

# PETROLEUM AND NATURAL GAS ENGINEERING, B.S.

**Begin Campus:** Any Penn State Campus

**End Campus:** University Park

## Program Description

The undergraduate curriculum in Petroleum and Natural Gas Engineering has been designed to equip the student with the fundamentals necessary to achieve lifelong professional growth. Graduates are prepared to enter both the private and public sectors as petroleum and natural gas engineers or to pursue further education at the graduate level.

The courses are structured to serve as a melting pot for theory, application to case studies, and engineering project design. This enables the student to appreciate and understand that a successful engineering design project requires a sound theoretical foundation, experimentation and engineering judgment. The thrust of the program structure emphasizes the fundamentals of mathematics and earth and engineering sciences and integrates them in application to traditional petroleum and natural gas engineering topics. Design projects are required throughout the curriculum. Execution of these projects requires an amalgamation of problem formulation strategies, testing of alternative design methodologies, feasibility studies, and economic and environmental considerations. Graduates of the program are expected to perform in various facets of the petroleum industry including drilling, production, evaluation, transportation, and storage. The petroleum and natural gas engineering faculty and staff are committed to an interactive teaching and learning environment to ensure that the student is an active participant in the learning process. General education opportunities are sufficiently broad and diverse in scope to enable the student to tailor the educational experience to particular interests, background, and expected role in society.

## What is Petroleum and Natural Gas Engineering?

Petroleum and Natural Gas Engineering is a field related to the extraction of hydrocarbon resources (either crude oil or natural gas) from subsurface reservoirs. As such, petroleum and natural gas engineers predominantly work in the upstream sector of the oil and energy industries, which comprises exploration, field development, well drilling, production and injection well optimization, and wastewater disposal and CO<sub>2</sub> sequestration well planning. Once oil and gas are discovered, petroleum engineers determine optimum drilling and completion methods, monitor and manage production operations, and design reservoir development strategies. They have the responsibility of providing engineering solutions with global economic, environmental, geopolitical, and societal impacts. Petroleum and natural gas engineers work closely with geoscientists and other science and technology specialists. In addition to hydrocarbon extraction, they are also well-suited to solve complex problems in geothermal energy, geological carbon sequestration, wastewater disposal, and environmental remediation of soil, groundwater, and other geologic media.

## You Might Like This Program If...

- You enjoy combining disciplines such as geology, physics, and mathematics to solve complex problems of importance to society.

- You want to use science and engineering principles to tackle the challenges of global energy demands.
- You seek a profession that offers domestic and international networking opportunities.
- You enjoy working in the field, performing sophisticated computer simulations, or interpreting geologic and production data.

## Entrance to Major

This program currently has administrative enrollment controls. Administrative Enrollment Controls are initiated when limitations of space, faculty, or other resources in a major prevent accommodating all students who request them. Students must follow the administrative enrollment controls that are in effect for the semester that they enter the university.

## First-Year Students Entering Summer 2023, Fall 2023, Spring 2024

In order to be eligible for entrance to this major, students must satisfy the following requirements:

- be enrolled in the College of Earth and Mineral Sciences or the Division of Undergraduate Studies
- 29.1-74 graded Penn State credits (excludes transfer and AP credits)
- completed with a grade of C or better: CHEM 110, MATH 140, MATH 141, PHYS 211
- earned a minimum cumulative grade-point average (GPA) of 2.00

## Students Who Entered Prior to Summer 2023

Students who entered the University from Summer 2018 through Spring 2023 should view the administrative enrollment controls in the appropriate Undergraduate Bulletin archive (<https://bulletins.psu.edu/undergraduate/archive/>). Students who entered the University prior to the summer 2018 semester should consult with their academic adviser about the administrative enrollment controls in effect for the semester they entered the university.

## Degree Requirements

**For the Bachelor of Science degree in Petroleum and Natural Gas Engineering, a minimum of 129 credits is required:**

Requirement	Credits
General Education	45
Requirements for the Major	114

**30 of the 45 credits for General Education are included in the Requirements for the Major. This includes: 3 credits of GH courses; 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.**

## Requirements for the Major

To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 (<https://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44>).

Code	Title	Credits
<b>Prescribed Courses</b>		
CHEM 111	Experimental Chemistry I	1

ECON 102	Introductory Microeconomic Analysis and Policy	3
EMCH 210	Statics and Strength of Materials <sup>2</sup>	5
EMCH 212	Dynamics	3
EME 460	Geo-resource Evaluation and Investment Analysis	3
EMSC 100S	Earth and Mineral Sciences First-Year Seminar <sup>1</sup>	3
ENGL 202C	Effective Writing: Technical Writing	3
GEOSC 1	Physical Geology	3
GEOSC 454	Geology of Oil and Gas	3
MATH 220	Matrices	2
MATH 231	Calculus of Several Variables	2
MATH 251	Ordinary and Partial Differential Equations	4
PNG 301	Introduction to Petroleum and Natural Gas Engineering	3
PNG 420	Applied Reservoir Analysis and Secondary Recovery	3
PNG 425	Principles of Well Testing and Evaluation	3
PNG 430	Reservoir Modeling	3
PNG 440W	Formation Evaluation	3
PNG 480	Surface Production Engineering	3
PNG 482	Production Engineering Laboratory	1
PNG 490	Petroleum and Natural Gas Engineering Capstone Design	1
PNG 491	Capstone Design in Drilling and Completions	1
PNG 492	Petroleum Engineering Capstone Design	1
<i>Prescribed Courses: Require a grade of C or better</i>		
CHEM 110	Chemical Principles I	3
CHEM 112	Chemical Principles II	3
EME 301	Thermodynamics in Energy and Mineral Engineering	3
EME 303	Fluid Mechanics in Energy and Mineral Engineering	3
MATH 140	Calculus With Analytic Geometry I	4
MATH 141	Calculus with Analytic Geometry II	4
PHYS 211	General Physics: Mechanics	4
PHYS 212	General Physics: Electricity and Magnetism	4
PNG 405	Rock and Fluid Properties	3
PNG 406	Rock and Fluid Laboratory	1
PNG 410	Applied Reservoir Engineering	3
PNG 450	Drilling Engineering	3
PNG 451	Drilling Laboratory	1
PNG 475	Production and Completions Engineering	3
<b>Additional Courses</b>		
Select 9 credits: one course from categories A, B, and C:		9
A.		
ENGL 15	Rhetoric and Composition or ENGL 30H Honors Rhetoric and Composition	
B.		
PHIL 103	Ethics	
PHIL 106	Business Ethics	
PHIL 107	Philosophy of Technology	
PHIL 233	Ethics and the Design of Technology	
C.		
CMPSC 201	Programming for Engineers with C++	

or CMPSC 202

**Supporting Courses and Related Areas**

Select 6 credits in consultation with adviser (students may apply 6 credits of ROTC) 6

<sup>1</sup> The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 can be substituted for EMSC 100S.

<sup>2</sup> Students at commonwealth campuses and/or transfer students can substitute the combination of EMCH 211 and EMCH 213.

**General Education**

Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (<https://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program/>) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

**Foundations (grade of C or better is required and Inter-Domain courses do not meet this requirement.)**

- **Quantification (GQ):** 6 credits
- **Writing and Speaking (GWS):** 9 credits

**Breadth in the Knowledge Domains (Inter-Domain courses do not meet this requirement.)**

- **Arts (GA):** 3 credits
- **Health and Wellness (GHW):** 3 credits
- **Humanities (GH):** 3 credits
- **Social and Behavioral Sciences (GS):** 3 credits
- **Natural Sciences (GN):** 3 credits

**Integrative Studies**

- **Inter-Domain Courses (Inter-Domain):** 6 credits

**Exploration**

- **GN**, may be completed with Inter-Domain courses: 3 credits
- **GA, GH, GN, GS, Inter-Domain courses.** This may include 3 credits of World Language course work beyond the 12th credit level or the requirements for the student's degree program, whichever is higher: 6 credits

**University Degree Requirements****First Year Engagement**

All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

### Cultures Requirement

6 credits are required and may satisfy other requirements

- United States Cultures: 3 credits
- International Cultures: 3 credits

### Writing Across the Curriculum

3 credits required from the college of graduation and likely prescribed as part of major requirements.

### Total Minimum Credits

A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

### Quality of Work

Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

### Limitations on Source and Time for Credit Acquisition

The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (<https://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#83-80>)). For more information, check the Suggested Academic Plan for your intended program.

## Integrated B.S. in Petroleum and Natural Gas Engineering and M.S. in Energy and Mineral Engineering

Requirements for the Integrated B.S. in Petroleum and Natural Gas Engineering and M.S. in Energy and Mineral Engineering can be found in the Graduate Bulletin (<https://bulletins.psu.edu/graduate/programs/majors/energy-mineral-engineering/#integratedundergradgradprogramstext>).

## Program Educational Objectives

1. Our graduates will integrate key science and engineering principles to address the technological challenges of the petroleum and natural gas industry.
2. Our graduates will practice in a broad range of petroleum engineering fields working on teams that create innovative solutions to the most pressing problems of the petroleum and natural gas industry by implementing the ideals of ethical behavior, professionalism, and environmental sensitivity and social awareness.
3. Our graduates will be recognized as critical and independent thinkers and will assume positions of leadership in defining the social, intellectual, business and technical dimensions of the professional organizations they belong to.
4. Our graduates will continue their lifelong learning process and participate in graduate education to remain as effective professionals in the workplace of the future.

## Student Outcomes

Student outcomes describe what students are expected to know and be able to do by the time of graduation. The Petroleum and Natural Gas Engineering program is designed to enable students to:

1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. 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
3. Communicate effectively with a range of audiences
4. 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
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.

## Academic Advising

The objectives of the university's academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in- and out-of class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee's unit of enrollment will provide each advisee with a primary academic adviser, the information needed to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (<https://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy/>)

### University Park

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## Suggested Academic Plan

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2023-24 academic year. To access previous years' suggested academic plans, please visit the archive (<https://bulletins.psu.edu/undergraduate/archive/>) to view the appropriate Undergraduate Bulletin edition (*Note: the archive only contains suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin*).

### Petroleum and Natural Gas Engineering, B.S. at University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

#### First Year

Fall	Credits	Spring	Credits
MATH 140 or 140G (GQ) <sup>*†#††</sup>	4	MATH 141 or 141G (GQ) <sup>*†#††</sup>	4
CHEM 110 (GN) <sup>*#††</sup>	3	ENGL 15, 30H, or ESL 15 (GWS) <sup>††</sup>	3
CHEM 111 (GN) <sup>†</sup>	1	CHEM 112 <sup>*#</sup>	3
EMSC 100S (or CAS 100 by substitution) (GWS) <sup>††1</sup>	3	PHYS 211 (GN) <sup>*#†</sup>	4
ECON 102 (GS) <sup>†</sup>	3	General Education Knowledge Domain	3
General Education Knowledge Domain	3		
	<b>17</b>		<b>17</b>

#### Second Year

Fall	Credits	Spring	Credits
PHYS 212 (GN) <sup>*†</sup>	4	PNG 301	3
EMCH 210	5	MATH 220	2
MATH 251	4	MATH 231	2
EME 210 or CMPSC 201	3	EMCH 212	3
		GEOSC 1	3
		PHIL 103, 106, 107, or 233 (GH) <sup>†</sup>	3
	<b>16</b>		<b>16</b>

#### Third Year

Fall	Credits	Spring	Credits
PNG 405 <sup>*</sup>	3	PNG 450 <sup>*</sup>	3
PNG 406 <sup>*</sup>	1	PNG 451 <sup>*</sup>	1
EME 301 <sup>*</sup>	3	PNG 475 <sup>*</sup>	3
EME 303 <sup>*</sup>	3	PNG 490	1
PNG 440W (Writing across the curriculum)	3	GEOSC 454	3
General Education Knowledge Domain	3	PNG 410 <sup>*</sup>	3
		General Education Health and Wellness (GHW)	1.5
	<b>16</b>		<b>15.5</b>

#### Fourth Year

Fall	Credits	Spring	Credits
PNG 420	3	PNG 425	3
PNG 430	3	PNG 480	3
PNG 491	1	PNG 482	1
ENGL 202C (GWS) <sup>††</sup>	3	PNG 492	1
EME 460	3	Technical Elective from approved department list <sup>2</sup>	3
Technical Elective from approved department list <sup>2</sup>	3	General Education Knowledge Domain	3
		General Education Health and Wellness (GHW)	1.5
	<b>16</b>		<b>15.5</b>

#### Total Credits 129

- \* Course requires a grade of C or better for the major
- † Course requires a grade of C or better for General Education
- # Course is an Entrance to Major requirement
- † Course satisfies General Education and degree requirement

#### University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy Cultural Diversity Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and satisfy a portion of that General Education requirement. If the student's program prescribes GWS these courses will replace both ENGL 15/ENGL 30H and CAS 100A/CAS 100B/CAS 100C. Each course is 3 credits.

<sup>1</sup> Students who begin their studies at non-UP locations and/or join the college after their first year should substitute CAS 100, CAS 100A, CAS 100B, or CAS 100C (GWS) for EMSC 100S (GWS). EMSC 100S Earth and Mineral Sciences First year Seminar (3) is a required course only for students who begin their studies at UP in the College of Earth and Mineral Sciences.

<sup>2</sup> Approved Technical Electives for the PNGE major can be found at the department web site: <http://www.eme.psu.edu/pnge/techelectives>. Students may use up to 6 credits of ROTC as technical electives.

#### Advising Notes:

Only students who are enrolled in EMSC or DUS are eligible to apply to PNGE.

Courses required for the major may be offered fall semester only, spring semester only, or both fall and spring semesters. Consult with your adviser and department to discuss your academic progress and course sequencing.

The PNGE program strongly recommends that students have summer internships, as many companies will only consider hiring PNGE graduates who have had at least one internship.

## Petroleum and Natural Gas Engineering, B.S. at Commonwealth Campuses

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

### First Year

Fall	Credits	Spring	Credits
MATH 140 (GQ) <sup>*†##</sup>	4	MATH 141 (GQ) <sup>*†##</sup>	4
CHEM 110 (GN) <sup>*##†</sup>	3	CHEM 112 <sup>*#</sup>	3
CHEM 111 (GN) <sup>†</sup>	1	PHYS 211 (GN) <sup>*##†</sup>	4
ENGL 15, 30H, or ESL 15 (GWS) <sup>††</sup>	3	ECON 102 (GS) <sup>†</sup>	3
General Education Knowledge Domain	3	General Education Health and Wellness (GHW)	1.5
General Education Health and Wellness (GHW)	1.5		
	<b>15.5</b>		<b>15.5</b>

### Second Year

Fall	Credits	Spring	Credits
PHYS 212 (GN) <sup>*†</sup>	4	PNG 301	3
EMCH 211	3	EMCH 212	3
MATH 251	4	EMCH 213	3
CAS 100, CAS 100A, CAS 100B, or CAS 100C (GWS) <sup>††1</sup>	3	MATH 220	2
EME 210 or CMPSC 201 (If CMPSC 201 is not available at your campus, take CMPSC 121 instead)	3	MATH 231	2
		GEOSC 1	3
	<b>17</b>		<b>16</b>

### Third Year

Fall	Credits	Spring	Credits
PNG 405 <sup>*</sup>	3	PNG 450 <sup>*</sup>	3
PNG 406 <sup>*</sup>	1	PNG 451 <sup>*</sup>	1
PNG 440W (Writing across the curriculum)	3	PNG 475 <sup>*</sup>	3
EME 301 <sup>*</sup>	3	PNG 490	1
EME 303 <sup>*</sup>	3	GEOSC 454	3
General Education Knowledge Domain	3	PNG 410 <sup>*</sup>	3
		PHIL 103, 106, 107, or 233 (GH) <sup>†</sup>	3
	<b>16</b>		<b>17</b>

### Fourth Year

Fall	Credits	Spring	Credits
PNG 420	3	PNG 425	3
PNG 430	3	PNG 480	3
PNG 491	1	PNG 482	1
EME 460	3	PNG 492	1

ENGL 202C (GWS) <sup>††</sup>	3	Technical Elective from approved department list <sup>2</sup>	3
Technical Elective from approved department list <sup>2</sup>	3	General Education Knowledge Domain	3
		General Education Knowledge Domain	3
	<b>16</b>		<b>17</b>

### Total Credits 130

\* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

# Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

### University Requirements and General Education Notes:

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General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

<sup>1</sup> Students who begin their studies at non-UP locations and/or join the college after their first year should substitute CAS 100, CAS 100A, CAS 100B, or CAS 100C (GWS) for EMSC 100S (GWS). EMSC 100S Earth and Mineral Sciences First year Seminar (3) is a required course only for students who begin their studies at UP in the College of Earth and Mineral Sciences.

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The PNGE program strongly recommends that students have summer internships, as many companies will only consider hiring PNGE graduates who have had at least one internship.

## Career Paths

Graduates of this program find rewarding careers across the globe as engineers for governmental and regulatory bodies, oil and gas producing companies, and other independent and service companies in the energy sector.



## Careers

Our graduates may be candidates for careers in a wide range of industries in both the private and public sector including major oil and gas production companies, large and small independents and service companies and government agencies. The oil and gas industry is a global industry, and both U.S. domestic and international careers are commonly pursued by PNGE graduates.

MORE INFORMATION ABOUT POTENTIAL CAREER OPTIONS FOR GRADUATES OF THE PETROLEUM AND NATURAL GAS ENGINEERING PROGRAM (<https://www.eme.psu.edu/recruiting-careers/>)

## Opportunities for Graduate Studies

Graduates may be well suited to pursue graduate-level studies. Further study toward an M.S. or Ph.D. can lead to research, university, or management positions.

MORE INFORMATION ABOUT OPPORTUNITIES FOR GRADUATE STUDIES (<https://www.eme.psu.edu/graduate/>)

## Professional Resources

- Society of Petroleum Engineers Penn State Student Chapter (<https://sites.psu.edu/spepennstate/positive-energy/>)
- American Association of Drilling Engineers Penn State Student Chapter (<https://orgcentral.psu.edu/organization/aade/>)
- Positive Energy (<https://sites.psu.edu/spepennstate/positive-energy/>)
- International Society of Explosives Engineers Penn State Student Chapter (<https://www.eme.psu.edu/undergraduate/undergraduate-resources/student-organizations/>)

## Accreditation

The Bachelor of Science in Petroleum and Natural Gas Engineering at University Park is accredited by the Engineering Accreditation Commission of ABET, <https://www.abet.org>, under the General Criteria and the Petroleum Engineering Program Criteria.

## Professional Licensure/Certification

Many U.S. states and territories require professional licensure/certification to be employed. If you plan to pursue employment in a licensed profession after completing this program, please visit the Professional Licensure/Certification Disclosures by State (<https://www.psu.edu/state-licensure-disclosures/>) interactive map.

## Contact

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