Department of Petroleum & Natural Gas Engineering

E-mail: Statler-PNGE@mail.wvu.edu (samuel.ameri@mail.wvu.edu)

Degree Offered

- Bachelor of Science in Petroleum and Natural Gas Engineering (B.S.P.N.G.E.)

Nature of the Program

Petroleum and Natural Gas Engineering is concerned with design and application aspects of the discovery, production, and transportation of oil and natural gas resources.

Professionals in this field must have a thorough understanding of the geological principles relating to the occurrence, discovery, and production of fluid hydrocarbons. The petroleum and natural gas engineer must know and be capable of applying both conventional engineering design principles as well as those pertaining specifically to the field of petroleum and natural gas engineering. These are developed in the petroleum and natural gas engineering courses in the curriculum. In addition, a strong foundation in mathematics and the sciences broadens the future engineer’s professional capabilities. Because many engineers will be employed as supervisors or executives, managerial and social skills are also emphasized.

Students are offered the opportunity to enter all phases of the petroleum and natural gas industry in meaningful and important jobs, continue their education towards advanced degrees, or in some cases pursue a combination of professional employment and continued education. The petroleum and natural gas engineering program is accredited by the Engineering Accreditation Commission (EAC) of ABET, http://www.abet.org.

Program Learning Objectives

- The graduates will be successful in their professional careers as petroleum engineers in the energy industry, government agencies, and/or postgraduate education.
- The graduates will continue to develop professionally and serve in leadership roles.
- The graduates will be successful in demonstrating their obligations to the profession, to their employer, and to society.

The foundation for achieving program objectives is established through a rigorous curriculum that provides the students with:

- An understanding of scientific and engineering principles and the application of these principles in solving petroleum and natural gas engineering problems using modern tools
- An integrated design experience leading to a capstone design course
- A balanced and rounded education to recognize the need for developing technical communication and teamwork skills, as well as understanding the engineer’s professional, ethical, and societal obligations

Student Outcomes

Upon graduation, all Bachelor of Science in Petroleum and Natural Gas Engineering students will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. 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
3. An ability to communicate effectively with a range of audiences
4. 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
5. 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
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

These outcomes are achieved by enrolling in rigorous individual courses in all basic areas of petroleum and natural gas engineering, basic science, mathematics, geology, and humanities and social sciences. The petroleum and natural gas engineering curriculum also contains significant laboratory components aimed at reinforcing the knowledge gained in the classroom. In the senior year, electives are offered in which the student may obtain additional depth of knowledge in specific areas of petroleum and natural gas engineering technology. Each student is individually assisted in course selection by an adviser who is a member of the petroleum and natural gas engineering faculty.
Students gain practical experience and first-hand knowledge of many aspects of petroleum and natural gas engineering through close proximity to the industry in West Virginia and surrounding states. Production sites, secondary and enhanced oil recovery projects, compressor stations, gas storage fields, and corporate offices all provide excellent opportunities for our students. Additional experience is provided through modern, well-equipped laboratories within the department and the University. Students are urged to gain field experience through summer employment in the industry.

FACULTY

CHAIR

• Samuel Ameri - M.S.Pet.E., P.E. (West Virginia University)
  Formation Evaluation

PROFESSORS

• Kashy Aminian - Ph.D. (University of Michigan)
  Graduate Coordinator. Natural Gas Engineering, Unconventional Reservoirs
• Shahab Mohaghegh - Ph.D. (Pennsylvania State University)
  Intelligent Systems, Shale Analytics

ASSOCIATE PROFESSOR

• H. Ilkin Bilgesu - Ph.D., P.E. (Pennsylvania State University)
  Drilling and Production Engineering
• Ebrahim Fathi - Ph.D. (University of Oklahoma)
  Phase Behavior

ASSISTANT PROFESSOR

• Ming Gu - Ph.D. (University of Texas)
  Rock Mechanics
• Mehrdad Zamirian - Ph.D. (West Virginia University)
  Property Evaluation
• Ali Takbiri Borujeni - Ph.D. (Louisiana State University)
  Stimulation Design

ADJUNCT PROFESSORS

• Alan Brannon - Ph.D. (West Virginia University)
  Petroleum Engineering Fundamentals
• Josh Dalton - MS, PNGE
• Pramod Thakur - Ph.D. (Pennsylvania State University)
  Coalbed Methane

Click here to view the Suggested Plan of Study (p. 4)

Curriculum in Petroleum and Natural Gas Engineering

General Education Foundations

Please use this link to view a list of courses that meet each GEF requirement. (http://registrar.wvu.edu/gef)

NOTE: Some major requirements will fulfill specific GEF requirements. Please see the curriculum requirements listed below for details on which GEFs you will need to select.

<table>
<thead>
<tr>
<th>General Education Foundations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 - Composition &amp; Rhetoric</td>
<td>3-6</td>
</tr>
<tr>
<td>ENGL 101</td>
<td>Introduction to Composition and Rhetoric</td>
</tr>
<tr>
<td>&amp; ENGL 102</td>
<td>and Composition, Rhetoric, and Research</td>
</tr>
<tr>
<td>or ENGL 103</td>
<td>Accelerated Academic Writing</td>
</tr>
<tr>
<td>F2A/F2B - Science &amp; Technology</td>
<td>4-6</td>
</tr>
<tr>
<td>F3 - Math &amp; Quantitative Reasoning</td>
<td>3-4</td>
</tr>
<tr>
<td>F4 - Society &amp; Connections</td>
<td>3</td>
</tr>
<tr>
<td>F5 - Human Inquiry &amp; the Past</td>
<td>3</td>
</tr>
<tr>
<td>F6 - The Arts &amp; Creativity</td>
<td>3</td>
</tr>
</tbody>
</table>
Please note that not all of the GEF courses are offered at all campuses. Students should consult with their advisor or academic department regarding the GEF course offerings available at their campus.

### Curriculum Requirements

To receive a degree of bachelor of science in petroleum and natural gas engineering, a student must meet the University's undergraduate degree requirements, take all of the courses indicated below, earn a grade of C- or better in all petroleum and natural gas engineering courses, and attain a grade point average of 2.25 or better in all petroleum and natural gas engineering courses, in all WVU courses, and overall. If a petroleum and natural gas engineering course is repeated, only the last grade received is used to compute the major grade point average, and the course credit hours are counted only once. This requirement assures that the student has demonstrated overall competence in the major.

#### Freshman Engineering Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 101</td>
<td>Engineering Problem Solving 1</td>
<td>2</td>
</tr>
<tr>
<td>CHE 102</td>
<td>Introduction to Chemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 102</td>
<td>Engineering Problem-Solving 2</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 103</td>
<td>Introduction to Nanotechnology Design</td>
<td>3</td>
</tr>
<tr>
<td>MAE 102</td>
<td>Introduction to Mechanical and Aerospace Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 191</td>
<td>First-Year Seminar</td>
<td>1</td>
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</tbody>
</table>

#### Non-Petroleum & Natural Gas Engineering Core

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CHEM 115</td>
<td>Fundamentals of Chemistry and Fundamentals of Chemistry 1 - Laboratory (GEF 2B)</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 116</td>
<td>Fundamentals of Chemistry and Fundamentals of Chemistry 2 - Laboratory (GEF 8)</td>
<td>4</td>
</tr>
<tr>
<td>ECON 201</td>
<td>Principles of Microeconomics (GEF 4)</td>
<td>3</td>
</tr>
<tr>
<td>ECON 202</td>
<td>Principles of Macroeconomics</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 101</td>
<td>Planet Earth</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 373</td>
<td>Introduction to Petroleum Geology</td>
<td>3</td>
</tr>
<tr>
<td>MATH 155</td>
<td>Calculus 1 (Minimum grade of C- is required)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 153</td>
<td>Calculus 1a with Precalculus and Calculus 1b with Precalculus (Minimum grade of C- is required)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 156</td>
<td>Calculus 2 (GEF 8 - Minimum grade of C- is required)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 251</td>
<td>Multivariable Calculus (Minimum grade of C- is required)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 261</td>
<td>Elementary Differential Equations</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 111</td>
<td>General Physics (GEF 8)</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 112</td>
<td>General Physics</td>
<td>4</td>
</tr>
<tr>
<td>STAT 215</td>
<td>Introduction to Probability and Statistics</td>
<td>3</td>
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<tr>
<td>or IENG 213</td>
<td>Engineering Statistics</td>
<td>3</td>
</tr>
<tr>
<td>EE 221</td>
<td>Introduction to Electrical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>MAE 241</td>
<td>Statics</td>
<td>3</td>
</tr>
<tr>
<td>MAE 243</td>
<td>Mechanics of Materials</td>
<td>3</td>
</tr>
<tr>
<td>MAE 320</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>MAE 331</td>
<td>Fluid Mechanics</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Petroleum & Natural Gas Engineering Core Requirements (Minimum grade of C- required)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>PNGE 200</td>
<td>Introduction to Petroleum Engineering</td>
<td>3</td>
</tr>
<tr>
<td>PNGE 310</td>
<td>Drilling Engineering</td>
<td>4</td>
</tr>
<tr>
<td>PNGE 312</td>
<td>Drilling Fluids Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>PNGE 332</td>
<td>Petroleum Properties and Phase Behavior (Fulfills Writing and Communications Skills Requirement)</td>
<td>3</td>
</tr>
<tr>
<td>PNGE 333</td>
<td>Basic Reservoir Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>
### Suggested Plan of Study

It is important for students to take courses in the order specified as much as possible; all prerequisites and concurrent requirements must be observed. A typical B.S.P.N.G.E. degree program that completes degree requirements in four years is as follows.

**First Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 155 (GEF 3)</td>
<td>4</td>
<td>MATH 156 (GEF 8)</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 101</td>
<td>2</td>
<td>ENGR 102</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 191</td>
<td>1</td>
<td>PHYS 111 (GEF 8)</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 115 &amp; 115L (GEF 2B)</td>
<td>4</td>
<td>CHEM 116 &amp; 116L (GEF 8)</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 101 (GEF 1)</td>
<td>3</td>
<td>GEF Elective 6</td>
<td>3</td>
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<tr>
<td>GEF Elective 5</td>
<td></td>
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<td></td>
<td>17</td>
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<td>18</td>
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**Second Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>PHYS 112</td>
<td>4</td>
<td>MATH 261</td>
<td>4</td>
</tr>
<tr>
<td>MATH 251</td>
<td>4</td>
<td>MAE 243</td>
<td>3</td>
</tr>
<tr>
<td>MAE 241</td>
<td>3</td>
<td>ENGL 102 (GEF 1)</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 101</td>
<td>3</td>
<td>PNE 200</td>
<td>3</td>
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<td>17</td>
<td></td>
<td>16</td>
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</table>

**Third Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>PNGE 332</td>
<td>3</td>
<td>PNGE 310</td>
<td>4</td>
</tr>
<tr>
<td>EE 221</td>
<td>3</td>
<td>PNGE 312</td>
<td>1</td>
</tr>
<tr>
<td>ECON 201 (GEF 4)</td>
<td>3</td>
<td>PNGE 333</td>
<td>3</td>
</tr>
<tr>
<td>MAE 320</td>
<td>3</td>
<td>ECON 202</td>
<td>3</td>
</tr>
<tr>
<td>GEF Elective 7</td>
<td>3</td>
<td>GEOL 373</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td>Additional GEF Course</td>
<td>3</td>
</tr>
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<td></td>
<td>15</td>
<td></td>
<td>17</td>
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</tbody>
</table>

**Fourth Year**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNGE 420</td>
<td>3</td>
<td>PNGE 400</td>
<td>1</td>
</tr>
</tbody>
</table>
PNGE 434  3 PNGE 405  1
PNGE 441  3 PNGE 432  1
PNGE 450  3 PNGE 480  3
PNGE 470  4 Two Professional Electives  6

Total credit hours: 128

Student Outcomes

Upon graduation, all Bachelors of Science of Science in Petroleum and Natural Gas Engineering students will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. 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
3. An ability to communicate effectively with a range of audiences
4. 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
5. 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
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

PNGE 191. First-Year Seminar. 1-3 Hours.
Engages students in active learning strategies that enable effective transition to college life at WVU. Students will explore school, college and university programs, policies and services relevant to academic success. Provides active learning activities that enable effective transition to the academic environment. Students examine school, college and university programs, policies and services.

PNGE 200. Introduction to Petroleum Engineering. 3 Hours.
PR: Sophomore standing. Introduction; origin, migration, and accumulation of petroleum; reservoir fluids properties; properties of reservoir rocks; exploration; drilling technology; reservoir engineering; well completions; production engineering. Open to all students.

PNGE 293. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293A. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293B. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293C. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293D. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293E. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293F. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293G. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293H. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293I. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293J. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293K. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293L. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.
PNGE 293M. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293N. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293O. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293P. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293Q. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293R. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293S. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293T. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293U. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293V. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293W. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293X. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293Y. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 293Z. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 297. Research. 1-6 Hours.
Independent Research projects.

PNGE 300. Transport Phenomena in Petroleum Engineering. 3 Hours.
PR: MAE 241. Introduction to fluid flow in pipes, two-phase flow, rotary drilling hydraulics, primary cementing jobs, flow calculations, flow measuring devices, fluid machinery, dimensional analysis, and heat transfer.

PNGE 310. Drilling Engineering. 4 Hours.
PR: GEOL 101 and MAE 331. Rock properties, functions and design considerations of rotating system, hoisting system, and circulation system; drilling fluids calculations and selections; hydraulic programs; drilling optimization; casting string design; cementing programs; and pressure control.

PNGE 312. Drilling Fluids Laboratory. 1 Hour.
PR or Conc: PNGE 310. Topics include clay hydration, viscosity of water-based fluids, mud weight control, filtration studies, thinning agents, chemical contaminants, lime muds, polymer muds, rheological models, and liquid and solid determination.

PNGE 322. Petroleum Properties and Phase Behavior. 3 Hours.
PR: PNGE 200 and CHEM 116 and (ENGL 102 or ENGL 103). Theoretical and applied phase behavior of hydrocarbon system and hydrocarbon fluids. Applications to petroleum reservoirs and production engineering design. (2 hr. lec., 3 hr. lab.).

PNGE 332. Basic Reservoir Engineering. 3 Hours.

PNGE 400. Petroleum Engineering Ethics. 1 Hour.
PR: PNGE 450 or consent. Introduction to petroleum and natural engineering ethics and moral issues concerning safety in engineering practice as well as those arising for engineers employed by corporations. Professionalism and professional registration.

PNGE 405. Multidisciplinary Team Project. 1 Hour.
PR: PNGE 434 and PNGE 470. Introduction to the need to seek input from other professionals, incorporate constraints imposed by other disciplines in solving petroleum and natural gas engineering design problems, and working with other professionals in a multi-disciplinary team.

PNGE 415. Well Control. 3 Hours.
PR: PNGE 310. Methods, techniques, equipment, and engineering calculations used in the control of oil and natural gas wells during drilling operations. Practical applications with rig floor simulator.
PNGE 420. Production Engineering. 3 Hours.
PR: PNGE 310 and PNGE 332. Well completion, performance of Productive formulation, drill stem tests, completion of wells, flowing wells, gas lift methods and equipment, pumping installation design, well stimulation, emulsions, treating, gathering, and storage of oil and gas, field automation. (3 hr. lec.).

PNGE 432. Petroleum Reservoir Engineering Laboratory. 1 Hour.
PR or Conc: PNGE 333. Laboratory evaluation of basic and special petroleum reservoir rock properties. (3 Hr. lab.).

PNGE 434. Applied Reservoir Engineering. 3 Hours.
PR: MATH 261 and PNGE 333 and PR or Conc: STAT 215 or IENG 213. Application of reservoir engineering data to calculation of recovery potentials and prediction of reservoir performance under a variety of production methods to effect maximum conservation.

PNGE 441. Oil and Gas Property Evaluation. 3 Hours.
PR: PNGE 333 and PR or Conc: PNGE 420 or consent. Reserve estimation decline analysis, petroleum property evaluation, including interest calculations, cost estimation and tax evaluation. Overview investment decision analysis and computer applications in property evaluation.

PNGE 450. Formation Evaluation. 3 Hours.
PR: PNGE 310 and PR or Conc: EE 221 or consent. Various well logging methods and related calculations with exercises in interpretation of data from actual well logs.

PNGE 460. Well Stimulation Design. 3 Hours.
PR: (MAE 243 and PNGE 420 and PNGE 333) or consent. Fundamentals of well stimulation and treatment design and their applications to low permeability formations.

PNGE 463. Horizontal Drilling. 3 Hours.
PR: MATH 261 and MAE 243 with a minimum grade of C- and PNGE 310 with a minimum grade of C. Fundamental concepts of horizontal drilling technology are introduced, which include (1) application of directional drilling, (2) design of directional well trajectory, (3) determination of well trajectory from survey data, (4) methods and tools of controlling wellpath while drilling, (5) calculation of torque and drag force in drillstring design, (6) application of geomechanics in directional drilling, and (7) borehole stability analysis.

PNGE 470. Natural Gas Engineering. 4 Hours.
PR: PNGE 333 and PR or Conc: MAE 320. Natural gas properties, compression, transmission, processing, and application of reservoir engineering principles to predict the performance and design of gas, gas-condensate, and storage reservoirs. Includes a laboratory devoted to gas measurements. (3 hr. lec, 3 hr. lab.).

PNGE 471. Natural Gas Production and Storage. 3 Hours.
PR: PNGE 470. Development of gas and gas-condensate reservoirs; design and development of gas storage fields in depleted gas, gas-condensate, oil reservoirs and aquifers.

PNGE 472. Shale Analytics. 3 Hours.
PR: PNGE 333 and PNGE 420. Combining domain expertise (reservoir and production engineering) with Artificial Intelligence and Machine Learning, this course introduces a new and realistic technology that avoids assumptions and interpretations in order to model the impact of completion, stimulation, and operational conditions on oil and gas production from the shale wells.

PNGE 480. Petroleum Engineering Design. 3 Hours.
PR: PNGE 420 and PNGE 434 and PNGE 441 and PR or Conc: PNGE 450. Comprehensive problems in design involving systems in oil and gas production, field processing, transportation, and storage.

PNGE 490. Teaching Practicum. 1-3 Hours.
PR: Consent. Teaching practice as a tutor or assistant.

PNGE 491. Professional Field Experience. 1-18 Hours.
PR: Consent. (May be repeated up to a maximum of 18 Hours.) Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

PNGE 493. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493A. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493B. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493C. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493D. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493E. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.
PNGE 493F. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493G. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493H. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493I. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493J. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493K. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493L. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493M. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493N. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493O. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493P. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493Q. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493R. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493S. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493T. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493U. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493V. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493W. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493X. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493Y. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 493Z. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

PNGE 494. Seminar. 1-3 Hours.
PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494A. Seminar. 1-3 Hours.
PNGE 494A. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494B. Seminar. 1-3 Hours.
PNGE 494B. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494C. Seminar. 1-3 Hours.
PNGE 494C. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494D. Seminar. 1-3 Hours.
PNGE 494D. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.
PNGE 494E. Seminar. 1-3 Hours.
PNGE 494E. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494F. Seminar. 1-3 Hours.
PNGE 494F. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494G. Seminar. 1-3 Hours.
PNGE 494G. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494H. Seminar. 1-3 Hours.
PNGE 494H. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494I. Seminar. 1-3 Hours.
PNGE 494I. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494J. Seminar. 1-3 Hours.
PNGE 494J. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494K. Seminar. 1-3 Hours.
PNGE 494K. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494L. Seminar. 1-3 Hours.
PNGE 494L. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494M. Seminar. 1-3 Hours.
PNGE 494M. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494N. Seminar. 1-3 Hours.
PNGE 494N. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494O. Seminar. 1-3 Hours.
PNGE 494O. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494P. Seminar. 1-3 Hours.
PNGE 494P. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494Q. Seminar. 1-3 Hours.
PNGE 494Q. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494R. Seminar. 1-3 Hours.
PNGE 494R. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494S. Seminar. 1-3 Hours.
PNGE 494S. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494T. Seminar. 1-3 Hours.
PNGE 494T. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494U. Seminar. 1-3 Hours.
PNGE 494U. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494V. Seminar. 1-3 Hours.
PNGE 494V. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494W. Seminar. 1-3 Hours.
PNGE 494W. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494X. Seminar. 1-3 Hours.
PNGE 494X. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494Y. Seminar. 1-3 Hours.
PNGE 494Y. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 494Z. Seminar. 1-3 Hours.
PNGE 494Z. Seminar. 1-3Hr. PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

PNGE 495. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

PNGE 496. Senior Thesis. 1-6 Hours.
PR: Consent.

PNGE 497. Research. 1-6 Hours.
Independent research projects.

PNGE 498. Honors. 1-3 Hours.
PR: Students in Honors Program and consent by the honors director. Independent reading, study or research.