PETROLEUM ENGINEERING

Anyone with an interest in energy and a strong desire to get paid for traveling the globe might consider the possibility of a career as a petroleum engineer. Petroleum engineers seek out oil and gas reservoirs beneath the earth’s surface. They develop the safest and most efficient methods of bringing those resources to the surface and to market.

Many petroleum engineers travel the world or live in foreign countries - wherever their explorations take them to find and recover valuable petroleum reserves. These travels can lead to the deserts, high seas, mountains, and arctic regions of the world in order to find untapped sources of energy for the world’s population. Petroleum engineers also tend to quickly assume leadership roles, handling large projects with high levels of responsibility.

Because of the increasing demand for energy, there has been an accompanying increase in the demand for petroleum engineers worldwide. In the United States, the oil industry workforce is aging, and numerous opportunities are expected as a result.

As a petroleum engineering student, you will study the technology of oil and gas drilling, production, reserves estimation, and the prediction of future production. You will also study various techniques for evaluating the characteristics of petroleum bearing formations and their fluid contents.

Petroleum Engineering is an independent degree program offered under the department of geological sciences and engineering

Mission Statement
To educate engineers for the worldwide petroleum industry, and to perform meaningful research that advances oil and gas recovery. Students graduating from the petroleum engineering program shall be well prepared to serve the industry and themselves, through their technical knowledge, ethical considerations, participation in professional societies and desire for life long learning. The petroleum engineering program emphasizes the importance of geomechanics in petroleum development, through building mechanical earth models.

Petroleum Engineering Educational Objectives

1. To produce a petroleum engineer who is capable of working as a drilling/completions, production, or reservoir engineer; or related fields of hydrogeology, petroleum transportation and storage, or oil and gas regulations.

2. To produce a petroleum engineer who understands the value of information in the exploitation of an oil or gas asset, and who can analyze and synthesize data to construct economic solutions to petroleum engineering problems.

3. To produce petroleum engineers who are recognized for their ability to integrate geology, geophysics, petrophysics and mechanical earth modeling to solve petroleum engineering problems within the framework of multidisciplinary teams.

Educational Outcomes

The petroleum engineering program educational outcomes are based on ABET’s outcomes 1 through 12 plus specific MEM related outcomes. The outcomes statements are as follows: Petroleum engineering seeks to graduate students who have:

1. The ability to apply knowledge of mathematics, science, and engineering.

2. The ability to design and conduct experiments, as well as to analyze and interpret data.

3. The 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.

4. The ability to function on multidisciplinary teams.

5. The ability to identify, formulate, and solve engineering problems.

6. The understanding of professional and ethical responsibility.

7. The ability to communicate effectively.

8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

9. Recognition of the need for and an ability to engage in life-long learning.

10. Knowledge of contemporary issues.

11. The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

12. The ability to use Mechanical Earth Modeling tools and techniques to solve problems associated with the production of oil and gas.

Bachelor of Science Petroleum Engineering

Entering freshmen desiring to study Petroleum Engineering will be admitted to the Freshman Engineering Program. They will, however, be permitted, if they wish, to state a Petroleum Engineering preference, which will be used as a consideration for available freshman departmental scholarships. The focus of the Freshman Engineering Program is on enhanced advising and career counseling, with the goal of providing to the student the information necessary to make an informed decision regarding the choice of a major. A grade point average of 2.80 or higher is required to enter the Petroleum Engineering program from the Freshman Engineering Program.

For the Bachelor of Science degree in Petroleum Engineering a minimum of 129 credit hours is required. These requirements are in addition to credit received for algebra, trigonometry, and basic ROTC courses. A student must maintain at least two grade points per credit hour for all courses taken in Petroleum Engineering.

Each student’s program of study must contain a minimum of 21 credit hours of course work in general education and must be chosen according to the following rules:

1. Six credit hours of English: All students are required to take ENGLISH 1120 and either ENGLISH 3560 (preferred) or ENGLISH 1160 or ENGLISH 1600.

2. Nine credit hours of basic humanities and social sciences: All students are required to take one history course, one economics course and one humanities course. The history course is to be selected from HISTORY 1200, HISTORY 1300, HISTORY 1310, or POL SCI 1200. The economics course may be either ECON 1100
or ECON 1200. The humanities course must be selected from “The Approved List of Humanities and Social Science Courses for Engineering Degrees” maintained by the Office of Undergraduate Studies.

3. Three credit hours as a depth requirement. Three credit hours must be taken in humanities or social sciences at the 2000-level or above and must be selected from the approved list. This course must have as a prerequisite one of the humanities or social sciences courses already taken. Foreign language courses numbered 1180 will be considered to satisfy this requirement. Students may receive humanities credit for foreign language courses in their native tongue only if the course is at the 4000-level. All courses taken to satisfy the depth requirement must be taken after graduating from high school.

4. Three credit hours of elective humanities and social sciences from the approved list.

5. Special topics and special problems and honors seminars are allowed only by petition to and approval by the student’s department chair.

The Petroleum Engineering program at Missouri S&T consists of a strong foundation in math, sciences and engineering fundamentals, plus strong content in the traditional Petroleum Engineering core areas of drilling, production and reservoir engineering. Two unique features of the curriculum are a strong sequence of courses in Geology and Geophysics, plus a two course sequence in finite element analysis and mechanical earth modeling. S&T Petroleum Engineering students are prepared to solve today’s problems and tomorrow’s. Students learn theory, have ample hands-on experiences in laboratories, and they learn many modern software packages used by the petroleum industry.

Students planning on majoring in petroleum engineering should take the following courses.

**Freshman Year**

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<tr>
<th>First Semester</th>
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<tr>
<td>ENGLISH 1120</td>
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<td>FR ENG 1100</td>
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<td>CHEM 1319</td>
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<td>PHYSICS 1135</td>
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<tr>
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<td>PET ENG 2510</td>
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<tr>
<td>MATH 1214</td>
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**Sophomore Year**

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<td>PHYSICS 2135</td>
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<td>PET ENG 3520</td>
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<td>GEOL 3310 (Geol 3319 lab optional)</td>
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<td>MECH ENG 2350</td>
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<td>CIV ENG 2200</td>
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<td>PET ENG 3320</td>
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<td>ECON 1100 or 1200</td>
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**Junior Year**

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<td>CIV ENG 3330</td>
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<td>PET ENG 4410</td>
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<td>PET ENG Reservoir Engineering Elective 4</td>
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<td>PET ENG 4710</td>
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**Senior Year**

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<td>Hum/Soc Sci Elective</td>
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**Total Credits: 129**

1. All freshmen Petroleum Engineering students must enroll in CHEM 1100.
2. Humanities/Social Science electives are to be selected from a list of approved courses as published by the department. Petroleum Engineering students are especially encouraged to study foreign languages.
3. All Petroleum Engineering students must take the Fundamentals of Engineering Examination prior to graduation. A passing grade on this examination is not required to earn a B.S. degree, however, it is the first step to becoming a registered professional engineer. This requirement is part of Missouri S&T assessment process as described in Assessment Requirements found elsewhere in this catalog. Students must sign a release form giving the University access to their Fundamentals of Engineering Examination score.
4. This is a reservoir engineering elective. Students should choose from PET ENG 4511, PET ENG 4531, PET ENG 4611, PET ENG 4311, or PET ENG 4621.
5. Select Petroleum Engineering electives in accordance with interest area. Students interested in reservoir engineering select from topics in advanced reservoir engineering, simulation, natural gas engineering, and formation characterization. Students interested in drilling/completions and production select petroleum electives such as advanced drilling, well completions, stimulation. Other general interest petroleum electives may be selected as available.
6. Students may also select ENGLISH 1160 or ENGLISH 1600.

The total number of credit hours required for a degree in Petroleum Engineering is 129.

Petroleum Engineering students must earn the grade of “C” or better in all Petroleum Engineering courses to receive credit toward graduation.

### Minor Curriculum in Petroleum Engineering

The petroleum industry employs not only petroleum but also civil, electrical, chemical, geological, mechanical and other engineers.

A petroleum engineering minor, therefore, enhances the academic credentials of a student and broadens their employment choices. A minor in petroleum engineering requires 15 hours of Missouri S&T credit to include the following:

- PET ENG 3520 Petroleum Reservoir Engineering 3
- PET ENG 4210 Drilling and Well Design 3
- PET ENG 4410 Well Performance and Production Systems 3
Two elective courses* 6

Total Credits 15

*The two elective courses are to be chosen from any petroleum engineering course and/or Petroleum Geology (GEOLOGY 5513).

Baojun Bai, Associate Professor
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Peyman Heidari, Assistant Professor
PHD The Pennsylvania State University

Steven Hilgedick, Assistant Teaching Professor
PHD Missouri University of Science and Technology

Mingzhen Wei, Assistant Professor
PHD New Mexico Tech

PET ENG 2000 Special Problems (IND 1.0-3.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

PET ENG 2001 Special Topics (IND 1.0-3.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

PET ENG 2002 Cooperative Work Training (IND 1.0-3.0)
On-the-job experience gained through cooperative education with industry, with credit arranged through departmental cooperative advisor. Grade received depends on quality of reports submitted and work supervisor's evaluation.

PET ENG 2510 Properties of Hydrocarbon Fluids (LEC 3.0)
Physical properties of petroleum fluids; chemical components of petroleum fluids. Elementary phase behavior; calculations of the physical properties of gases, liquids, and gas-liquid mixtures in equilibrium. Prerequisite: Chem 1310.

PET ENG 3000 Special Problems (IND 1.0-3.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

PET ENG 3001 Special Topics (LEC 0.0 and LAB 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

PET ENG 3320 Petrophysics (LEC 2.0 and LAB 1.0)
Fundamental properties of petroleum reservoir rocks, including lithology, porosity, absolute permeability, pore surface area, relative and effective permeability, fluid saturations, rock wettability, capillary characteristics, acoustic properties, and electrical properties. Darcy’s law for single phase linear horizontal and tilted flow and radial flow. Prerequisites: Preceded or accompanied by both Pet Eng 2510 and Physics 1135.

PET ENG 3330 Well Logging (LAB 1.0 and LEC 2.0)
An introduction to the electrical, nuclear, and acoustic properties of rocks: theory and interpretation of conventional well logs. Prerequisites: Physics 2135 or 2111; Pet Eng 3520.

PET ENG 3520 Petroleum Reservoir Engineering (LEC 3.0)
Properties of reservoir formations and fluids; reservoir volumetrics, reservoir statics, reservoir dynamics. Darcy’s law and the mechanics of single and multiphase fluid flow through reservoir rock, capillary phenomena, material balance, reservoir drive mechanisms. Prerequisite: Accompanied or preceded by Pet Eng 2510.

PET ENG 3529 Petroleum Reservoir Laboratory (LAB 1.0)
Core analysis determination of intensive properties of crude oil and its products; equipment and methods used to obtain petroleum reservoir information. Prerequisite: Accompanied or preceded by Pet Eng 3520.

PET ENG 4000 Special Problems Special Problems Special Problems (IND 0.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

PET ENG 4001 Special Topics (LEC 0.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

PET ENG 4010 Ethics and Professionalism (LEC 1.0)
Topics related to Ethics and Professionalism. Lifelong learning, teamwork and discussion of current events. (Course cannot be used for graduate credit). Prerequisite: Senior standing in Pet Eng.

PET ENG 4097 Petroleum Engineering Design (LEC 3.0)
Senior capstone design project(s) based on industry data. Application of reservoir engineering: drilling and production engineering principles to evaluate and solve an industry problem such as a new field development, evaluation of an existing reservoir asset, or analysis of field re-development. Prerequisites: Pet Eng 3520, Pet Eng 3410, and senior standing.

PET ENG 4099 Undergraduate Research (IND 0.0-6.0)
Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

PET ENG 4109 Field Studies (LAB 1.0)
Field trip, which studies different aspects of petroleum engineering like reservoirs, caprocks and traps, drilling rigs, petroleum production facilities, refineries and petroleum engineering research facilities. This course takes the students for one week to petroleum operations and geological outcrops in Oklahoma and Texas to expose students to field work.

PET ENG 4111 Fundamental Digital Applications In Petroleum Engineering (LEC 3.0)
Applications of Windows-based Visual Basic solutions to engineering problems including selected topics in fluid flow, PVT behavior, matrices in engineering solutions, translating curves to computer solutions, predictor-corrector material balance solutions, and graphical display of results. Prerequisite: Junior Standing.

PET ENG 4210 Drilling and Well Design (LAB 1.0 and LEC 2.0)
This course covers drilling fluids, including mixing and analysis of rheological properties; pressure loss calculations; casing design; well cementing; pore pressure and geomechanical considerations in drilling; completion equipment; and completion design. Prerequisite: Preceded or accompanied by Civ Eng 3330.

PET ENG 4211 Advanced Drilling Technology (LEC 3.0)
In-depth study of directional well planning and drilling. The course covers the bottom hole assembles and operational techniques used in drill directional drilling as well as the limiting factors and hole problems related to horizontal wells. Prerequisites: Pet Eng 4210.
PET ENG 4311 Reservoir Characterization (LEC 3.0)
The integration and extrapolation of Geologic, Geophysical, and Petroleum Engineering data for flow model construction. Prerequisites: Pet Eng 3520 and Pet Eng 3310.

PET ENG 4410 Well Performance and Production Systems (LEC 2.0 and LAB 1.0)
Introduction to the producing wellbore system; inflow performance relationships, effect of formation damage on well flow, nodal systems analysis; perforating methods and their effect on inflow; stimulation treatments to enhance well performance. Introduction to well completions, diagnostics and well servicing. Overview of production systems. Prerequisite: Preceded or accompanied by Pet Eng 3520.

PET ENG 4421 Artificial Lift (LEC 3.0)
This course is a study of artificial lift methods used to produce liquids (oil/water) from wellbores. Methods covered include sucker rod (piston) pumps, electric submersible pumps, gas lift, hydraulic lift and plunger lift. Prerequisite: Pet Eng 4410.

PET ENG 4431 Well Completion Design (LEC 3.0)
An overview of the hardware, fluids and processes employed in completing oil and gas wells. Examination of types of well completions and considerations in their design. Introduction to downhole mechanics and tubing movement and stress calculations. Prerequisite: Pet Eng 3520.

PET ENG 4441 Well Stimulation (LEC 3.0)
This course reviews fundamentals of hydraulic fracturing and builds on the basic theory through the use of STIMPLAN software and hands on industry examples. The course teaches the methods used to plan, execute and evaluate hydraulic fracturing treatments. Students may not earn credit for both Pet Eng 4441 and Pet Eng 6441. Prerequisites: Pet Eng 3520 and Pet Eng 3330.

PET ENG 4511 Applied Petroleum Reservoir Engineering (LEC 3.0)
Quantitative study of oil production by natural forces, gas cap, water influx, solution gas, etc.; material balance equations, study of gas, non-retrograde gas condensate, and black oil reservoirs. Predictive calculations of oil recovery from different reservoir types. Prerequisites: Pet Eng 3520 and 3529.

PET ENG 4520 Well Test Analysis (LEC 2.0 and LAB 1.0)
Causes of low well productivity; analysis of pressure buildup tests, drawdown tests, multi-rate tests, injection well fall off tests, and open flow potential tests; design of well testing procedures. Prerequisite: Pet Eng 3520.

PET ENG 4531 Natural Gas Engineering (LEC 3.0)
Gas reserves estimation, deliverability, and future production performance prediction. Deliverability testing of gas wells including isochronal, flow after flow, drawdown and buildup. Gasfield development and underground storage. Gas production metering gauging and transmission. Prerequisite: Preceded or accompanied by Pet Eng 3520.

PET ENG 4590 Petroleum Economics and Asset Valuation (LEC 3.0)
Uncertainty in the estimation of oil and gas reserves; tangible and intangible investment costs; depreciation; evaluation of producing properties; federal income tax considerations; chance factor and risk determination. Petroleum economic evaluation software is introduced. Prerequisites: Pet Eng 3520, Econ 1100 or Econ 1200.

PET ENG 4611 Secondary Recovery Of Petroleum (LEC 3.0)
Oil recovery by water injection. Effects of wettability, capillary pressure, relative permeability, mobility ratio on displacement, sweep, and recovery efficiencies. Piston-like and Buckley-Leverett models. Fractional flow and front advance equation. Oil recovery prediction methods for linear and pattern waterfloods in single and multi-layered reservoirs. Prerequisites: Pet Eng 3520, Pet Eng 3529.

PET ENG 4621 Fundamentals Of Petroleum Reservoir Simulation (LEC 3.0)

PET ENG 4631 Applied Reservoir Simulation (LEC 3.0)
Simulation of actual reservoir problems using both field and individual well models to determine well spacing, production effects of secondary and enhanced recovery processes, future rate predictions and recovery, coning effects, relative permeability adjustments and other history matching techniques. Prerequisite: Pet Eng 3520.

PET ENG 4710 Finite Element Analysis with Applications in Petroleum Engineering (LEC 2.0 and LAB 1.0)
This course introduces finite element analysis (FEA) methods and applications of FEA in subsurface engineering. The course is intended to provide a fundamental understanding of FEA software and experience in creating meshes for petroleum reservoirs or other subsurface features. Prerequisites: Pet Eng 3520, Geology 3310, and Math 3304.

PET ENG 4720 Mechanical Earth Modeling (LEC 3.0)
This course introduces the work process necessary to create the Mechanical Earth Model's principle components, formation in-situ stress and strength. 1-D modeling methods are reviewed and extended to 3-D; and the integration of MEM with well design is shown. An MEM model will be created and compared to actual field results. Prerequisites: Pet Eng 3310 and Geology 3310.

PET ENG 4811 Offshore Petroleum Technology (LEC 3.0)
An introduction to the development of oil and gas fields offshore, including offshore leasing, drilling, well completions, production facilities, pipelines, and servicing. Subsea systems, and deepwater developments are also included. This course is suitable for mechanical, electrical and civil engineering students interested in ultimately working offshore.

PET ENG 4821 Environmental Petroleum Applications (LEC 3.0)
This course is a study of environmental protection and regulatory compliance in the oil and gas industry. The impact of various environmental laws on drilling and production operations will be covered. Oilfield and related wastes and their handling are described. Federal, state and local regulatory agencies are introduced, and their role in permitting and compliance monitoring is presented. Legal and ethical responsibilities are discussed. Prerequisite: Chem 3130.

PET ENG 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects of projects in the department. Consent of instructor required.

PET ENG 5001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

PET ENG 5010 Seminar (RSD 0.0-6.0)
Discussion of current topics.
**PET ENG 5040 Oral Examination** (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/comprehensive examination (oral/written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

**PET ENG 5085 Internship** (IND 0.0-15)
Students working toward a doctor of engineering degree will select, with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

**PET ENG 5099 Research** (IND 0.0-12)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.