. **Prerequisites:** Graduate classification.

PETE 644 CO2 Capture and Uses: Sequestration, Enhanced Oil Recovery (EOR)

Credits 3. 3 Lecture Hours. Understanding the need and potential of CO_2 captures and uses, including sequestration and Enhanced Oil Recovery (CCS-EOR), the scientific, technological and economic aspects of identifying and implementing a CCS-EOR; overview of safety, environmental and legal aspects. **Prerequisites:** Graduate classification.

PETE 645 Upscaling of Geologic Models for Flow Simulation

Credits 3. 3 Lecture Hours. In-depth understanding of current approaches to upscaling of 3D geologic models for reservoir flow simulation; includes development of upscaling solvers. **Prerequisites:** Graduate classification.

PETE 647 Petroleum Thermodynamics

Credits 3. 3 Lecture Hours. Understanding the principles of bulk equilibrium, bulk non-equilibrium, interfacial and thin-film thermodynamics in relation to hydrocarbon reservoirs; application in shale gas, shale light oil, heavy oil production, CO_2 injection in light and heavy oils, and phase-splitting calculations; complex diffusion processes and species distribution in hydrocarbon reservoirs from irreversible thermodynamics. **Prerequisite:** Graduate classification or approval of instructor.

PETE 648 Pressure Transient Testing

Credits 3. 3 Lecture Hours. Diffusivity equation and solutions for slightly compressible liquids; dimensionless variables; type curves; applications of solutions to buildup, drawdown, multi-rate, interference, pulse and deliverability tests; extensions to multiphase flow; analysis of hydraulically fractured wells. **Prerequisites:** PETE 324 and PETE 620.

PETE 649 Boundary Element Method for Geomechanics

Credits 3. 3 Lecture Hours. 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. **Prerequisites:** Computer language such as Fortran, C, C#, C++, Matlab.

PETE 651 Probabilistic Reserves Evaluation

Credits 3. 3 Lecture Hours. Oil and gas reserves definitions and reporting regulations; probabilistic reserves estimation methods; unconventional resources characterization; reserves valuation techniques. **Prerequisites:** Graduate classification or approval of instructor.

PETE 652 Deterministic Reserves Evaluation

Credits 3. 3 Lecture Hours. Oil and gas reserves definitions and reporting regulations; deterministic estimation methods; unconventional resources characterization; reserves valuation techniques. **Prerequisites:** Graduate classification or approval of instructor.

PETE 653 Linear and Nonlinear Rock Mechanics

Credits 3. 3 Lecture Hours. Formulation of linear poro-elasticity equations; formulation of non-linear poro-elasticity and plasticity equations; formulation of various rock failure theories; solving linear and non-linear elasticity and plasticity equations using analytical methods; solving 2-D poro-elasticity and plasticity equations using a semi-analytical method; applying the solutions to drill string, casing, reservoir compaction, breakouts and sand production problems. **Prerequisites:** Calculus and graduate classification.

PETE 655 Finite Element Method for Geomechanics

Credits 3. 3 Lecture Hours. Formulation of the 2D and 3D finite element method; development of a simple finite element computer program; linear and non-linear constitutive relation for soft and hard rocks; applications to porous flow and geomechanics problems; code the finite element computer programs and practice to solve geomechanics problems, reservoir flow, reservoir compaction, subsidence, borehole breakout and casing stability problems. **Prerequisites:** Computer language such as Fortran, C, C#, C++, or Matlab.

PETE 656 Advanced Numerical Methods for Reservoir Simulation

Credits 3. 3 Lecture Hours. Numerical simulation of flow in porous media based on numerical methods for partial differential equations; supplemented by published papers and research topics; development of a reservoir simulator. **Prerequisites:** Graduate classification; basic reservoir simulation or equivalent course; linear algebra and matrix computations or equivalent course; advanced calculus or equivalent course; programming experience.

PETE 657/CSCE 657 High Performance Computing for Earth Science and Petroleum Engineering

Credits 3. 3 Lecture Hours. Numerical simulation of problems in Earth Sciences and Petroleum Engineering using high performance computing (HPC); development of a parallel reservoir simulator. **Prerequisite:** Graduate classification. **Cross Listing:** CSCE 657/PETE 657.

PETE 658 Energy and Sustainability

Credits 3. 3 Lecture Hours. Overview of energy resources and use with emphasis on long-term sustainability; considers fossil, nuclear, and alternative energy sources, electricity and transportation, energy conversions, energy efficiency, energy security, energy policy, and environmental impact. **Prerequisites:** Graduate classification.

PETE 659 Rock Mechanics Related to Hydraulic Fracturing

Credits 3. 3 Lecture Hours. Fundamentals of rock mechanics; calculation of displacements and stresses of opening fractures; evaluation of stress shadow effects; investigation of local stress reorientation and fracture interaction; analysis of near-tip stresses; determination of fracture propagation direction; summary of hydraulic fracturing treatments and modeling in unconventional reservoirs. **Prerequisite:** Graduate classification.

PETE 660 Technical Writing and Presentations for Petroleum Engineers

Credits 3. 3 Lecture Hours. 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.

PETE 661 Drilling Engineering

Credits 3. 3 Lecture Hours. 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.

PETE 662 Production Engineering

Credits 3. 3 Lecture Hours. Development of fundamental skills for the design and evaluation of well completions, monitoring and management of the producing well, selection and design of article lift methods, modeling and design of surface facilities.

PETE 663 Formation Evaluation and the Analysis of Reservoir Performance

Credits 3. 3 Lecture Hours. 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); specifically, the assessment of field performance data and the optimization of hydrocarbon recovery by analysis/interpretation/integration of geologic, well log, and well performance data. **Prerequisite:** Approval of instructor or graduate classification.

PETE 664 Petroleum Project Evaluation and Management

Credits 3. 3 Lecture Hours. Introduction to oil industry economics, including reserves estimation and classification-, building and using reservoir models, developing and using reservoir management processes, managing new and mature fields, and investment ranking and selections.

PETE 665 Petroleum Reservoir Engineering

Credits 3. 3 Lecture Hours. 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. **Prerequisite:** Approval of instructor or graduate classification.

PETE 667 Petroleum Engineering Reserves and Evaluation

Credits 3. 3 Lecture Hours. Estimation and valuation of hydrocarbon reserves and resources, with emphasis on probabilistic methods, technically challenging reservoirs, and unconventional resources. **Prerequisite:** PETE 664, approval of instructor.

PETE 678 Resource Shale Petrophysics

Credits 3. 3 Lecture Hours. 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. **Prerequisite:** Graduate classification.

PETE 679 Unconventional Reservoir Methods and Analysis

Credits 3. 3 Lecture Hours. Exploration of the latest practices in the use of unconventional reservoirs, reservoir characterization, horizontal drilling and completion optimization methodologies; focus on practices for reservoir engineering and production analysis techniques.

PETE 680 Applied Rock and Fracture Mechanics for Unconventional Reservoirs

Credits 3. 3 Lecture Hours. Introduction of key rock and fracture mechanics concepts for unconventional reservoirs and discussion of the layered nature of mudstones and its effect on their mechanical behavior and response to hydraulic fracturing treatments; presentation of problem in field techniques, laboratory measurements and engineering analyses for solving rock and fracture mechanics, and discussion of how these are used together to construct predictive models and solve practical problems of rock failure and hydraulic fracture propagation; demonstrations of rock testing and hydraulic fracture experiments. **Prerequisite:** MATH 152, PHYS 206, or graduate classification.

PETE 681 Seminar

Credits 0. 0 Lecture Hours. Presentations by experts in petroleum technologies.

PETE 684 Professional Internship

Credits 1 to 4. 1 to 4 Other Hours. Training under the supervision of practicing professional engineers in settings appropriate to the student's professional objectives. May be taken four times for credit. **Prerequisite:** Graduate classification and one semester of graduate work completed.

PETE 685 Directed Studies

Credits 1 to 12. 1 to 12 Other Hours. Students undertake and complete limited investigations not within their thesis research and not covered in established curricula. **Prerequisites:** Graduate classification; approval of instructor.

PETE 686 Petroleum Data Analytics and Machine Learning

Credits 3. 3 Lecture Hours. Data analytics suitable for petroleum engineers and geoscientists; emphasis on implementation of data-driven methods on certain types of subsurface data; creation of data-driven workflows and application to subsurface data generated during petroleum engineering and geoscience operations; study of case studies with an emphasis on the use of supervised learning, classification and regression, unsupervised learning, transformations, clustering and feature extraction, and neural networks using open-source Python computational platforms; exploration of the basics of machine learning, data science and data analysis and their applications to petroleum engineering and geoscience. **Prerequisite:** PETE 301 or GEOP 361, or equivalent; graduate classification; or approval of instructor.

PETE 689 Special Topics in...

Credits 1 to 4. 1 to 4 Other Hours. Special topics in an identified area of petroleum engineering. May be repeated for credit.

PETE 691 Research

Credits 1 to 23. 1 to 23 Other Hours. Advanced work on some special problem within field of petroleum engineering; thesis course.

PETE 692 Professional Study

Credits 1 to 12. 1 to 12 Other Hours. Approved professional study or project. May be taken more than once but not to exceed 6 hours of credit towards a degree.