Bachelor of Science in Petroleum Engineering

Program Description

In our Petroleum Engineering Department, we strive to lead the world in education, training, research and innovation for the responsible and sustainable acquisition and development of subsurface energy resources. With a dedicated and renowned faculty, state-of-the-art research facilities and hands-on learning opportunities, Mines is a top choice for undergraduate and graduate students who want to explore the dynamic field of petroleum engineering.

To realize this goal, we designed our petroleum engineering program to ensure you receive the foundational coursework, hands-on experience and inspiration to thrive—wherever your next step takes you. Whether pursuing a career in the private or public sectors or a path in academics, international or domestic, you'll benefit from our passionate faculty, research opportunities and close industry partnerships.

Our petroleum engineering program explores a variety of disciplines and topics related to petroleum engineering, including:

- Oil and natural gas exploration and extraction
- Drilling, completions, stimulation and production
- Reservoir engineering and simulation
- Data analytics and machine learning
- Geothermal energy
- Carbon sequestration
- Sustainability, environmental and safety issues

And more. Our graduates go on to a variety of exciting careers in the petroleum engineering field. Whether working as production engineers, reservoir engineers, drilling engineers, data scientists, consultants or even entering academics, Mines students are some of the most sought after graduates in the industry.

Program Objectives (ABET Focused)

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to communicate effectively with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Student Learning Outcomes

The Petroleum Engineering program's objectives are broad statements that describe what our graduates are expected to attain within three to five years of completing their degree. The Petroleum Engineering Department's faculty and other constituents have affirmed the following Program Educational Objectives:

- Obtain an industry, government, or academic position in petroleum engineering, or a related field, or be pursuing a graduate education in petroleum engineering or in a related field;
- Demonstrate advancement in their chosen careers and exercising leadership in the area of petroleum engineering;
- Continue to develop personally and professionally, and serve others, through continuing education, professional societies, educational institutions, community groups, and other organizations; and,
- Identify the ethical implications and social impacts of engineering decisions.

ABET Accreditation Status

The Bachelor of Science in Petroleum Engineering is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org/, under the commission's General Criteria and Program Criteria for Petroleum and Similarly Named Engineering Programs.

Primary Contact

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https://petroleum.mines.edu/
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Curriculum

All disciplines within petroleum engineering are covered to great depth at the undergraduate and graduate levels, both in the classroom and laboratory instruction, and in research. Specific areas include fundamental fluid and rock behavior, drilling, formation evaluation, well completions and stimulation, well testing, production operations and artificial lift, reservoir engineering, supplemental and enhanced oil recovery, economic evaluation of petroleum projects, environmental and safety issues, and the computer simulation of most of these topics.

The Petroleum Engineering student studies mathematics, computer science, chemistry, physics, general engineering, geology, the humanities, technical communication (including researching subjects, report writing, oral presentations, and listening skills), and environmental topics. A unique aspect is the breadth and depth of the total program structured in a manner that prepares each graduate for a successful career from the standpoints of technical competence, managerial abilities, and multidisciplinary experiences. The needs for continued learning and professionalism are stressed.

The strength of the program comes from the high quality of students and professors. The faculty has expertise in teaching and research in all the major areas of petroleum engineering listed above. Additionally, many of the faculty members have significant industrial backgrounds that lead to meaningful design experiences for the students. Engineering design is taught throughout the curriculum including a senior design course on applying the learned skills to real world reservoir development and management problems.

The department is constantly updating the instructional facilities and equipment for laboratory instruction and experimental research. To maintain leadership in future petroleum engineering technology, decision making, and management, computers are incorporated into every part of the program, from undergraduate instruction through graduate student and faculty research.

The department is close to oil and gas field operations, petroleum companies, research laboratories, and geologic out-crops of nearby producing formations. There are many opportunities for short field trips and for summer and part-time employment in the oil and gas industry.

Degree Requirements (Petroleum Engineering)

First Year

		lec	lab	sem.hrs
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
GEGN101	EARTH AND ENVIRONMENTAL SYSTEMS			4.0
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
PHGN100	PHYSICS I - MECHANICS			4.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				32.0

Sophomore

Fall		**lec**	**lab**	**sem.hrs**
CEEN241	STATICS			3.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
PEGN201	PETROLEUM ENGINEERING FUNDAMENTALS			3.0
EDNS151	CORNERSTONE - DESIGN I			3.0
				17.0

Spring		**lec**	**lab**	**sem.hrs**
PEGN251	FLUID MECHANICS			3.0
PEGN308	RESERVOIR ROCK PROPERTIES			3.0
PEGN282	PROFESSIONAL SKILLS 1			1.0
CHGN209	INTRODUCTION TO CHEMICAL THERMODYNAMICS			3.0
HASS215	FUTURES			3.0
EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
				16.0

Summer		**lec**	**lab**	**sem.hrs**
PEGN315	SUMMER FIELD SESSION I	1.0		1.0
				1.0

Junior

Fall		**lec**	**lab**	**sem.hrs**
PEGN311	DRILLING ENGINEERING			3.0
PEGN312	PROPERTIES OF PETROLEUM ENGINEERING FLUIDS			3.0
PEGN382	PROFESSIONAL SKILLS 2			1.0
GEOL315	SEDIMENTOLOGY AND STRATIGRAPHY			3.0
CEEN311	MECHANICS OF MATERIALS			3.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
				16.0

Spring		**lec**	**lab**	**sem.hrs**
PEGN361	COMPLETION ENGINEERING			3.0
PEGN411	MECHANICS OF PETROLEUM PRODUCTION			3.0
PEGN419	INTRODUCTION TO FORMATION EVALUATION AND WELL LOGGING			3.0
PEGN438	PETROLEUM DATA ANALYTICS			3.0
PEGN482	PROFESSIONAL SKILLS 3			1.0
GEOL308	INTRODUCTORY APPLIED STRUCTURAL GEOLOGY			3.0
S&W	SUCCESS AND WELLNESS			1.0
				17.0

Summer		**lec**	**lab**	**sem.hrs**
PEGN316	SUMMER FIELD SESSION II	2.0		2.0
				2.0

Senior

Fall		**lec**	**lab**	**sem.hrs**
PEGN423	PETROLEUM RESERVOIR ENGINEERING I			3.0
PEGN422	ECONOMICS AND EVALUATION OF OIL AND GAS PROJECTS			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0

FREE	Free Elective			6.0
				15.0
Spring		**lec**	**lab**	**sem.hrs**
PEGN424	PETROLEUM RESERVOIR ENGINEERING II			3.0
PEGN426	FORMATION DAMAGE AND STIMULATION			3.0
PEGN439	MULTIDISCIPLINARY PETROLEUM DESIGN			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
				15.0

Total Semester Hrs: 131.0

Major GPA

During the 2016-2017 academic year, the Undergraduate Council considered the policy concerning required major GPAs and which courses are included in each degree's GPA. While the GPA policy has not been officially updated, in order to provide transparency, council members agreed that publishing the courses included in each degree's GPA is beneficial to students.

The following list details the courses that are included in the GPA for this degree:

- PEGN100 through PEGN599 inclusive

Five-Year Combined Baccalaureate and Master's Degree

The Petroleum Engineering Department offers the opportunity to begin work on a Master of Engineering or Master of Science Degree while completing the requirements for the bachelor's Degree. These degrees are of special interest to those planning on studying abroad or wanting to get a head start on graduate education.

Students enrolled in Mines' combined undergraduate/graduate program may double count up to six credits of graduate coursework to fulfill requirements of both their undergraduate and graduate degree programs. These courses must have been passed with "B-" or better, not be substitutes for required coursework, and meet all other University, Department, and Program requirements for graduate credit.

Students are advised to consult with their undergraduate and graduate advisors for appropriate courses to double count upon admission to the combined program.

COURSES

PEGN198. SPECIAL TOPICS IN PETROLEUM ENGINEERING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

PEGN199. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: "Independent Study" form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

PEGN201. PETROLEUM ENGINEERING FUNDAMENTALS. 3.0 Semester Hrs.
This course provides an introduction to the oil and gas industry and the various areas associated with petroleum engineering. Topics covered include exploration, development, drilling, production, stimulation, reservoir management, processing, transportation, engineering ethics and professionalism. This course is required for petroleum engineering majors and is open to those interested in petroleum engineering as a minor, and for any other interested students.
Course Learning Outcomes

- Reflect on the origin and importance of petroleum and natural gas in global society.
- Interpret geologic control and subsurface feature data for petroleum engineering applications.
- Justify the role of the main sub-disciplines (drilling, completion, production, and reservoir) of petroleum engineering and how they relate to each other.
- Analyze issues of health, safety, environment, social responsibility, economics, and sustainability as applied in the oil and gas industry.
- Practice using petroleum engineering language derived from testing data, engineering drawings, specifications, and other technical information.
- Analyze equitable and ethical working conditions for all personnel in the field of petroleum engineering.
- Discriminate among career options in the upstream petroleum engineering lifecycle and how these careers depend on, interact with, and support other downstream, midstream, and upstream aspects.

PEGN251. FLUID MECHANICS. 3.0 Semester Hrs.
Introductory and fundamental course in engineering fluid flow. Properties of fluids and fluid flow, fluid statics, mass and momentum balance, differential equations, dimensional analysis, laminar and turbulent flow in pipes, and two-phase flow. Lecture format with demonstrations and practical problem-solving. May not also receive credit for MEGN351 or CEEN310. Prerequisite: CEEN241 or MNGN318.
Course Learning Outcomes

- Define fluid and recognize the limit of this continuum-scale concept.
- Name and describe fluid properties: density, velocity, acceleration, viscosity, surface tension, wetting.
- Classify fluids based on their rheological behaviors.
- Explain and compute hydrostatic pressure and force.
- Apply correlations to compute properties of fluids and simple flows.
- Describe and apply principles of mass/momentum conservation to solve fluid flows.
- Distinguish laminar and turbulent flows.
- Recognize the value of dimensionless correlations and identify dimensionless variables.

PEGN282. PROFESSIONAL SKILLS 1. 1.0 Semester Hr.
This course is the first in a three-course series designed for petroleum engineering students to develop skills in oral and written communication, professionalism, diversity, and ethics. The course is designed as a

discussion-based seminar course and will focus on critical thinking and problem-solving. Assignments will be based on technical and non-technical material relating to earth, energy, and the environment. Students will work individually and in multicultural teams on assignments throughout the semester.

Course Learning Outcomes

- Develop critical thinking skills around topics of earth, energy, and environment.
- Demonstrate critical reading skills in field-specific research and technical reports.
- Work effectively in multicultural teams.
- Analyze issues of health, safety, environment, social responsibility, and sustainability as applied to the oil and gas industry.

PEGN298. SPECIAL TOPICS IN PETROLEUM ENGINEERING. 1-6 Semester Hr.

(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

PEGN299. INDEPENDENT STUDY. 1-6 Semester Hr.

(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

PEGN299. INDEPENDENT STUDY. 1-6 Semester Hr.

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PEGN305. COMPUTATIONAL METHODS IN PETROLEUM ENGINEERING. 2.0 Semester Hrs.

This course is an introduction to computers and computer programming applied to petroleum engineering. Emphasis will be on learning Visual Basic programming techniques to solve engineering problems. A toolbox of fluid property and numerical techniques will be developed. 2 hours lecture; 2 semester hours. Prerequisite: MATH213.

Course Learning Outcomes

- Describe what programming is and how valuable it is to the petroleum field.
- Recognize and apply variable types and operators and construct error-free statements.
- Construct syntax for various programming building blocks such as decisions and loops.
- Analyze an algorithm, decide on appropriate logic, and write statements corresponding to the selected language.
- Identify why a program is not working and/or solve the errors – including invalid syntax, flawed logic, and possible inappropriate numerical technique.
- Develop programs for storing and analyzing data.
- Create programs to solve problems found in the petroleum field such as data analysis, pressure traverses, and fluid property calculations.

PEGN308. RESERVOIR ROCK PROPERTIES. 0-3 Semester Hr.

Introduction to basic reservoir rock properties and their measurements. Topics covered include: porosity, saturations, volumetric equations, land descriptions, trapping mechanism, pressure and temperature gradient, abnormally pressured reservoirs. Darcy's law for linear horizontal and tilted flow, radial flow for single-phase liquids and gases, multiphase flow (relative permeability). Capillary pressure and formation compressibility are also discussed. Co-requisites: CEEN241, PEGN251, PEGN201. 2 hours lecture; 3 hours lab; 3 semester hours.

Course Learning Outcomes

- Recognize reservoir forming (sandstone and carbonate) rock types, their textures, and pore structures.
- Determine porosity, discuss the factors that affect porosity, and describe the methods of determining values of porosity.
- Describe methods of determining fluid saturation in reservoir rock and show the relationship between fluid saturation and capillary pressure.
- Define permeability and its determinants and measurement methods for determining values of absolute permeability.
- Handle and prepare cores according to standard core handling procedures.
- Discuss effective and relative permeability; reproduce typical relative permeability curves and show the effect of saturation history on relative permeability.
- Demonstrate the techniques of averaging porosity, fluid saturation, permeability, and reservoir pressure data.
- Reproduce the Darcy equation in differential form, explain its meaning, and integrate the equation for typical reservoir systems.
- Explain boundary tension and wettability and their effect on capillary pressure. Convert laboratory capillary pressure values to reservoir conditions
- Define and describe unconventional (oil and gas) resources and geothermal energy

PEGN311. DRILLING ENGINEERING. 3.0 Semester Hrs.

Study of drilling operations, rig equipment and procedures, wellbore construction processes and planning, drilling fluid design, hydraulics, well control, bit selection and drill string design, directional drilling, and completion equipment. Prerequisite: PEGN251 with a grade of C or higher, PEGN315, CEEN241. Co-requisite: PEGN305.

Course Learning Outcomes

- Memorize and explain drilling operational equipment and procedures.
- Calculate standard drilling engineering values.
- Start the construction of the well-planning process.
- Apprise and select drill bits, BHA’s, and tubular such as drill pipe and casing sizes.
- Plan and assess wellbore trajectories for directional and horizontal wellbores.
- Predict hydraulic pressure magnitudes and power losses.
- Recognize and perform basic well control procedures.
- Assess drilling fluid types and measure their properties.
- Review and classify various well completion types, equipment, and procedures.

PEGN312. PROPERTIES OF PETROLEUM ENGINEERING FLUIDS. 3.0 Semester Hrs.

(WI) Properties of fluids encountered in petroleum engineering including reservoir, drilling, and completion fluids, and oilfield waters. Phase behavior, density, viscosity, interfacial tension, and composition of oil, gas, and brine systems. Interpreting lab data for engineering applications. Flash calculations with k-values and equation of state. Introduction to fluid properties software. Laboratory experimentation of fluid properties.

Prerequisites: PEGN308 (C or better), CHGN209 (C or better). 2 hours lecture; 3 hours lab; 3 semester hours.
Course Learning Outcomes

- Recognize hydrocarbons and non-hydrocarbons that are commonly seen in oil and gas reservoirs and their influences on fluid properties.
- Use phase diagrams of mixtures to calculate the physical properties of gases and liquids and classify reservoir fluids.
- Calculate the behavior of hydrocarbon mixtures in the two-phase region.
- Recognize the different types of reservoir fluids.
- Estimate properties of dry and wet gas reservoirs.
- Describe the physical properties of black oils, conduct laboratory procedures to characterize black oil properties, and recognize correlations that can be used to determine black oil properties.
- Design a laboratory experiment related to black oil properties.
- Separator calculation for black oils and other reservoir fluid types.
- Describe the properties of oilfield waters and their solution chemistry.

PEGN315. SUMMER FIELD SESSION I. 1.0 Semester Hr.
This 8 day course taken after the completion of the sophomore year is designed to introduce the student to oil and gas field and other engineering operations. Engineering design problems are integrated throughout the 8 day session. On-site visits to various oil field operations in the past included the Rocky Mountain region, the U.S. Gulf Coast, California, Alaska, Canada and Europe. Topics covered include drilling, completions, stimulations, surface facilities, production, artificial lift, reservoir, geology and geophysics. Also included are environmental and safety issues as related to the petroleum industry. 3 hours lab; 1 semester hour. Prerequisite: PEGN308 (grade C or better).
Course Learning Outcomes

- Identify and differentiate between types of oil and gas industry companies and employment opportunities.
- Observe and describe petroleum engineering field and office practices including drilling, completions, production, operations, decommissioning, stakeholder engagement and social responsibility through writing and oral communications.
- Describe and compare field and office experiences with colleagues sharing similar experiences.
- Identify oil and gas company ethical and professional responsibilities and their impact on global, economic, and societal contexts including health, safety, environment, and sustainability.

PEGN316. SUMMER FIELD SESSION II. 2.0 Semester Hrs.
This two week course is taken after the completion of the junior year. Emphasis is placed on the multidisciplinary nature of reservoir management. Field trips in the area provide the opportunity to study eolian, fluvial, lacustrine, near shore, and marine depositional systems. These field trips provide the setting for understanding the complexity of each system in the context of reservoir development and management. Petroleum systems including the source, maturity, and trapping of hydrocarbons are studied in the context of petroleum exploration and development. Geologic methods incorporating both surface and subsurface data are used extensively. 6 hours lab; 2 semester hours. Prerequisite: PEGN315, PEGN419, GEOL308, and GEOL315.
Course Learning Outcomes

- Describe eolian, fluvial, lacustrine, and marine depositional systems and relate them to various drilling, completion, stimulation, production, reservoir, and other petroleum engineering applications
- Explain the complexity that occurs within a single depositional environment and how that affects the overall reservoir development and management.
- Describe structural components of geologic systems and relate them to various drilling, completion, stimulation, production, reservoir, and other petroleum engineering applications.
- Explain how geological systems affect petroleum exploration and development and how these components affect economic decisions.
- Describe how reservoir heterogeneity arises from geologic complexity and may affect field development and management decisions.
- Integrate the knowledge gained to develop a comprehensive plan for acquiring and developing local oil and gas fields.

PEGN340. COOPERATIVE EDUCATION. 0-3 Semester Hr.
(I, II, S) Supervised, full-time, engineering-related employment for a continuous
six-month period (or its equivalent) in which specific educational objectives are achieved. Prerequisite: Second semester sophomore status and a cumulative grade-point average of at least 2.00. 0 to 3 semester hours. Cooperative Education credit does not count toward graduation except under special conditions.

PEGN350. GEOTHERMAL ENERGY. 3.0 Semester Hrs.
Students will learn geothermal energy resources and their utilization based on geoscience and engineering perspectives. Geoscience topics include world distribution of geothermal resources and their classification, heat and mass transfer, geothermal reservoirs, hydrothermal geochemistry, exploration methods, and resource assessment. Engineering topics include thermodynamics of geothermal fluids, power cycles, electricity generation, drilling and well measurements, reservoir-surface engineering, and direct utilization. Economic and environmental considerations and case studies on social acceptance with community are also presented.

PEGN361. COMPLETION ENGINEERING. 3.0 Semester Hrs.
(WI) This class is a continuation from drilling in PEGN311 into completion operations. Topics include casing design, cement planning, completion techniques and equipment, tubing design, wellhead selection, and sand control, and perforation procedures. 3 hours lecture; 3 semester hours. Prerequisite: PEGN311 and CEEN311.
Course Learning Outcomes

- Identify, formulate, and solve well completion engineering problems by applying the principles of fluid mechanics, rock mechanics, and materials science.
- Design and evaluate well completion systems, including casing seat depth, tubing size, and packer selection, using appropriate engineering design principles.
- Calculate and analyze design pressures, burst, collapse, and tensile loads on casing and tubing strings under various operating conditions, ensuring structural integrity and compliance with industry standards.
- Design a primary cementing program to achieve effective zonal isolation and well integrity, incorporating slurry selection, displacement efficiency, and cement evaluation techniques.
- Apply professional and ethical judgment by evaluating health, safety, environmental, and societal impacts of completion technology choices, including sand control, perforation systems, and cementing practices.
- Communicate effectively through preparation and delivery of technical reports, design summaries, and oral presentations on well completion design and analysis.

- Research and apply emerging completion technologies, including expandable liners, advanced perforation systems, and intelligent completion tools.

PEGN382. PROFESSIONAL SKILLS 2. 1.0 Semester Hr.
This course is the second in a three-course series designed for petroleum engineering students to develop skills in oral and written communication, professionalism, diversity and ethics. The course is designed as a discussion based seminar course and will focus on oral and written communication skills. Assignments will be based on technical and non-technical material relating to earth, energy, and the environment. Students will work individually and in multicultural teams on assignments throughout the semester. Prerequisite: PEGN282.
Course Learning Outcomes

- Practice using petroleum engineering language derived from testing data, engineering drawings, specifications, and other technical information.
- Write and present technical reports for engineering and management personnel using petroleum engineering terminology.
- Collaborate with multicultural team members to solve operational problems in petroleum engineering.

PEGN398. SPECIAL TOPICS IN PETROLEUM ENGINEERING. 0-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

PEGN398. SPECIAL TOPICS. 1-6 Semester Hr.

PEGN398. SPECIAL TOPICS. 1-6 Semester Hr.

PEGN398LA. SPECIAL TOPICS. 0-6 Semester Hr.

PEGN399. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

PEGN399. INDEPENDENT STUDY. 1-6 Semester Hr.

PEGN411. MECHANICS OF PETROLEUM PRODUCTION. 3.0 Semester Hrs.
Nodal analysis for pipe and formation deliverability including single and multiphase flow. Natural flow and design of artificial lift methods including gas lift, sucker rod pumps, electrical submersible pumps, and hydraulic pumps. 3 hours lecture; 3 semester hours. Prerequisite: PEGN251, PEGN308 (grade of C or better), PEGN311, and PEGN312.
Course Learning Outcomes

- Create IPR and OPR: Create inflow and outflow performance relationships for oil and gas wells using available information, such as reservoir characteristics, fluid properties, well completion details, wellbore configuration, wellhead specifications, etc.
- Estimate the impacts of various factors on IPR and OPR: Estimate the effects of different factors on the inflow and outflow performance relationships for oil and gas wells, such as reservoir and completion variables, artificial lift, fluid properties, wellbore design, etc.
- Provide production design using Nodal analysis: Analyze, troubleshoot, and optimize oil and gas well production based on available production data using nodal analysis.
- Select and design artificial lift system: Select and design artificial lift systems for oil and gas wells based on expected reservoir and completion conditions.
- Identify flow assurance problems and provide resolutions: Recognize some typical flow assurance problems and surface facilities in the oil and gas industry, and create solutions to solve encountered problems

PEGN414. WELL TESTING AND ANALYSIS. 3.0 Semester Hrs.
Solution to the diffusivity equation. Transient well testing: build-up, drawdown, multi-rate test analysis for oil and gas. Flow tests and well deliverabilities. Type curve analysis. Super position, active and interference tests. Well test design. Prerequisites: MATH225 and PEGN419. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Understand the theoretical basis of well-test analysis.
- Explain the capabilities and limitations of well-test analysis.
- Develop well-test analysis skills - both manual and computerized.
- Estimate reservoir properties from well tests.

PEGN419. INTRODUCTION TO FORMATION EVALUATION AND WELL LOGGING. 3.0 Semester Hrs.
Equivalent with GPGN419,
An introduction to well logging methods, including the relationship between measured properties and reservoir properties. Analysis of log suites for reservoir size and content. Graphical and analytical methods will be developed to allow the student to better visualize the reservoir, its contents, and its potential for production. Use of the computer as a tool to handle data, create graphs and log traces, and make computations of reservoir parameters is required. 3 hours lecture; 3 semester hours. Prerequisites: GEOL315, PHGN200 (grade of C or better).
Course Learning Outcomes

- Learn basic petrophysics in open hole logs.
- Understand theoretical fundamentals of logs.
- Ability to calculate and interpret petrophysical properties.
- Ability to interpret well logs.

PEGN422. ECONOMICS AND EVALUATION OF OIL AND GAS PROJECTS. 3.0 Semester Hrs.
Project economics for oil and gas projects under conditions of certainty and uncertainty. Topics include time value of money concepts, discount rate assumptions, measures of project profitability, costs, taxes, expected value concept, decision trees, gambler’s ruin, and Monte Carlo simulation techniques. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Understand the key players in the oil and gas industry.
- Create an economic model for oil and gas income and service-producing investments.
- Evaluate the economic model using income or service decision criteria.
- Analyze economic models to identify problem areas.
- Apply the knowledge learned in building and evaluating models into an Authorization for Expenditure presentation (AFE).
- Create and deliver a convincing AFE.
- Understand petroleum reserves classification.
- Understand the basics of taxes (internationally and domestically) and their implications on an economic model.
- Calculate After-Tax Cash Flows and incorporate them into an AFE.

- Evaluate a decline curve and understand its implications on an economic model.
- Understand how price decks are developed and start to predict future prices based on logical assumptions.
- Incorporate risk and uncertainty into a model using software and by-hand calculations.

PEGN423. PETROLEUM RESERVOIR ENGINEERING I. 3.0 Semester Hrs.
Data requirements for reservoir engineering studies. Material balance calculations for normal gas, retrograde gas condensate, solution-gas and gas-cap reservoirs with or without water drive. Primary reservoir performance. Forecasting future recoveries by incremental material balance. 3 hours lecture; 3 semester hours. Prerequisite: PEGN419, PEGN316 and MATH 225 or MATH235.
Course Learning Outcomes

- Differentiate between conventional and unconventional petroleum reservoirs based on geology and identify engineering principles that influence their production behavior.
- Describe the role of rock and fluid properties on mechanisms that drive primary production from petroleum reservoirs.
- Apply scientific and mathematical principles for petroleum systems analysis to reservoir engineering applications for estimation of petroleum reserves.
- Analyze production decline curves to estimate the ultimate recovery of conventional and unconventional petroleum reservoirs.
- Analyze oil-water immiscible displacement processes to estimate oil displacement efficiency.

PEGN424. PETROLEUM RESERVOIR ENGINEERING II. 3.0 Semester Hrs.
Reservoir engineering aspects of supplemental recovery processes. Introduction to liquid-liquid displacement processes, gas-liquid displacement processes, and thermal recovery processes. Introduction to numerical reservoir simula tion, history matching and forecasting. Prerequisite: PEGN423 and PEGN438. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Identify the physics behind supplementary/enhanced oil recovery methods and fluid displacement processes, by describing the effects of fluid and rock properties and their interactions on fluid displacement efficiency.
- Apply mathematical models for the operational design of supplementary oil recovery methods, such as waterflooding, to estimate the microscopic, areal, and vertical displacement efficiencies.
- Describe fundamentals of numerical reservoir simulation technology, by explaining the physical processes represented in governing equations of fluid flow in porous media and describing the components of a numerical reservoir simulator.
- Describe the differences between various numerical discretization techniques, and their strength and limitations, in solving transport equations in porous media.
- Apply numerical reservoir simulation to evaluate flow and displacement processes during supplementary oil recovery operations, and analyze the results obtained from the numerical simulation.
- Describe modeling techniques for unconventional reservoirs to analyze well performance in such reservoirs.
- Classify enhanced oil recovery processes.
- Apply screening methodologies for the selection of enhanced oil recovery methods.

PEGN426. FORMATION DAMAGE AND STIMULATION. 3.0 Semester Hrs.
Skin damage associated with formation damage, well deviation, and perforating. Formation damage mechanisms and causes. Stimulation techniques, including acidizing and fracturing. Calculation of matrix and fracturing rates and pressures. Design of matrix acidizing treatments. Selection/determination of hydraulic fracturing components including rock mechanical properties, in-situ stresses, proppants, fluid types, and diversion. Reservoir considerations in fracture propagation and design. Stimulation diagnostics and their application. Prerequisite: PEGN361 and PEGN411.
Course Learning Outcomes

- Differentiate between various formation damage mechanisms and causes.
- Assess well damage using the concepts of skin and effective wellbore radius for full and partially penetrating wellbores.
- Compare different stimulation methods and their applicability and potential for success in various reservoirs.
- Design a matrix acidizing treatment taking into consideration reservoir conditions, geologic parameters, and pumping components such as acid volumes required, injection rates and pressures, etc.
- Interpret the values of and uses for various hydraulic fracturing variables such as closure pressure, rock mechanical properties, fracture mechanics, etc.
- Conclude from the results of various hydraulic fracturing treatment designs including variations in proppant selection, injection rates, fluid and proppant volumes, etc.

PEGN428. ADVANCED DRILLING ENGINEERING. 3.0 Semester Hrs.
Rotary drilling systems with emphasis on design of drilling programs, directional and horizontal well planning. This elective course is recommended for petroleum engineering majors interested in drilling. Prerequisite: PEGN311, PEGN361. 3 hours lecture; 3 semester hours.

PEGN430. ENVIRONMENTAL LAW AND SUSTAINABILITY. 3.0 Semester Hrs.
(WI) In this course students will be introduced to the fundamental legal principles that are relevant to sustainable engineering project development. General principles of United States (U.S.) environmental regulation pertaining to air quality, water quality, waste management, hazardous substances remediation, regulation of chemical manufacture and distribution, natural resources, and energy will be discussed in parallel with international laws pertaining to environmental protection and human rights. In the context of engineering project design, students will explore legal, societal, and ethical risks, and risk mitigation methodologies. 3 hours lecture; 3 semester hours. Prerequisites: HASS100. Corequisites: HASS200.
Course Learning Outcomes

- demonstrate knowledge and understanding, verbally and in writing, of domestic and international environmental law and applicable administrative and judicial procedure.

- write persuasively and effectively through a variety of formal and informal writing exercises and independent research of environmental law, social responsibility, and sustainability issues.
- apply knowledge of environmental law, social responsibility and sustainability in the design and implementation of a team project that promotes just and sustainable engineering solutions

PEGN438. PETROLEUM DATA ANALYTICS. 0-3 Semester Hr.
Introduction to elementary probability theory and its applications in engineering and sciences; discrete and continuous probability distributions; parameter estimation; hypothesis testing; linear regression; spatial correlations and geostatistics with emphasis on applications in earth sciences and engineering. 2 hours lecture; 3 hours lab; 3 semester hours. Prerequisite: MATH112 and CSCI128.
Course Learning Outcomes

- Practice using petroleum engineering language derived from reservoir data and data analytics.
- Write technical reports for geoscientists and other engineers using petroleum engineering terminology.
- Collaborate with multicultural team members to solve large problems in subsurface modeling and data analysis.
- Formulate complex data analytics problems related to petroleum engineering.
- Solve complex problems using different approaches and compare them in terms of performance.
- Implement systematic design procedures and determine specifications to meet project requirements.

PEGN439. MULTIDISCIPLINARY PETROLEUM DESIGN. 3.0 Semester Hrs.
Equivalent with GEGN439,GPGN439,
(WI) This is a multi-disciplinary design course that integrates fundamentals and design concepts in geology, geophysics, and petroleum engineering. Students work in integrated teams consisting of students from each of the disciplines. Multiple open-ended design problems in oil and gas exploration and field development, including the development of a prospect in an exploration play and a detailed engineering field study are assigned. Several detailed written and oral presentations are made throughout the semester. Project economics including risk analysis are an integral part of the course. Prerequisites: GEOL308, PEGN316. Co-requisites: PEGN426. 2 hours lecture, 3 hours lab; 3 semester hours.
Course Learning Outcomes

- Develop and apply task-related skills. Task-related skills include analyzing data and information and integrating this information to obtain a solution to an open-ended problem.
- Develop and apply meeting management, brainstorming, and critical team skills. Critical team skills include communication, coordination, leadership, feedback, backup, adaptability, and team orientation.
- Apply a task performance strategy using common processes for multidisciplinary teamwork.
- Design an exploitation strategy for a petroleum field that satisfies relevant technical, professional, and societal constraints.
- Build a project management plan that will be followed, modified, and adapted during the execution of the project to solve an open-ended problem. The project management plan includes a schedule (Gantt charts), budget, tasks, deliverables, resource utilization, and internal milestones.

PEGN440. INTRODUCTION TO THE DIGITAL OILFIELD. 3.0 Semester Hrs.
Capstone course for Petroleum Data Analytics minor. The course starts with an introduction to data analysis and visualization packages. The course then has three projects to include drilling, production, and reservoir data analysis along with data visualization techniques. The student will be required to prepare both oral and written and oral project updates and final results. Prerequisite: PEGN438.
Course Learning Outcomes

- Prepare and analyze data from various petroleum data streams including drilling, completions, stimulation, production, and reservoir management.
- Design petroleum engineering projects that satisfy relevant technical, professional, and societal constraints. These projects will incorporate other associated disciplines and will require Use industry analytical graphical software.
- Apply statistical methods to derive insights into petroleum data sets.
- Interpret petroleum data and derive useful conclusions.
- Independent research (prior knowledge, skills attained in previous courses, original ideas, etc.)
- Build a project business plan. Plan will apply project management skills (schedule, budget, tasks, deliverables, resource utilization, internal milestones, Gantt charts, people, and other available tools)
- Demonstrate professionalism through attendance, demeanor, participation, exhibiting integrity, accepting responsibility, taking initiative, team participation and providing leadership as necessary to ensure project success.
- Create formal and informal communications for individual, team, and industry/company use that document and facilitate progress and enhance the impact of the final design.

PEGN450. ENERGY ENGINEERING. 3.0 Semester Hrs.
Energy Engineering is an overview of energy sources that will be available for use in the 21st century. After discussing the history of energy and its contribution to society, we survey the science and technology of energy, including geothermal energy, fossil energy, solar energy, nuclear energy, wind energy, hydro energy, bio energy, energy and the environment, energy and economics, the hydrogen economy, and energy forecasts. This broad background will give you additional flexibility during your career and help you thrive in an energy industry that is evolving from an industry dominated by fossil fuels to an industry working with many energy sources. Prerequisite: MATH213, PHGN200. 3 hours lecture; 3 semester hours.

PEGN460. FLOW IN PIPE NETWORKS. 3.0 Semester Hrs.
This course will provide an introduction to single and two phase hydraulics phenomena and modeling approaches to calculate pressure/temperature profile, losses along and flow rates along a production system. Furthermore, topics related to pipeline flow control and maintenance such as leak detection, damage prevention, integrity and pipe repairs will be covered. Finally, Federal Pipeline Safety Regulations and Health, Safety, and the Environment (HSE) regulations for the transportation of gas and hazardous liquids by pipeline will be discussed. In addition, this course will provide an introduction in transient theoretical modeling and design applications. OLGA transient multiphase flow simulator will be introduced and used to complete homework and final project. Industrial practices and operational problem related to transient production design will be covered. Prerequisites: PEGN251, CHGN209 , MATH225, and PEGN305. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- 1.Estimate local rates, pressure and temperature drops on individual sections of a given pipeline network for single and two-phase flow system under steady state condition.
- 2. Apply required criteria to select required pipe specifications.
- 3. Establish understanding about flow control and pipeline maintenance.
- 4. Understand HSE regulations to transport gas and hazardous liquids.
- 4.Understand and evaluate different transient flow conditions existing in the oil and natural gas industry.
- 5. Use prediction tools to identify and mitigate transient conditions and flow assurance problems for a given production system.
- 6. Provide solutions to eliminate, mitigate or remediate operational problems in a production system.

PEGN461. SURFACE FACILITIES DESIGN AND OPERATION. 3.0 Semester Hrs.
This course will cover surface facilities typically required in the oil and gas industry. The course provides basic operation, design and evaluation of individual equipment such as Control equipment (control valve, pressure/level/flow rate/temperature), Liquid/gas Separators, Flowmeters, Boosting Equipment (pumps, compressors), Heaters, and Storage. Basic principles are described to design and evaluate different midstream processes such as Oil/water treating, Gas/liquid and liquid/liquid separation, Crude oil stabilization, Gas handling facilities, Dehydration, Gas Sweetening, Liquefied Natural Gas (LNG), Gas to Liquids (GTL). Furthermore, potential operation problems and piping and instrumentation diagram/drawing (P&ID) related to this processes will be discussed. Calculation examples and a design project can be given to integrate all acquired knowledge. Furthermore, ASME and API norms related to material selection, equipment selection, operation and maintenance will be discussed. Finally, Health, Safety, and the Environment (HSE) regulations for midstream operations will be discussed. Course objectives include learning how to select and operate different surface equipment required in the oil and natural gas industry, learning how to monitor, troubleshoot and optimize the operation of different surface equipment required in the oil and natural gas industry. Prerequisites: PEGN251, CHGN209, MATH225, PEGN305. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- 1. Select different surface equipment, typically required for oil and natural gas production, treatment and transportation, based on expected operating conditions.
- 2. Monitor, troubleshoot and optimize the operation of different surface equipment required in the oil and natural gas industry.
- 3.Design oil, water and gas handling facilities based on the expected operation requirements.

PEGN462. FLOW ASSURANCE. 3.0 Semester Hrs.
This course will cover hydrocarbon production including design and operational issues. Major subjects to be covered include the prediction of hydrates formation, paraffin, asphaltene, scale and sand deposition, and remedial actions. In addition, operational problems such as slugging, emulsions and corrosion will be covered. This course will provide to student's strong background on hydraulic modeling. Prerequisites: PEGN251, CHGN209, MATH225, and PEGN305. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- The student outcome are the abilities to understand and evaluate different flow assurance problems existing in the oil and natural gas industry. Furthermore, use prediction tools to identify flow assurance problems for a given production system; provide solutions to eliminate, mitigate or remediate flow assurance problems encountered in production systems.

PEGN463. PETROLEUM MIDSTREAM DESIGN. 3.0 Semester Hrs.
This course will cover the development of an integrated project in the midstream area. In this the students will integrate the knowledge from the midstream classes to solve a given problem with consideration of social responsibility and societal impacts. The objective is to work with several companies from the midstream sector to solve field problems. Furthermore, in this class, we will have some classes to cover more specific subjects with different presenters (i.e. safety, regulations, marketing, environment, new technologies for pipe repairs or inspections, software, process to sell/buy oil, etc), field visits, etc. 3 hours lecture; 3 semester hours. Prerequisite: PEGN460, PEGN461, PEGN462. Co-requisite: PEGN460.
Course Learning Outcomes

- TBD

PEGN481. PETROLEUM SEMINAR. 2.0 Semester Hrs.
(I) (WI) Written and oral presentations by each student on current energy topics.
This course is designated as a writing intensive course (WI).
Prerequisite: none. 2 hours lecture; 2 semester hours.
Course Learning Outcomes

- Effectively communicate in a variety of formats - both orally and in written form, and with a range of audiences
- Explain, integrate, and evaluate contemporary issues that apply to the oil and gas profession, considering economic, environmental, corporate, social, political, ethical, health, safety, manufacturability, and sustainability issues
- Demonstrate professionalism through attendance, demeanor, and participation
- Effectively function on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

PEGN482. PROFESSIONAL SKILLS 3. 1.0 Semester Hr.
This course is the third in a three-course series designed for petroleum engineering students to develop skills in oral and written communication, professionalism, diversity and ethics. The course is designed as a discussion based seminar course and will focus on oral and written communication skills, professionalism, diversity and ethics. Assignments will be based on technical and non-technical material relating to earth, energy, and the environment. Students will work individually and in multicultural teams on assignments throughout the semester. Prerequisite: PEGN382.
Course Learning Outcomes

- Critique professional and/or technical papers or reports and analyze elements of professional writing, ethics, and engineering soundness.
- Design an ideal team for a given project scenario taking into consideration required functionality for team success, leadership, varying agendas, team member collaboration, inclusive environment, diversity strategies, and Stakeholder requirements.

- Adapt communications to various audiences and stakeholders (e.g., managers, community members, regulators, technicians).

PEGN490. RESERVOIR GEOMECHANICS. 3.0 Semester Hrs.
The course provides an introduction to fundamental rock mechanics and aims to emphasize their role in oil and gas exploration, drilling, completion and production engineering operations. Deformation as a function of stress, elastic moduli, in situ stress, stress magnitude and orientation, pore pressure, strength and fracture gradient, rock characteristic from field data (seismic, logging, drilling, production), integrated wellbore stability analysis, depletion and drilling induced fractures, compaction and associated changes in rock properties, hydraulic fracturing and fracture stability are among the topics to be covered. Pre-requisites: CEEN311. 3 hours lecture; 3 hours lab, 3 semester hours.

PEGN497. SPECIAL SUMMER COURSE. 0-15 Semester Hr.

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PEGN498. SPECIAL TOPICS IN PETROLEUM ENGINEERING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

PEGN498. SPECIAL TOPICS. 1-6 Semester Hr.

PEGN499. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

PEGN499. INDEPENDENT STUDY. 1-6 Semester Hr.

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