# Emphasis in Energy Engineering, Department of Chemical Engineering

## 1.0 Introduction

Three of the major challenges facing humanity are limitations in the supplies of food, water, and energy. The proposed emphasis in energy engineering is meant to give undergraduates in Chemical Engineering a suite of technical electives that will equip them with the engineering and professional skills required to address the need for clean and secure energy. Environmental protection, energy use, and energy production are included in the emphasis. The appearance of the emphasis on students’ transcripts and resumes will help potential employers and graduate programs identify those with an interest and background in energy engineering.

The emphasis will require 15 units and this requirement fits within the current requirement of 17 hours of technical electives in Chemical Engineering. The Chemical Engineering Program requires 130 hours and is summarized as an attachment to this proposal.

### 1.1 Core Electives

Table 1 lists the core electives for the proposed emphasis. Students will complete 9 units from these 6 courses. The core courses include petroleum and natural gas engineering (5155, 5157, and 5159), combustion engineering (5153), air pollution control engineering (5305) and green engineering (5307). The latter includes energy conservation via process synthesis, pollution prevention, and the fate of contaminants in the environment. One additional core elective is planned, Production Engineering III, that will cover production management and transportation.

Table 1 Core Chemical Engineering Courses in Energy (9 units required)

|  |  |  |  |
| --- | --- | --- | --- |
| Course  | Title | Units | Comments |
| CH EN 5153 | Fundamentals of Combustion | 3 |  |
| CH EN 5155 | Reservoir Engineering | 3 |  |
| CH EN 5157 | Production Engineering I | 1.5 |  |
| CH EN 5159 | Production Engineering II | 1.5 |  |
| CH EN 5305 | Air Pollution Control Engineering | 3 |  |
| CH EN 5307 | Green Engineering | 3 |  |

### 1.2 Supporting Electives

Table 2 lists supporting courses that provide a broad overview of energy related topics including climate change, sustainability, geology, ethics, and statistics. The supporting courses also include nuclear engineering and the design of thermal systems for power plants. Two of the supporting courses satisfy other undergraduate requirements: PHIL 4540 satisfies the humanities foundation requirements and PHYS 3150 satisfies the international requirement. One additional supporting course is planned, an introduction to logging and geophysics.

Table 2 Supporting Courses in Other Departments (6 units required)

|  |  |  |  |
| --- | --- | --- | --- |
| Course  | Title | Units | Comments |
| ATMOS 5400 | The Climate System | 3 |  |
| ECE 2210 | Electrical and Computer Engineering for Non-majors | 3 |  |
| ECE 3600 | Introduction to Electric Power Engineering | 3 |  |
| GEO 5220 | Seismology II: Exploration and Engineering Seismology | 3 |  |
| GEO 5240 | Physical Fields II: Electrical Methods | 3 |  |
| GEO 5260 | Petrophysics and Well Logging | 2 |  |
| GEO 5370 | Contaminant Partitioning for Scientists & Engineers | 3 |  |
| GEO 5390 | Solute Transport and Subsurface Remediation | 3 |  |
| GEO 5690 | Aqueous Geochemistry for Engineers & Scientists | 3 |  |
| GEO 5760 | Stratigraphy and Sedimentary Processes | 4 |  |
| GEO 5920 | Fundamentals of Applied Earth Science | 1.5 |  |
| MATH 3070 | Applied Statistics | 4 |  |
| MATH 3090 | Design of Experiments | 3 |  |
| MATH 3150 | Partial Differential Equations for Engineering Students | 2 |  |
| MATH 5600 | Survey of Numerical Methods | 4 |  |
| ME EN 5800 | Sustainable Energy Engineering | 3 |  |
| ME EN 5810 | Thermal Systems Design | 3 |  |
| NUCL 3000 | Nuclear Principles in Engineering and Science | 3 |  |
| NUCL 4000 | Nuclear Engineering and Science Using the TRIGA | 3 |  |
| NUCL 5100 | Reactor Physics | 3 |  |
| PHIL 4540 | Engineering, Ethics, and Society | 3 | Fulfills HF |
| PHYS 3150 | Energy and Sustainability: A Global Perspective | 3 | Fulfills IR |

## 2.0 Significance of Energy Engineering

Energy is fundamental to all aspects of our lives. We transform energy from one form to another in order to heat and cool our buildings, cook our food, heat water, go from one place to another, clean our clothes, raise food, purify water, and run the labor saving devices that make our lives so comfortable. We currently rely heavily on fossil fuels to meet our energy needs. Concerns over the limited supplies of these fuels and over their environmental impact make energy engineering a critically important discipline.

The increasing awareness of the importance of energy in our society is leading to the development of departments, programs, institutes, journals, and professional organizations devoted to energy. For example, at Stanford University you will find the Department of Energy Resources Engineering and the Global Climate & Energy Project (http://pangea.stanford.edu/ERE/index.php and http://gcep.stanford.edu/). Penn State has a new undergraduate program entitled, Energy Engineering. The University of Utah is home to the Institute for Clean and Secure Energy (http://www.icse.utah.edu/) and the Energy and Geoscience Institute (http://www.egi.utah.edu/).

As a profession, energy engineers are represented by several professional societies that also publish energy-related journals. The Association of Energy Engineers (AEE) (http://www.aeecenter.org/) publishes three journals: *Energy Engineering*, *Strategic Planning for Energy and the Environment*, and *Cogeneration & Distributed Generation*. The American Society of Civil Engineers (ASCE) publishes the *Journal of Energy Engineering*. The American Institute of Chemical Engineers (AIChE) publishes *Environmental Progress and Sustainable Energy*. The American Chemical Society (ACS) publishes *Energy and Fuels* and *Environmental Science and Technology*. The Society of Petroleum Engineers has more than 90,000 members worldwide and publishes the *Journal of Petroleum Technology*.

## 3.0 Synergy with Chemical Engineering Major

The Chemical Engineering Program provides a natural home for an emphasis in energy engineering because its required curriculum includes basic science and engineering courses that are fundamental to energy engineering. Some of the relevant required courses are summarized in Table 3.

In addition, the Chemical Engineering Program requires 17 hours of technical elective credits. Of these, at least 9 are usually in Chemical Engineering, at least two must be in upper division mathematics, and the balance can be from departments other than Chemical Engineering. Hence, it will be possible for students to complete their technical elective requirements inside the proposed energy engineering emphasis.

Table 3 Required, Energy-related Courses in Chemical Engineering Program

|  |  |  |  |
| --- | --- | --- | --- |
| Course  | Title | Units | Comments |
| PHYS 2210 | Physics for Scientists and Engineers I | 4 |  |
| PHYS 2220 | Physics for Scientists and Engineers II | 4 |  |
| CH EN 2300 | Thermodynamics I | 2 |  |
| CH EN 2800 | Fundamentals of Process Engineering | 3 |  |
| CHEM 2310 | Organic Chemistry I | 4 | Lab as 2315 |
| CHEM 3060 | Quantum Chemistry | 4 |  |
| CH EN 3353 | Fluid Mechanics | 3 |  |
| CH EN 3453 | Heat Transfer | 3 |  |
| CH EN 3853 | Chemical Engineering Thermodynamics | 3 |  |
| CH EN 3603 | Mass Transfer & Separations | 3 |  |
| CH EN 3553 | Chemical Reaction Engineering | 3 |  |
| CH EN 4203 | Process Control | 3 |  |
| CH EN 4253 | Process Design I | 3 |  |
| CH EN 5253 | Process Design II | 3 |  |

## 4.0 Supporting Documents

A supporting letter from Dean Richard Brown is attached, followed by the standard, four-year Chemical Engineering Program of Study.



**FOUR-YEAR PROGRAM IN CHEMICAL ENGINEERING**

|  |  |
| --- | --- |
| **FIRST YEAR** |   |
| FALL SEMESTERMATH 1210 or 1270 Calculus I1 (4)CHEM 1210 General Chemistry I (4)CHEM 1215 General Chemistry Lab I (1)WRTG 2010 Intermediate Writing (3)CH EN 1703 Intro to Computing in ChE (2)General Education (3) TOTAL HOURS: 17 | SPRING SEMESTERMATH 1220 or 1280 Calculus II1 (4)CHEM 1220 General Chemistry II2 (4)CHEM 1225 General Chemistry Lab II (1)PHYS 2210 Phycs For Scien & Eng I (4)CH EN 4755 Undergraduate Seminar (0.5)General Education (3) TOTAL HOURS: 16.5  |
| **SECOND YEAR** |  |
| FALL SEMESTERMATH 2250 Diff Equ & Lin Algebra (4)ME EN 1300 Statics and Strength of Matls (4)PHYS 2220 Phycs For Scien & Eng II (4)PHYS 1809 General Physics Laboratory (1)CH EN 2450 Numerical Methods (2)General Education (3) TOTAL HOURS: 18 | SPRING SEMESTERMATH Technical Elective3 (Math) (2 to 4)CH EN 2300 Thermodynamics I (2)CH EN 2800 Fund. of Process Engineering (3)CHEM 2310 Organic Chemistry I4 (4)CHEM 2315 Organic Chemistry lab I4 (1)CH EN 4755 Undergraduate Seminar (0.5)General Education (3) TOTAL HOURS: 17.5 |
| **THIRD YEAR** |  |
| FALL SEMESTERCHEM 3060 Quantum Chem (4)CH EN 3353 Fluid Mechanics (3)CH EN 3453 Heat Transfer (3)CH EN 3853 Chemical Eng Thermo (3)CH EN 4753 Undergraduate Seminar (0.5)Technical Elective3 (3) TOTAL HOURS: 16.5  | SPRING SEMESTERCH EN 3603 Mass Transfer & Separations (3)CH EN 3553 Chemical Reaction Eng (3)CH EN 5103 Biochemical Engineering (3)Technical Electives3 (4)General Education/Bachelor Degree Requir. (3) TOTAL HOURS: 16  |
| **FOURTH YEAR** |  |
| FALL SEMESTERCH EN 4903 Projects Laboratory I (4)CH EN 4253 Process Design I (3)CH EN 4203 Process Control (3)CH EN 4753 Undergraduate Seminar (0.5)Technical Elective3 (3)General Education (3) TOTAL HOURS: 16.5 | SPRING SEMESTERCH EN 4905 Projects Laboratory II5 (3)CH EN 5253 Process Design II (3)Technical Elective3 (3)General Education (3) TOTAL HOURS: 12 |
|  |  GRAND TOTAL HOURS: 130  |

1. Students with adequate math preparation are encouraged to take the MATH 1270 and 1280, Accelerated Engineering Calculus series, in place of MATH 1210 and 1220. Students who take 1210/1220 are encouraged to take MATH 2210 as a technical elective.

2. Students who qualify should take CHEM 1221, Honors General Chemistry II and CHEM 1241, Honors General Chemistry Lab II, instead of CHEM 1220, General Chemistry II, and CHEM 1225, General Chemistry Lab II.

3. A total of 17 credit hours of technical elective courses are required.

4. Students who qualify should take CHEM 2311, Honors Organic Chemistry I, instead of CHEM 2310.

5. CH EN 4905 fulfills the Upper-division Writing/Communication requirement.