

# Department of Petroleum and Natural Gas Engineering

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## Degrees Offered

- Masters of Science, Petroleum and Natural Gas Engineering (M.S.P.N.G.E.)
- Doctor of Philosophy, Petroleum and Natural Gas Engineering (Ph.D.)

The Petroleum and Natural Gas Engineering (PNGE) graduate programs are designed for students who have already completed a basic petroleum engineering curriculum.

## Degree Programs

The Department of Petroleum and Natural Gas Engineering admits students to the following degree programs: master of science in petroleum and natural gas engineering (M.S.P.N.G.E.) and petroleum and natural gas engineering major under the Statler College of Engineering and Mineral Resources' interdisciplinary doctor of philosophy (Ph.D.). Students in these programs must comply with the rules and regulations as presented in the general requirements for graduate work in the Statler College of Engineering and Mineral Resources.

## Program Objectives

The objective of the Petroleum and Natural Gas Engineering (PNGE) graduate programs is to educate and train men and women who will be capable of performing at the highest levels of the petroleum and natural gas engineering profession. The programs provide students with the advanced technical knowledge and engineering skills needed by the oil and gas industry in the state, the nation, and the world. Moreover, the programs will make students competent to perform independent research and will prepare them to be the future providers of high quality education in petroleum and natural gas engineering. Graduates have the opportunity to enter all phases of the oil and natural gas industry, government agencies, and academia in meaningful and important jobs.

## Student Learning Outcomes

- Graduates will have in-depth knowledge of petroleum and natural gas engineering principles and applications to function effectively in their profession or continue their education.
- Graduates will have the ability to perform independent research to solve engineering and scientific problems encountered in their profession.

## Areas of Research

- Development of the Unconventional Oil and Gas Resources
- Drilling and Completion
- Stimulation
- Reservoir Characterization and Formation Evaluation
- CO<sub>2</sub> Sequestration and Enhanced Oil Recovery
- Reservoir Modeling and Simulation
- Application of Artificial Intelligence

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## FACULTY

### CHAIR

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

### PROFESSORS

- Kashy Aminian - Ph.D. (University of Michigan)  
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 Engineering

## ASSISTANT PROFESSOR

- Ali Takbiri Boroujeni - Ph.D. (Louisiana State University)  
Fracturing
- Ming Gu - Ph.D. (University of Texas)  
Rock Mechanics
- Ebrahim Fathi - Ph.D. (University of Oklahoma)  
Phase Behavior

## TEACHING ASSISTANT PROFESSOR

- Mehrdad Zamirian - Ph.D. (West Virginia University)  
Property Evaluation

## ADJUNCT PROFESSOR

- Alan Brannon - Ph.D. (West Virginia University)  
Natural Gas Engineering
- Pramod Thakur - Ph.D. (Pennsylvania State University)  
Coalbed Methane Development

## Masters Admission

A candidate for the M.S.P.N.G.E. program must meet the following requirements:

- B.S. degree in engineering from an ABET-accredited, or an internationally-recognized engineering program or equivalent with a grade point average (GPA) equal to, or greater than, 3.0 (on a 4.0 scale) (Applicants who cannot meet this condition may be considered for provisional admission.)
- International students must demonstrate proficiency in communicating in English (a minimum TOEFL score of 550, or IBT score of 79, or IELTS score of 6.5).
- At least three recommendation letters (One letter must be from the applicant's academic advisor or equivalent.)

## Doctoral Admission

A candidate for the degree of Doctor of Philosophy (Ph.D.) must comply with the rules and regulations as outlined in the general requirements for graduate work in engineering and the specific requirements stated in the departmental guidelines.

A candidate for the degree of Doctor of Philosophy (Ph.D.) must meet the following requirements:

- B.S. or M.S. degree in petroleum engineering from an ABET-accredited, or an internationally-recognized petroleum engineering program or equivalent with a grade point average (GPA) equal to, or greater than, 3.0 and 3.2, respectively
- A score of at least seventy-fifth percentile for Graduate Record Examination (GRE) quantitative analysis
- International students must demonstrate proficiency in communicating in English (a minimum TOEFL Score of 550, or IBT Score of 79, or IELTS Score of 6.5).
- At least three recommendation letters (One letter must be from the applicant's previous thesis advisor or an academic equivalent.)

## Curriculum in Master of Science in Petroleum and Natural Gas Engineering

A candidate for the M.S. degree in petroleum and natural gas engineering must comply with the rules and regulations as outlined in the WVU Graduate Catalog and the specific requirements of the Statler College and the Petroleum and Natural Gas Engineering Department.

## Program Requirements

All M.S. degree candidates are required to perform research and follow a planned program of study. The student's research advisor, in conjunction with the student's Advising and Examining Committee (AEC) will be responsible for determining the plan of study appropriate to the student's needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their career.

## Curriculum Requirements

A minimum cumulative GPA of 3.0 is required in all courses

### Course Requirements

A minimum of 60% of courses must be from 500 level or above

|   |   |
|---|---|
| All students are required to take Graduate Seminar (PNGE 796) for each semester enrolled. | 3 |
| PNGE 796                                  Graduate Seminar                                |   |

A maximum of three credit hours each of Graduate Seminar (PNGE 796) and Independent Study (PNGE 695) can be counted towards meeting the coursework requirements.

|                         |    |
|-------------------------|----|
| Any PNGE course 400-799 | 15 |
|-------------------------|----|

|  |   |
|--|---|
| Any BIOM, CE, CHE, CHEM, CPE, CS, EE, IENG, IH&S, GEOL, MAE, MATH, MINE, PNGE, PHYS, SAFM, SENG, or STAT courses 400-799 | 6 |
|--|---|

|                                      |     |
|--------------------------------------|-----|
| Complete 1 of the following options: | 6-9 |
|--------------------------------------|-----|

**Thesis Option - 6 hours**

|  |  |
|--|--|
| PNGE 697                                  Research (6 hours) |  |
|--|--|

    Written Research Proposal

    Thesis

    Final Oral or Written Examination

**Problem Report Option - 9 hours**

    Complete 6 additional hours of coursework

|  |  |
|--|--|
| PNGE 697                                  Research (3 hours) |  |
|--|--|

    Written Research Proposal

    Formal written report or professional report/paper

    Final Oral or Written Examination

|             |       |
|-------------|-------|
| Total Hours | 30-33 |
|-------------|-------|

## Final Examination

M.S. students following the thesis or problem report option must prepare a written research proposal. The proposal must be approved by the student's AEC at least one semester prior to the final oral examination.

All students, regardless of option, are required to pass a final oral or written examination, administered by their AEC, covering the thesis or problem report and/or related course material.

## Suggested Plan of Study

The plan below illustrates the Thesis Option. 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 M.S.P.N.G.E degree program that completes degree requirements in one and half years is as follows.

**First Year**

| Fall     | Hours Spring | Hours |
|----------|--------------|-------|
| PNGE 796 | 1 PNGE 796   | 1     |
| Course   | 3 PNGE 697   | 3     |
| Course   | 3 Course     | 3     |
| Course   | 3 Course     | 3     |
|          | 10           | 10    |

**Second Year**

| Fall     | Hours |
|----------|-------|
| PNGE 796 | 1     |
| PNGE 697 | 3     |
| Course   | 3     |
| Course   | 3     |
|          | 10    |

Total credit hours: 30

## Curriculum in Doctor of Philosophy - Petroleum and Natural Gas Engineering

A candidate for the Ph.D. degree with a major in petroleum and natural gas engineering must comply with the rules and regulations as outlined in the WVU Graduate Catalog and the specific requirements of the Statler College and the Petroleum and Natural Gas Engineering Department.

## Program Requirements

The doctor of philosophy degree with a major in petroleum and natural gas engineering is administered through the college's interdisciplinary Ph.D. program. The research work for the doctoral dissertation must show a high degree of originality on the part of the student and must constitute an original contribution to the art and science of petroleum and natural gas engineering.

All Ph.D. degree candidates are required to perform research and follow a planned program of study. The student's research advisor, in conjunction with the student's Advising and Examining Committee (AEC) will be responsible for determining the plan of study appropriate to the student's needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their career.

## Curriculum Requirements

A minimum cumulative GPA of 3.0 is required in all courses

### Course Requirements \*

All students are required to take Graduate Seminar (PNGE 796) for each semester enrolled.

A maximum of three credit hours each of Graduate Seminar (PNGE 796) and Independent Study (PNGE 795) can be counted towards meeting the coursework requirements.

|  |    |
|--|----|
| Research                               | 24 |
| PNGE 797                      Research |    |

Select the following based on degree path:

|  |    |
|--|----|
| Any BIOM, CE, CHE, CHEM, CPE, CS, EE, GEOL, IENG, IH&S, MAE, MATH, MINE, PNGE, PHYS, SAFM, SENG, or STAT courses 500-799 | 24 |
|--|----|

### Examinations

Qualifying Exam

Candidacy Exam

Final Exam

|             |    |
|-------------|----|
| Total Hours | 48 |
|-------------|----|

## Examinations

### QUALIFYING EXAM

All students must take and pass a written qualifying examination. Normally, the qualifying examination is given no later than one semester after completion of eighteen credit hours toward the doctoral degree. This examination is designed to assess the basic competency of students in the petroleum and natural gas engineering field to determine whether or not they have sufficient knowledge to undertake independent research.

### CANDIDACY EXAMINATION

In order to be admitted to candidacy, the student must pass a candidacy exam, which is designed to evaluate the student's overall ability to engage in high-level research. A student must pass the qualifying examination prior to taking Candidacy Exam. The Candidacy Exam is administered by the student's AEC and requires preparation and defense of the dissertation research proposal. The Candidacy Exam may also include testing on material in related fields, as deemed necessary by the AEC.

A student who has successfully completed all coursework, passed the qualifying and candidacy exam and successfully defended the research proposal is defined as one who is a candidate for the Ph.D. degree.

### FINAL EXAMINATION

At the completion of the dissertation research, candidate must prepare a dissertation and pass the final oral examination (defense) administered by his/her AEC.

In order to complete the Ph.D. requirements, a student must pass a final oral examination on the results embodied in the dissertation. This examination is open to the public and, in order to evaluate critically the student's competency, may include testing on material in related fields, as deemed necessary by the AEC. In addition, since the Ph.D. degree is primarily a research degree that embodies the results of an original research work and represents a significant contribution to scientific literature, the student must submit a manuscript on this research to the AEC.

## 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 doctoral degree program that completes degree requirements in three years is as follows.

| <b>First Year</b>  |                     |              |
|--------------------|---------------------|--------------|
| <b>Fall</b>        | <b>Hours Spring</b> | <b>Hours</b> |
| PNGE 796           | 1 PNGE 796          | 1            |
| Course             | 3 Course            | 3            |
| Course             | 3 Course            | 3            |
| PNGE 797           | 2 PNGE 797          | 2            |
|                    | 9                   | 9            |
| <b>Second Year</b> |                     |              |
| <b>Fall</b>        | <b>Hours Spring</b> | <b>Hours</b> |
| PNGE 796           | 1 PNGE 796          | 1            |
| PNGE 797           | 2 PNGE 797          | 2            |
| Course             | 3 Course            | 3            |
| Course             | 3 Course            | 3            |
|                    | 9                   | 9            |
| <b>Third Year</b>  |                     |              |
| <b>Fall</b>        | <b>Hours Spring</b> | <b>Hours</b> |
| PNGE 796           | 1 PNGE 796          | 1            |
| PNGE 797           | 8 PNGE 797          | 8            |
|                    | 9                   | 9            |

Total credit hours: 54

## Major Learning Outcomes

### PETROLEUM AND NATURAL GAS ENGINEERING

- Graduates will have in-depth knowledge of petroleum and natural gas engineering principles and applications to function effectively in their profession or continue their education.
- Graduates will have the ability to perform independent research to solve engineering and scientific problems encountered in their profession.
- Graduates will have in-depth petroleum and natural gas scientific and engineering knowledge to provide high quality education in petroleum and natural gas engineering.

## COURSES

### **PNGE 501. Petroleum Engineering Problems. 1-3 Hours.**

PR: Senior standing. Investigation of a special problem in petroleum engineering.

### **PNGE 532. Introduction to Reservoir Simulation. 3 Hours.**

PR or CONC: PNGE 434 or Consent. Partial differential equations for fluid flow in porous media and the use of finite difference equations in solving reservoir flow problems for various boundary conditions. Study of individual well pressures and fundamentals of history matching.

### **PNGE 533. Secondary Recovery of Oil by Water Flooding. 3 Hours.**

PR: PNGE 333. Theory of immiscible fluid displacement mechanism, evaluation and economics of water flood projects, and oil field flooding techniques. (3 hr. lec.).

### **PNGE 591A. Advanced Topics. 1-6 Hours.**

PR: Consent. Investigation in advanced topics that are not covered in regularly scheduled courses.

### **PNGE 601. Fluid Flow in Porous Media. 3 Hours.**

PR: PNGE 434 and MATH 261 or consent. Theoretical and practical aspects of the physical principles of hydrodynamics in porous media. (3 hr. lec.).

### **PNGE 632. Reservoir Simulation and Modeling. 3 Hours.**

PR: PNGE 532 or consent. Application of finite-difference equations to multi-phase fluid flow in porous media in two or three dimensions with gravity and capillary pressure effects. Simulation of waterflood performance and enhanced recovery techniques.

### **PNGE 633. Advanced Secondary Recovery. 3 Hours.**

PR: PNGE 533. Secondary recovery of oil by gas flooding, miscible fluid injection, in-situ combustion, and heat injection. (3 hr. lec.).

### **PNGE 634. Pressure Transient Analysis. 3 Hours.**

PR: PNGE 434 or consent. Methods of analysis of pressure transient data obtained from well testing for the purpose of determining in-situ reservoir conditions including porosity, lateral extent, average reservoir pressure, and formation permeability.

### **PNGE 691A-Z. Advanced Topics. 1-6 Hours.**

PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

**PNGE 693A-Z. Special Topics. 1-6 Hours.**

A study of contemporary topics selected from recent developments in the field.

**PNGE 695. Independent Study. 1-6 Hours.**

Faculty supervised study of topics not available through regular course offerings.

**PNGE 697. Research. 1-15 Hours.**

PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.).

**PNGE 701. Environmental Issues in Petroleum Engineering. 3 Hours.**

PR: Graduate standing. Environmental impacts of petroleum exploration and production, methods to minimize or eliminate potential environmental impacts, treatment and disposal of the drilling and production wastes, and remediation methods for petroleum contaminated sites.

**PNGE 710. Advanced Drilling Engineering. 3 Hours.**

PR: PNGE 310. Drilling optimization, methods for estimating formation pore and fracture pressures, air drilling, application of directional drilling and deviation control, horizontal drilling, and coiled tubing applications.

**PNGE 711. Advanced Productions Engineering. 3 Hours.**

PR: PNGE 420. Advanced well completion methods, problem well analysis, well remediation and workover planning, multi-phase flow in pipes, system approach for oil and gas wells, application of NODAL analysis, and surface and subsurface production equipment.

**PNGE 734. Advanced Reservoir Engineering. 3 Hours.**

PR: PNGE 434. Modeling and simulation of heterogeneous reservoirs, predicting the performance of the heterogeneous reservoirs during primary, secondary, and enhanced recovery production.

**PNGE 735. Advanced Formation Evaluation. 3 Hours.**

PR: PNGE 450. Advanced methods for interpreting well logs, shaly sand analysis, and production logging methods.

**PNGE 770. Advanced Natural Gas Engineering. 3 Hours.**

PR: PNGE 470. Application of reservoir modeling, history matching, and type curves techniques to analyze and predict the performance of conventional and unconventional gas reservoirs.

**PNGE 790. Teaching Practicum. 1-3 Hours.**

PR: Consent. Supervised practice in college teaching of petroleum and natural gas engineering. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading may be S/U.).

**PNGE 791A-Z. Advanced Topics. 1-6 Hours.**

PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

**PNGE 792. Directed Study. 1-6 Hours.**

Directed study, reading, and/or research.

**PNGE 793A-Z. Special Topics. 1-6 Hours.**

A study of contemporary topics selected from recent developments in the field.

**PNGE 794. Seminar. 1-6 Hours.**

Special seminars arranged for advanced graduate students.

**PNGE 795. Independent Study. 1-9 Hours.**

Faculty supervised study of topics not available through regular course offerings.

**PNGE 796. Graduate Seminar. 1 Hour.**

PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

**PNGE 797. Research. 1-15 Hours.**

PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.).

**PNGE 798. Thesis or Dissertation. 1-6 Hours.**

PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.