# Articulation Agreement

## The University of Pittsburgh Swanson School of Engineering & Arcadia University

***Overview of Program***

The purpose of this document is to establish an Articulation Agreement between the University of Pittsburgh, Swanson School of Engineering and Arcadia University. Students are eligible under the guidelines of this Articulation Agreement if they have completed each of the following requirements:

- The student must have been enrolled at Arcadia University for at least the past two years.
- The student must have received cumulative GPA of 3.0 or higher as calculated on a 4.0 scale. Students intending on applying to Bioengineering must have received a cumulative GPA of 3.5 or higher.
- The student must have received a favorable recommendation from the Articulation Agreement Program Liaison at Arcadia University. This recommendation must be included in the student's application packet to the University of Pittsburgh's Office of Admissions and Financial Aid.
- The student must have successfully completed the specific science and math prerequisite courses for the intended major listed in the University of Pittsburgh, Swanson School of Engineering Articulation Agreement Curriculum Guide with a re-calculated GPA of 3.0 in these courses and a grade of C or better in each course.
- The student must have completed or plan to transfer back courses for the major requirement prescribed by Arcadia University for graduation, including:
    - The student must have completed at least 102 credits, with a minimum of 8 credits in physics courses counting towards the physics major.

Admission to the University of Pittsburgh, Swanson School of Engineering is dependent on meeting the above criteria. Admission is guaranteed for a minimum of ten (10) students in the program each academic year. Further students can be considered on a case by case basis, dependent on space available at the junior level at Pitt.

***Introduction***

This agreement specifies the terms by which the University of Pittsburgh and Arcadia University agree to cooperate in facilitating the transfer of students to pursue dual baccalaureate degrees from the University of Pittsburgh, Swanson School of Engineering and Arcadia University.

The articulation agreement program between the University of Pittsburgh and Arcadia University will normally consist of three years of instruction at Arcadia University followed by instruction at the University of Pittsburgh. While some students may be able to complete the prescribed engineering courses in four semesters (two years), certain engineering degree programs may necessitate attendance for additional terms to complete all degree requirements. Due to this fact, this agreement is not a 3/2 agreement.

Provided that all stipulated criteria have been met, the student will receive a Bachelor of Arts or Science degree in Mathematics, Computer Science, Chemistry, Physics, or Biology from Arcadia University and a Bachelor of Science in Engineering degree from the University of Pittsburgh.

The Swanson School of Engineering offers a B.S.E. degree with majors in Bioengineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Engineering Science, Environmental Engineering, Industrial Engineering, Materials Science and Engineering, and Mechanical Engineering.

Students from Arcadia University who will be transferring to the University of Pittsburgh as part of this agreement will also be eligible to participate in the School's other education enhancement programs including the Cooperative Education Program and the Engineering International Program. Students may also choose to pursue either a minor or certificate in another engineering or arts and sciences area. Participation in these optional programs may require additional time to graduate. Interested students should consult the University of Pittsburgh Undergraduate Catalog for more information (https://catalog.upp.pitt.edu/).

Any and all modifications of this document must occur through formal notification and revision of this agreement.

***Recruitment***

The availability of the articulation agreement program between the University of Pittsburgh, Swanson School of Engineering and Arcadia University will be included in literature developed and distributed by both institutions. Arcadia University is encouraged to develop brochures and other suitable material outlining the course content and the features of this program. Such information concerning the program may be distributed through Arcadia University's Office of Admissions. Arcadia University will be primarily responsible for student recruitment for this articulation agreement program. As required, the appropriate Swanson School of Engineering faculty and staff will be available by telephone and e-mail to assist Arcadia University students, faculty and staff.

All descriptive literature, promotional material or advertising material developed by Arcadia University describing or discussing this articulation agreement program should be submitted to the Senior Associate Dean for Academic Affairs at the University of Pittsburgh, Swanson School of Engineering for review and approval prior to publication and distribution. Approval by the University of Pittsburgh for such material and literature will not be unreasonably delayed.

***Application for Admission***

Students admitted to this program should have a strong background in science and mathematics in order to be competitive for transfer to the University of Pittsburgh. They should complete the prescribed courses from the Articulation Agreement Curriculum Guide at Arcadia University during their first three years at Arcadia University in order to be able to complete the University of Pittsburgh course work in the appropriate time.

A transfer application may also be accessed on-line from: https://admissions.pitt.edu/transfer/.

Transfer application materials can be mailed to:

Office of Admissions and Financial Aid
University of Pittsburgh
4227 Fifth Avenue
Pittsburgh, PA 15213
(412) 624-PITT
pitt.admissions@pitt.edu

Additional information may be found at https://admissions.pitt.edu/.

Completed application materials must indicate that the student is following the terms of this articulation agreement and must be submitted by July 1 for consideration for Fall semester admission, October 1 for Spring admission and February 1 for Summer admission. A recommendation from the Arcadia University Articulation Agreement Program Liaison is also required and should be sent along with the application materials.

Ideally, the student should indicate interest in the program during his/her first year at Arcadia University. He/she should consult with the Articulation Agreement Program Liaison to make sure that the appropriate courses are taken. During the student's second year, the Arcadia University Articulation Agreement Program Liaison should inform the Swanson School of Engineering of the student's intent to transfer and indicate the engineering program of interest.

***Candidate Selection***

The Swanson School of Engineering agrees to review in an expeditious and non-prejudicial manner those students who follow the articulation agreement between the University of Pittsburgh, Swanson School of Engineering and Arcadia University.

To be admitted to the University of Pittsburgh, Swanson School of Engineering, students must meet the following requirements:

- The student must have been enrolled at Arcadia University for at least the past two years.
- The student must have received an overall GPA of 3.0 or higher as calculated on a 4.0 scale. Students intending on applying to Bioengineering must have received a cumulative GPA of 3.5 or higher.
- The student must have received a favorable recommendation from the Articulation Agreement Program Liaison at Arcadia University. This recommendation must be included in the student's application packet to the University of Pittsburgh's Office of Admissions and Financial Aid.
- The student must have successfully completed the specific science and math prerequisite courses for the intended major listed in the University of Pittsburgh, Swanson School of Engineering Articulation Agreement Curriculum Guide with a recalculated GPA of 3.0 or higher in these courses and a grade of C or better in each course.*****
- The student must have completed or plan to complete the major requirements prescribed by Arcadia University for graduation, including:
    - The student must have completed at least 102 credits, with a minimum of 8 credits in physics courses counting towards the physics major.

Students must complete their last thirty credits at the University of Pittsburgh. A grade of "C" or better must be earned in the prescribed courses in order to receive transfer credit and be eligible to fall under this agreement. Courses in which a grade of C- or lower was received will not be counted for transfer credit.

****Students Unable to Complete Articulation Agreement Curriculum Guide***

If a student is unable to complete the prescribed curriculum at Arcadia University due to the fact that some courses are not offered at Arcadia University, students will still be considered for admission based on the University of Pittsburgh Office of Admissions and Financial Aid's transfer student guidelines. Information regarding the standard transfer student guidelines may be obtained by the University of Pittsburgh's Office of Admissions and Financial Aid.

***Statute of Limitations***

All course work must be completed within the 12-year statute of limitations for the University of Pittsburgh.

***Course Selection***

The University of Pittsburgh, Swanson School of Engineering will provide an Articulation Agreement Curriculum Guide to guide students at Arcadia University regarding their course selection.

Arcadia University Articulation Agreement Program Liaison should work to make sure that the students interested in this program are taking the appropriate courses as prescribed in the Articulation Agreement Curriculum Guide. Questions about transferability of courses should be made to the University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services.

The University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services will update Arcadia University of all curriculum changes as related to the Articulation Agreement Curriculum Guide. The provisions and contents of this document are subject to change at any time at the University of Pittsburgh's sole discretion. The University of Pittsburgh will make reasonable efforts to allow students already in the articulation agreement program at the time changes are made, to complete the program under the conditions in effect at the time of their enrollment in the program.

***Advising Services***

Arcadia University's appropriate advisors and associated faculty will advise students during the first three years. Students may also contact the University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services for appropriate advisement regarding transferability of courses.

***Student Services***

Students transferring from an articulation program to the University of Pittsburgh, Swanson School of Engineering will be treated on an equal basis with current Swanson School of Engineering students with regard to selection of courses and other student services. Transferring students will also have the Coordinator of Transfer Student Services available for questions regarding their assimilation to the University of Pittsburgh. Transfer students are also encouraged to enroll in an Engineering Transfer Seminar during their first semester at the University of Pittsburgh.

***Terms of the Agreement***

The liaisons from both institutions will review this agreement annually, revising it if necessary. An extensive review will take place five years from the date of signing. Attachments regarding curriculum requirements should be reviewed as required.

Lacking such a review, the agreement will continue until either the Dean of Arcadia University or the Dean of the Swanson School of Engineering receives written notification of termination. Students enrolled in this program at the time of termination shall be allowed to proceed according to the policies outlined previously in this agreement.

Acting for our respective institutions, we accept the terms of the above agreement.

Jeff Rutenbeck

(Date) 5/4/2021

Jeffrey B. Rutenbeck, PhD
Provost & Senior Vice President for Academic Affairs
Arcadia University

Ann E. Cudd

(Date) 5/13/2021

Ann E. Cudd, PhD
Provost and Senior Vice Chancellor
University of Pittsburgh

Rebecca E. Kohn 03-29-2021

Rebecca E. Kohn, PhD
Dean, College of Arts & Sciences
Vice Provost, Academic Planning & Faculty Affairs
Arcadia University

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(Date) 05-11-2021 | 10:40 AM EDT

James R. Martin II, PhD
U.S. Steel Dean of Engineering
Swanson School of Engineering
University of Pittsburgh

Approved as to Legal Form by Arcadia University
Office of General Counsel
By: Sarah Middleton, Staff Attorney
Date: May 4, 2021

***Contacts***

**For assistance with administrative policies and procedures:**
**Contact the *Swanson School of Engineering's Associate Dean's Office*:**

Mary Besterfield-Sacre, PhD
Associate Dean for Academic Affairs
Swanson School of Engineering
mbsacre@pitt.edu

Office of the Associate Dean for Academic Affairs
SSoEAcademicDean@engr.pitt.edua
P: 412-624-9825
F: 412-624-2827

**For assistance with transfer admission, engineering departmental, and course content questions:**
**Contact the *Swanson School of Engineering's Transfer Student Services Office*:**

Transfer Student Services Office
Swanson School of Engineering
University of Pittsburgh
152B Benedum Hall
Pittsburgh, PA 15261
ssoetransfer@pitt.edu
P: 412-624-9825
F: 412-624-2827

**For assistance with student records questions:**
**Contact *the Swanson School of Engineering Strategic Business and Financial Operations:***

Strategic Business and Financial Operations
Swanson School of Engineering
University of Pittsburgh
151 Benedum Hall
ssoeadministration@pitt.edu
P: 412-624-9800
F: 412-624-9808

**For additional information about the University of Pittsburgh, visit our web site(s):**
University of Pittsburgh (http://www.pitt.edu/)
Swanson School of Engineering (http://www.engineering.pitt.edu/)
Office of Admissions (https://admissions.pitt.edu/)

# The University of Pittsburgh Swanson School of Engineering Articulation Agreement Curriculum Guide

*The equivalents of the following course are required for students to satisfy the terms of the Articulation Agreement. Students must complete the foundation engineering courses required for all majors as well as the required courses for their intended major. Please email the Swanson School of Engineering's Coordinator for Transfer Student Services with questions regarding course equivalencies. If your institution does not offer a required course listed in this guide, please contact your Articulation Agreement Program Liaison about other ways to fulfill these requirements.*

## *Foundation Engineering Courses Required for All Majors:*

Mathematics
- Calculus 1 – 4 credits (MATH 0220)
- Calculus 2 – 4 credits (MATH 0230)

Physics
- Basic Physics for Science and Engineers 1 – 4 credits (PHYS 0174)
- Basic Physics for Science and Engineers 2 – 4 credits (PHYS 0175)

Chemistry
- General Chemistry 1 – 4 credits (CHEM 0110)
- General Chemistry 2 – 4 credits (CHEM 0120)
    - *All engineering students are required to complete one semester of chemistry lab at a minimum. If the home institution offers the class and lab separate, students must take at least one lab.*

Engineering / Computer Science
- Engineering Analysis (Programming in HTML & Excel) – 3 credits (ENGR 0015)
    - *Alternative engineering classes may fill this requirement with approval of University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services.*
- Engineering Computing (Programming in C & MATLAB) – 3 credits (ENGR 0016)

Humanities & Social Sciences
- 6 courses totaling 18 credits (or more) of non-technical coursework taken to satisfy the Bachelor's degree awarded by the home institution. Among these courses, students must take:
    - Courses from 3 different academic disciplines.
    - 2 courses from the same department or theme. 1 of these courses must be non-introductory.

## *REQUIRED FOR ALL MAJORS IN:*

**Bioengineering**

Mathematics
- Analytical Geometry & Calculus 3 – 4 credits (MATH 0240)
- Introduction to Matrices & Linear Algebra – 3 credits (MATH 0280)
- Differential Equations – 3 credits (MATH 0290)

Chemistry
*(Both courses below are optional, but recommended for students interested in medical school)*
- Organic Chemistry 1 w/ Lab – 3 + 1 credits (CHEM 0310 & 0330)
- Organic Chemistry 2 w/ Lab – 3 + 1 credits (CHEM 0320 & 0340)

Biological Sciences
- Human Physiology – 3 credits (BIOSC 1250)

- Foundations of Biology Lab 1 – 1 credit (BIOSC 0050, last offered Summer 2019), OR
- Foundations of Biology Research Lab 1 – 1 credit (BIOSC 0057), OR
- Foundations of Biology SEA-PHAGES Lab 1 – 1 credit (BIOSC 0058), OR
- Foundations of Biology Research Lab 2 – 1 credit (BIOSC 0067), OR
- Foundations of Biology SEA-PHAGES Lab 2 – 1 credit (BIOSC 0068)
  ***Note**: **BIOSC 0058/BIOSC 0068** is a specialized two term sequence, in which students isolate and characterize a phage in **BIOSC 0058** and continue to use this phage in **BIOSC 0068** to perform additional experiments. The Department of Biological Sciences hopes that students in **BIOSC 0058** will continue on to **BIOSC 0068**, although there is no mandatory participation in the latter course. As such, it is recommended that you take **BIOSC 0057** or **BIOSC 0067** if you are only considering 1 credit of biology laboratory experience.*

Engineering
- Statics and Mechanics of Materials 1 – 3 credits (ENGR 0135)

Engineering/Science Electives
- Two courses (6 credits total) in advanced science, computer science, mathematics, or co-operative education programs. These courses must be approved by the University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services.

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## Chemical Engineering

Mathematics
- Analytical Geometry & Calculus 3 – 4 credits (MATH 0240)
- Differential Equations – 3 credits (MATH 0290)

Chemistry
- Organic Chemistry 1 – 3 credits (CHEM 0310)
- Organic Chemistry 2 – 3 credits (CHEM 0320)
    - *Laboratory portion optional, but recommended for students interested in medical school & can count towards Advance Science Lab requirements.*
- Intermediate Physical Chemistry – 3 credits (CHEM 1480)
- Biochemistry – 3 credits (CHEM 1810, or CHEM 1880, or BIOSC 1000)

Advanced Science (*Choose one course below*)
- Cell Biology – 3 credits (BIOSC 1500)
- Molecular Biology – 3 credits (BIOSC 1940)
- Introduction to Analytical Chemistry – 3 credits (CHEM 0250)
- Inorganic Chemistry – 3 credits (CHEM 1130)
- Synthesis & Characterization of Polymers – 3 credits (CHEM 1600)
- Intermediate Programming using JAVA – 4 credits (CS 0401)
- Principles of Modern Physics 1 – 3 credits (PHYS 0477)
- *Alternative science classes may fill this requirement with approval of University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services*

Advanced Science Lab (*Choose two credits from courses below*)
- Foundations of Biology Lab 1 – 1 credit (BIOSC 0057)
- Introduction to Analytical Chemistry Lab – 1 credit (CHEM 0260)
- Organic Chemistry 1 & 2 Lab – 2 credit (CHEM 0345)
- Physical Chemistry Lab 2 – 1 credit (CHEM 1440)
- Synthesis & Characterization of Polymers Lab – 1 credit (CHEM 1605)
- *Alternative science labs may fill this requirement with approval of University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services*

Engineering
- Probability and Statistics for Engineers 1 – 4 credits (ENGR 0020)
    - *Please note that this course must have Calculus as a prerequisite. This course CANNOT be satisfied through Advanced Placement credit.*

**Chemical Engineering *(continued)***

Engineering Elective (*Choose one course below*)

- Materials Structure and Properties – 3 credits (ENGR 0022)
- Statics and Mechanics of Materials 1 – 3 credits (ENGR 0135)
- Linear Systems and Circuits 1 – 3 credits (COE/ECE 0031)

Professional Electives

- One course (3 credits total) in communication, advanced science, computer science, math, or co-op education program. This course must be approved by the University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services.

## Civil Engineering

Mathematics
- Calculus 3 – 4 credits (MATH 0240)
- Differential Equations – 3 credits (MATH 0290)

Engineering
- Probability and Statistics for Engineers 1 – 4 credits (ENGR 0020)
    - *Please note that this course must have Calculus as a prerequisite. This course CANNOT be satisfied through Advanced Placement credit.*
- Statics for Civil & Environmental Engineers – 3 credits (ENGR 0131)
- Mechanics of Materials for Civil & Environmental Engineers – 3 credits (ENGR 0141)
- Dynamics for Civil & Environmental Engineering – 3 credits (ENGR 0151)
- Computer Methods in Civil & Environmental Engineering 1 – 3 credits (CEE 0109)
- Engineering Economic Analysis – 3 credits (IE 1040)

Engineering Elective (*Choose one course below*)
- Linear Systems and Circuits – 3 credits (COE/ECE 0031)
- Digital Logic – 3 credits (COE/ECE 0132)
- Introduction to Thermodynamics – 3 credits (MEMS 0051)
  GIS, GPS, and Computer Methods – 3 credits (GEOL 1445) *This course can count as either an Engineering Elective or Science Elective, but not both.*

Science Elective (*Choose one course below*)
- Foundations of Biology 1 – 3 credits (BIOSC 0150)
- Ecology – 3 credits (BIOSC 0370)
- Biochemistry – 3 credits (BIOSC 1000)
- Microbiology – 3 credits (BIOSC 1850)
- Organic Chemistry 1– 3 (CHEM 0310)
- Physical Geology – 3 credits (GEOL 0040)
- Geology – 3 credits (GEOL 0800)
- Environmental Geology – 3 credits (GEOL 0860)
- Physical Oceanography – 3 credits (GEOL 0890)
- GIS, GPS, and Computer Methods – 3 credits (GEOL 1445) *This course can count as either an Engineering Elective or Science Elective, but not both.*

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## Computer Engineering

Mathematics
- Matrices & Linear Algebra – 3 credits (MATH 0280)
- Differential Equations – 3 credits (MATH 0290)

Engineering / Computer Science
- Linear Circuits & Systems + Lab – 4 credits (ECE 0101)
- Digital Circuits & Systems + Lab - 4 credits (ECE 0201)
- Embedded Systems & Interf. + Lab – 4 credits (ECE 0202)
- Problem Solving C++ - 3 credits (ECE 0301)
- Data Structures & Algorithms – 3 credits (ECE 0302)
- Analytical Methods – 3 credits (ECE 0401)

Communications (*Choose one course below*)
- Argument – 3 credits (COMMRC 0500)
- Public Speaking – 3 credits (COMMRC 0520)
- Discussion – 3 credits (COMMRC 0540)
- Written Professional Communication – 3 credits (ENGCMP 0400)
- Research Writing – 3 credits (ENGCMP 0450)
- Persuasive Writing – 3 credits (ENGCMP 0515)
- Communication Skills for Engineers – 3 credits (ENGR 1010)

Technical Electives
- Three courses (9 credits total) in advanced science, computer science, math, or engineering program. These courses must be approved by the University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services.

Open Electives
- Any course (3 credits total) that are NOT of a similar nature to, or lower level than, a required or previously taken course can be used to fulfill this requirement. Three credits of Physical Education or three credits of Band, ROTC, or Chorus may also be used as an open elective.

## Electrical Engineering

Mathematics

- Calculus 3 – 4 credits (MATH 0240)
- Matrices & Linear Algebra – 3 credits (MATH 0280)
- Differential Equations – 3 credits (MATH 0290)

Engineering / Computer Science

- Linear Circuits & Systems + Lab – 4 credits (ECE 0101)
- Microelectronic Circuits + Lab – 4 credits (ECE 0102)
- Digital Circuits & Systems + Lab - 4 credits (ECE 0201)
- Problem Solving C++ - 3 credits (ECE 0301)
- Analytical Methods – 3 credits (ECE 0401)
- Signals, Systems, & Probability – 3 credits (ECE 0402)

Communications (*Choose one course below*)

- Argument – 3 credits (COMMRC 0500)
- Public Speaking – 3 credits (COMMRC 0520)
- Discussion – 3 credits (COMMRC 0540)
- Written Professional Communication – 3 credits (ENGCMP 0400)
- Research Writing – 3 credits (ENGCMP 0450)
- Persuasive Writing – 3 credits (ENGCMP 0515)
- Communication Skills for Engineers – 3 credits (ENGR 1010)

Technical Electives

- Three courses (9 credits total) in advanced science, computer science, mathematics, or engineering program. These courses must be approved by the University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services.

Open Elective

- Any course (3 credits total) that are NOT of a similar nature to, or lower level than, a required or previously taken course can be used to fulfill this requirement. Three credits of Physical Education or three credits of Band, ROTC, or Chorus may also be used as an open elective.

**Engineering Science – *All Concentrations***

Mathematics
- Calculus 3 – 4 credits (MATH 0240)
- Matrices & Linear Algebra – 3 credits (MATH 0280)
- Differential Equations – 3 credits (MATH 0290)
- Complex Variables and Applications – 3 credits (MATH 1560)

Engineering
- Probability and Statistics for Engineers 1 – 4 credits (ENGR 0020)
  - *Please note that this course must have Calculus as a prerequisite. This course CANNOT be satisfied through Advanced Placement credit.*
- Materials Structure and Properties – 3 credits (ENGR 0022)

***Engineering Physics Emphasis***
- Basic Laboratory Physics for Science & Engineers – 2 credits (PHYS 0219)
- Principles of Modern Physics 1 – 3 credits (PHYS 0480)
- Principles of Modern Physics 2 – 3 credits (PHYS 0481)
- Mechanics – 3 credits (PHYS 1331)
- Intermediate Electricity and Magnetism – 3 credits (PHYS 1351)
- Wave Motion & Optics – 3 credits (PHYS 1361)
- Linear Systems and Circuits 1 – 3 credits (MEMS 0031)

***Nanotechnology: Chemistry/Bioengineering Emphasis***
(*Choose three courses below*)
- Organic Chemistry 1 w/ Lab – 3 + 1 credits (CHEM 0310 & 0330)
- Organic Chemistry 2 w/ Lab – 3 + 1 credits (CHEM 0320 & 0340)
  - *Laboratory portion optional, but may be co-requisite at transferring institution*
- Inorganic Chemistry -3 credits (CHEM 1130)
- Physical Chemistry 1 – 3 credits (CHEM 1410)
- Physical Chemistry 2 – 3 credits (CHEM 1420)
- Biochemistry – 3 credits (BIOSC 1000)

***Nanotechnology: Physics/Materials Emphasis***
- Basic Laboratory Physics for Science & Engineers – 2 credits (PHYS 0219)
- Principles of Modern Physics 1 – 3 credits (PHYS 0480)
- Principles of Modern Physics 2 – 3 credits (PHYS 0481)
- Linear Systems and Circuits 1 – 3 credits (MEMS 0031)

- Intermediate Electricity and Magnetism – 3 credits (PHYS 1351)
  *OR*
- Wave Motion & Optics – 3 credits (PHYS 1361)

## Environmental Engineering

Mathematics
- Calculus 3 – 4 credits (MATH 0240)
- Differential Equations – 3 credits (MATH 0290)

Required Chemistry and Biology Courses
- Organic Chemistry 1– 3 (CHEM 0310)
- Foundations of Biology 1 – 3 credits (BIOSC 0150)

Engineering
- Probability and Statistics for Engineers 1 – 4 credits (ENGR 0020)
    - *Please note that this course must have Calculus as a prerequisite. This course CANNOT be satisfied through Advanced Placement credit.*
- Statics for Civil & Environmental Engineers – 3 credits (ENGR 0131)
- Mechanics of Materials for Civil & Environmental Engineers – 3 credits (ENGR 0141)
- Computer Methods in Civil & Environmental Engineering 1 – 3 credits (CEE 0109)
- Engineering Economic Analysis – 3 credits (IE 1040)

Earth Science Elective (*Choose one course below*)
- GEOL 0040 Physical Geology
- GEOL 0800 Geology
- *Alternative Earth Science courses may fill this requirement with approval of University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services*

Environmental Program Electives (*Choose up to four*)
- CHEM 0260 Analytical Chemistry
- CHEM 0320 Organic Chemistry 2
- CHEM 1130 Inorganic Chemistry
- CHEM 1410 Physical Chemistry
- CHEM 1810 Chemical Biology
- GEOL 0820 Natural Disasters
- GEOL 1051 Groundwater Geology
- GEOL 1055 Environmental Science, Ethics, & Public Policy
- GEOL 1445 GIS, GPS, and Computer Methods for Earth Sciences
- GEOL 1446 Advanced Geographic Information Systems
- GEOL 1460 Remote Sensing of the Earth
- *Alternative Environmental Program courses may fill this requirement with approval of University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services*

## Industrial Engineering

Mathematics
- Calculus 3 – 4 credits (MATH 0240)
- Matrices & Linear Algebra – 3 credits (MATH 0280)
- Differential Equations – 3 credits (MATH 0290)

Engineering (*Courses may be taken at Pitt through PCHE cross registration (if available))*
- Probability, Random Variables, and Distributions – 3 credits (IE 1070)
  - *Please note that this course must have Calculus as a prerequisite. This course CANNOT be satisfied through Advanced Placement credit.*
- Engineering Economic Analysis – 3 credits (IE 1040)
- Statistical Testing and Regression – 3 credits (IE 1071)

Engineering (*Maximum of 2 courses listed below*)
- Materials Structure and Properties – 3 credits (ENGR 0022)
- Statics and Mechanics of Materials 1 – 3 credits (ENGR 0135)
- Linear Systems and Circuits 1 – 3 credits (COE/ECE 0031)
- Introduction to Thermodynamics – 3 credits (MEMS 0051)

Additional Humanities/Social Science Elective – 3 credits

Technical Electives
- Two courses (6 credits total) in advanced engineering, life science, computer science, math or other technical areas. These courses must be approved by the University of Pittsburgh, Swanson School of Engineering's Coordinator of Transfer Student Services.

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## Materials Science & Engineering

Mathematics

- Calculus 3 – 4 credits (MATH 0240)
- Matrices & Linear Algebra – 3 credits (MATH 0280)
- Differential Equations – 3 credits (MATH 0290)

Engineering

- Statics – 3 credits (ENGR 0131)
- Mechanics of Materials – 3 credits (ENGR 0141)
- Electrical Circuits – 3 credits (MEMS 0031)
- Probability & Statistics for Engineers 1 – 4 credits (ENGR0020)
    - *Please note that this course must have Calculus as a prerequisite. This course CANNOT be satisfied through Advanced Placement credit.*

Communications (*Choose one course below*)

- Argument – 3 credits (COMMRC 0500)
- Public Speaking – 3 credits (COMMRC 0520)
- Discussion – 3 credits (COMMRC 0540)
- Written Professional Communication – 3 credits (ENGCMP0400)
- Communication Skills for Engineers – 3 credits (ENGR1010)

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**Mechanical Engineering**

Mathematics

- Calculus 3 – 4 credits (MATH 0240)
- Matrices & Linear Algebra – 3 credits (MATH 0280)
- Differential Equations – 3 credits (MATH 0290)

Engineering

- Statics – 3 credits (ENGR 0131)
- Mechanics of Materials – 3 credits (ENGR 0141)
- Electrical Circuits – 3 credits (MEMS 0031)
- Dynamics – 3 credits (MEMS 1015)

Communications (*Choose one course below*)

- Argument – 3 credits (COMMRC 0500)
- Public Speaking – 3 credits (COMMRC 0520)
- Discussion – 3 credits (COMMRC 0540)
- Written Professional Communication – 3 credits (ENGCMP0400)
- Communication Skills for Engineers – 3 credits (ENGR1010)

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# *Course Descriptions*

## Chemistry

**CHEM 0110 General Chemistry 1 (4 credits)** This is the first half of an introductory two-term general chemistry sequence. It includes 3 hours of lecture per week and one 4-hour session per week comprising one hour of recitation and 3 hours of laboratory. Chemistry 0110 covers stoichiometry, atomic and molecular structure, and states of matter. (*Prerequisite: High School Algebra*)

**CHEM 0120 General Chemistry 2 (4 credits)** This is the second half of the introductory two-term general chemistry sequence. It includes 3 hours of lecture per week and one 4 hour session per week comprising one hour of recitation and 3 hours of laboratory. Chemistry 0120 covers chemical thermodynamics, equilibrium, electrochemistry, nuclear chemistry, kinetics, and descriptive chemistry. (*Prerequisite: CHEM 0110)*

**CHEM 0250 Introduction to Analytical Chemistry (3 credits)** This course is concerned with the rigorous treatment of chemical equilibrium as it applies to aqueous solutions. Acid/base equilibria, buffers, titrations, absorption spectrophotometry, potentiometry and potentiometric sensors, chromatography and electrophoresis will be discussed. Three hours of lecture per week. (*Prerequisite: CHEM 0120)*

**CHEM 0260 Introduction to Analytical Chemistry Lab (1 credit)** The primary objectives of this course are to introduce the student to current analytical methods and to cultivate sound experimental technique. Laboratory work includes ion-exchange separations, complexometric and potentiometric acid-base titrations, absorption spectrophotometry and gas chromatography.

**CHEM 0310 Organic Chemistry 1 (3 credits)** This course is an introduction to the theory and practice of organic chemistry through the study of structural principles, reaction mechanisms, and synthesis. The basic goals of the course are to develop appreciation and skill in the methods of molecular analysis which have made organic chemistry such a powerful intellectual discipline. Topics covered will include conformational analysis of alkanes, stereochemistry and various reactions of alkanes, alkenes, alkynes, and conjugated systems. The course will prepare the student for work in advanced topics in organic chemistry, biochemistry, chemical engineering and the health related sciences. (*Prerequisite: CHEM 0120*)

**CHEM 0320 Organic Chemistry 2 (3 credits)** This course is a continuation of Chemistry 0310. The reactions of aromatic molecules and more complex functional groups such as alcohols, aldehydes, ketones and carboxylic acids will be considered. Molecules of biological interest may be discussed toward the end of the term. (*Prerequisite: CHEM 0310*)

**CHEM 0330 Organic Chemistry Laboratory 1 (1 credit)** The laboratory program in organic chemistry is designed to train students in the important techniques used by the professional organic chemist and to demonstrate many of the principles discussed in the organic lecture courses. Chemistry 0330 is devoted to the purification, characterization, and identification of organic molecules using the techniques of recrystallization distillation, thin-layer, column, and

gas-liquid chromatography, melting point determination and infrared and nuclear magnetic resonance spectroscopy. (*Prerequisite or Co-requisite: CHEM 0310*)

**CHEM 0340 Organic Chemistry Laboratory 2 (1 credit)** The second term organic lab course, Chem 0340, provides students with an opportunity to carry out important multistep synthetic schemes and characterize the products using techniques mastered in Chemistry 0330. Students will also gain experience using library resources and developing skills in computer based molecular modeling. (*Prerequisite or Co-requisite: CHEM 0320*)

**CHEM 1130 Inorganic Chemistry (3 credits)** Molecular orbital and hybridization bonding theories are developed to allow the interrelationship of molecular structure, bonding, and trends within the periodic table to be applied to a large number of inorganic complexes and materials. Topics include drawing connections between molecular shapes and group theory in regards to MO's that support certain geometries of complexes. Bonding interactions are connected to spectral and chemical properties for molecules. Common structures of ionic solids and condensed phase materials, the acid/base behavior of ligands in both sigma and pi bonding modes, and introductory transition metal and organometallic chemistry are discussed. The interaction between a metal's dn configuration, its requisite ligands, its reactivity and structures of its complexes are stressed.

**CHEM 1410 Physical Chemistry 1 (3 credits)** Basic lecture course dealing with quantum theory, atomic and molecular structure, symmetry, spectroscopy and diffraction methods. Three hours of lecture per week. (*Prerequisites: CHEM 0120, PHYS 0175, and MATH 0240)*

**CHEM 1420 Physical Chemistry 2 (3 credits)** Basic lecture course dealing with thermodynamics, equilibria, kinetic theory, introductory statistical mechanics and reaction kinetics.

**CHEM 1440 Physical Chemistry Lab 2 (1 credit)** This course has one four hour lab each week. Approximately 7 experiments are performed during the term, with an emphasis on the macroscopic properties of matter. The course is designed to expand upon the principles and techniques covered in Chemistry 1430 as well as to introduce the student to newer methods such as the study of fast reactions using pulsed dye lasers.

**CHEM 1480 Intermediate Physical Chemistry (3 credits)** This lecture course emphasizes the applications of physical chemistry of importance to engineering students. (*Prerequisites: CHEM 0120, MATH 0240, and PHYS 0175)*

**CHEM 1600 Synthesis & Characteristics of Polymers (3 credits)** The synthesis and characterization of polymers is the focus of this course. Current methods of polymer synthesis will be surveyed. Particular attention will be paid to the practical implementation of these reactions and the kinetic consequences of particular reaction strategies in homopolymer, copolymer, and block copolymer synthesis. Techniques for the characterization of polymer molecular weight (light scattering, gel permeation chromatography, vapor pressure osmometry, viscosity, etc.), chemical composition, and stereochemistry (FT-IR, NMR, other spectroscopic

and chemical methods) will be discussed. A brief treatment of polymer solution thermodynamics and selected topics of current interest in polymer chemistry will be included.

**CHEM 1605 Synthesis & Characteristics of Polymers Lab (1 credit)** This course includes a weekly 4 hour laboratory complementing the lecture material covered in Chemistry 1600. The laboratory is divided evenly between polymer synthesis and characterization.

**CHEM 1810 Chemical Biology (3 credits)** Revolutionary transformations in chemistry and biology have led to the merging of these disciplines where contributions from both fields impact our molecular and quantitative understanding of biology. Rapid growth in this area has been driven in part by students and researchers applying synthesis, quantitative analysis, and theoretical reasoning to the study complex cellular processes. This course focuses on enzyme mechanisms in biological pathways, kinetics and thermodynamics, and chemical tools to probe and screen components of the cell. Some other topics include DNA/RNA processing, macromolecular interactions, chemical signaling, posttranslational modifications, chemical syntheses of biomolecules, and development of assays for high throughput drug screening.

**CHEM 1880 Chemical Biology for Engineers (3 credits)** Chemical engineers have made significant contributions towards the development of pharmaceutical research and manufacturing, and there are now also growing opportunities in field of biotechnology. In this course students broadly examine the nomenclature, functions and mechanisms utilized by DNA, RNA and proteins and learn foundation knowledge in order to contribute to these fields. This includes examination of enzyme mechanisms of therapeutic targets and how pathways of enzymes can produce natural products, such as terpenes and polyketides, that are common antibiotic and antifungal agents. Specialized topics will also be considered such as the engineering of proteins with new catalytic functions and metabolic engineering to produce therapeutics and commodity chemicals. Students also learn about the molecular mechanisms involved in the cellular processes of replication, transcription and translation. These topics include recombinant DNA technology and new therapeutic strategies that have emerged in manufacturing such as antisense oligonucleotide technology.

## Mathematics

**MATH 0220 Calculus 1 (4 credits)** This is the first course in the basic calculus sequence and is intended for all mathematics, engineering, science, and statistics students. Math 0220 covers the derivative and integral of functions of a single variable. A lab component in which students apply numeric, algebraic, and graphing technologies to calculus problems is an integral part of the course. For additional information refer to the web page http://calculus.math.pitt.edu.

**MATH 0230 Calculus 2 (4 credits)** This is the second course in the basic calculus sequence and is intended for all mathematics, engineering, science, and statistics students. Math 0230 covers symbolic and numerical integration techniques and applications, modeling, differential equations, and Taylor series. A lab component in which students apply numeric, algebraic, and graphing technologies to calculus problems is an integral part of the course. (*Prerequisite: MATH 0220*)

**MATH 0240 Calculus 3 (4 credits)** This is the third course in the calculus sequence and is intended for honors students majoring in mathematics, engineering, science and statistics. It covers vectors, parameterized curves and surfaces, differentiation of functions of several variables, optimization, integration of functions of two and three variables, line integrals, flux integrals, and calculus of vector fields. (*Prerequisite: MATH 0230*)

**MATH 0280 Matrices & Linear Algebra (3 credits)** This course is designed primarily for engineering students. The main subject of the course is ordinary differential equations. Topics include first order differential equations, higher order linear differential equations and systems of first order linear and nonlinear differential equations. Matrix methods will be introduced and used to solve systems of linear equations. The computer package MATLAB will be used to assist in computations. (*Prerequisite: MATH 0220*)

**MATH 0290 Differential Equations (3 credits)** This course presents an introduction to the theory of differential equations from an applied perspective. Topics include linear and nonlinear ordinary differential equations, Laplace transform, and introduction to partial differential equations. (*Prerequisite: MATH 0230*)

**MATH 1560 Complex Variables and Applications (3 credits)** This course covers the following topics: elementary operations with complex numbers, derivatives, integrals, Cauchy's Theorem and its consequences such as the integral formula, power series, residue theorem, applications to real integrals, series and, as time allows, conformal mapping.

## Physics

**PHYS 0174 Basic Physics for Science and Engineers 1 (4 credits)** The first term in a two-term introductory lecture-demonstration sequence in physics for science and engineering students. Subjects covered in Physics 0174 include: kinematics; Newton's laws of motion; energy; momentum, rotational motion, rigid body motion, angular momentum, simple harmonic motion, gravitation, mechanical waves, sound waves, and the kinetic theory of gases. (*Prerequisite or Co-requisite: MATH 0220*)

**PHYS 0175 Basic Physics for Science and Engineers 2 (4 credits)** This is the second term in a two-term introductory sequence in physics for science and engineering students. Subjects covered in Physics 0175 include: electrostatics, electric currents, magnetism, induction, simple AC circuits, Maxwell's equations, electromagnetic waves, geometric and wave optics, followed by an introduction to quantum physics, including photons, the Bohr atom and spectra, and elementary wave mechanics. (*Prerequisite: PHYS 0174; Prerequisite or Co-requisite: MATH 0230*)

**PHYS 0219 Basic Laboratory Physics for Science & Engineers (2 credits**) This is the introductory course in physics laboratory associated with Physics 0174, 0175. The course involves carrying out experiments in mechanics, electricity, heat, sound, optics, atomic physics, nuclear physics, and quantum physics. The student then gets insight into the collection, interpretation and presentation of experimental data and into the assessment of errors.

**PHYS 0477 Introduction to Thermal Physics, Relativity, and Quantum Mechanics (4 credits)**

**PHYS 0480 Principles of Modern Physics 1 (3 credits)** This first term of a two-term sequence in modern physics will cover: Special Relativity, experimental quantum effects which led to the development of Quantum Theory, an introduction to Quantum Mechanics and the quantum theory of atomic structure.

**PHYS 0481 Principles of Modern Physics 2 (3 credits)** This course (follow up to Physics 0479, Modern Physics 1) will cover the following topics: quantum mechanics of many particle systems, multielectron atoms and the periodic table, basics of quantum statistical mechanics, introduction to solid state physics (conductors, semiconductors, superconductors), basic nuclear physics, introduction to elementary particle physics.

**PHYS 1331 Mechanics (3 credits)** This course aims to discuss the principles of Newtonian mechanics and to develop these principles and their applications as far as Lagrangian and Hamiltonian dynamics. Various ways of formulating the equations of motion and of solving some specific problems will be developed.

**PHYS 1351 Intermediate Electricity and Magnetism (3 credits)** Vector calculus, electrostatics, including Poisson's and Laplace's equations and associated boundary conditions and boundary value problems, Electric current, Lorentz force law, Magnetic field and Biot-Savart Law, Electromagnetic induction, Maxwell's equations, E and B in matter.

**PHYS 1361 Wave Motion & Optics (3 credits)** This combined lab/lecture course introduces the student to classical wave phenomena, with most examples taken from optics and electromagnetism. The laboratory component of the course consists of a series of eight mandatory experiments, two on geometrical, six on wave optics, followed by two special projects, chosen by the student. Two weekly one-hour lectures will present the theory of geometrical and wave optics and discuss experimental aspects of the lab projects.

## Engineering

**ENGR 0011/0015 Introduction to Engineering Analysis (3 credits)** Introduction to engineering analysis and engineering design. Includes units and conversion factors, graphs, data analysis and curve fitting. Use of spreadsheets. Introduction to engineering analysis, including statics, strength of materials, electrical circuits, heat transfer, fluid mechanics, and introduction to rate phenomena. Applications to engineering design. Fundamentals of report writing.

**ENGR 0012/0016 Engineering Computing (3 credits)** Course is designed to teach students the fundamentals of computing and the concept of engineering design as applied to the design of software. Fundamentals include basic computer organization, formulation of algorithms, basic data structures, pseudo-code, and top-down iterative refinement. In the concurrent laboratory, proficiency is developed in a high-level language and a text editor/word processor. The course includes material on the use of MATLAB and C++. (*Prerequisite: ENGR 0012*)

**ENGR 0020 Probability and Statistics for Engineers 1 (4 credits)** A basic course in probability and statistics. Topics covered include: data analysis, probability, random variables, discrete and continuous probability distributions, estimation, hypothesis testing, and regression analysis statistical process control. (*Prerequisite: MATH 0230*)

**ENGR 0022 Material Structures and Properties (3 credits)** An introduction to the basic concepts of materials science and engineering. The concepts of atomic, crystal, micro- and macro-structure, their control and effect on chemical, electrical, magnetic and mechanical properties. Modification of properties by heat treatment and control of processing. Fundamental considerations in materials selection.

**ENGR 0131 Statics for Civil & Environmental Engineers (3 credits)** A basic course in statics. Utilizing the free-body diagram. The course covers forces and equilibria of particles, rigid bodies, surfaces, trusses, beams, cables, and other basic structural elements. Use is made of computers for problem solving. (*Prerequisite: PHYS 0174*)

**ENGR 0135 Statics and Mechanics of Materials 1 (3 credits)** First of a two course sequence covering statics and strength of materials. Topics covered include: concurrent force systems, equilibrium, axial loading, stress, strain, deformation, moments, equivalent systems, centroids, centers of mass, and distributed loads, free-body diagrams, equilibrium of rigid and deformable bodies, plane trusses, frames and machines equilibrium in 3D, torsion and friction. Use is made of computers for problem solving.

**ENGR 0141 Mechanics of Materials for Civil & Environmental Engineers (3 credits)** An introductory course in the mechanics of deformable bodies, with special application to the range of topics needed by Civil Engineers. The course material covers internal strains, stresses and deformations, which occur when a structure is subjected to applied loads. Problems with tie-in to practical design issues will be covered. (*Prerequisite: ENGR 0131*)

**ENGR 0145 Statics & Mechanics of Materials 2 (3 credits)** An introductory course in the mechanics of deformable solids. Material covers the internal stresses, strains, and displacements that occur when a structure is subjected to applied loads. Open-ended design problems are presented and discussed. *(Prerequisite: ENGR 0135)*

**ENGR 0151 Dynamics for Civil & Environmental Engineers (3 credits)** A basic course in dynamics. Utilizing the Newtonian Mechanics of Particles, the course covers kinematics and kinetics of particles, kinetics of systems of particles, work and energy, introduction to vibrations, single-degree-freedom systems, and two-degrees-of-freedom systems. Applications of dynamics in civil engineering problems. Use is made of computer solution to a two-story building vibration. (*Prerequisites: ENGR 0141 and MATH 0290*)

**ENGR 1010 Communication Skills for Engineers (3 credit)** Utilizing a variety of spoken, written, and audio-video activities, the students learn how to give instructions, use feedback, listen, conduct the job and appraisal interview, run meetings, use groups, make presentations, manage crises. Most of the skills they need to strengthen their personal, interpersonal, group, and organizational communicative skills. The instructing–learning process emphasizes motivation,

concentration, participation, organization, comprehension, repetition, articulateness, and confidence.

**CEE 0109 Computer Methods in Engineering 1 (3 credits)** This course teaches the use of CAD as a design tool. Coverage includes both 2D drawing, 3D drawing and rendering. Visual Basic programming is employed for constructing complex objects and to communicate with other programs. *(Co-requisite: ENGR 0012 and MATH 0240)*

**ECE 0101 Linear Circuits and Systems (4 credits)** This course covers the fundamentals of linear electric circuit analysis used throughout the electrical and computer engineering curricula. Students learn basic concepts and terminology of electrical engineering and develop knowledge and skills to analyze, evaluate, and design electrical circuits in class and in an accompanying laboratory where they build prototyping and analysis skills using modern test equipment. Primary topics include electric variables and circuit elements, Kirchhoff's and Ohm's Laws, mesh and node equations, Thevenin and Norton equivalent circuits, first- and second-order circuits, time- and frequency-domain analyses, ideal transformers, and AC power. *(Prerequisite: PHYS 0175 and ENGR 0012 or ENGR 0016 Corequisite: ECE 0401)*

**ECE 0102 Microelectronic Circuits (4 credits)** This course covers the fundamentals of microelectronic circuits,specifically operational amplifiers, diode and rectifier circuits, analysis and design of MOS field-effect transistor and bipolar-junction transistor amplifiers, and CMOS digital-logic circuits. In this course, the students will integrate their knowledge of linear circuits and will learn how to analyze, evaluate, and design electronic circuits. This course includes a laboratory section in which the students will gain prototyping, design, and testing skills using conventional equipment. *(PREQ: ECE 0101 or ECE 0031 or COE 0031)*

**ECE 0201 Digital Circuits and Systems (4 credits)** In this course, students study the fundamental building blocks used in the design of modern digital electronics and computers. Students learn how to use and combine digital components to create circuits that perform fundamental computing tasks such as arithmetic and storage of information. Primary topics covered include Boolean algebra and binary arithmetic, combinational and sequential logic circuits, Finite-State Machine (FSM), Hardware Design Language (HDL), and Register Transfer Level (RTL) for digital design. Students extend their knowledge to practice by way of hands-on laboratory exercises where various software and hardware tools are used to design and test solutions for real-world applications. After completing this course, students understand the design of digital computing systems at their most fundamental level and are able to craft such systems using modern tools and techniques. *(PREQ: PHYS 0175)*

**ECE 0202 Embedded Processors and Interfacing (4 credits)** This course covers the fundamentals of embedded processors and interfacing, including microprocessor structure and instruction sets, programming using C and assembly languages, memory and peripherals, interfacing, and embedded system design. Detailed studies of microprocessor I/O and interrupt techniques as applied to analog-to-digital, digital-to-analog, timers, and parallel and serial interfaces are also included. Laboratory activities provide the student with experience in developing and testing the hardware and software required to incorporate embedded computers

into systems that solve real-world problems. (*PREQ: (ECE 0201 and ECE 0301) or ((COE or CS 0447 or COE 0147) and (COE 0501 or ECE 0501)))*

**ECE 0301 ECE Problem Solving with C++ (3 credits)** This course covers fundamental concepts and techniques in software design for solving problems in electrical and computer engineering (ECE) using C++. Students learn procedural and object-oriented program development, as well as basic control structures, data structures, and algorithms. Students apply these skills in crafting and testing structured programs to solve problems of interest in ECE, such as linear circuits and systems, digital circuits and systems, and linear algebra and differential equations, through assignments that are tied to concepts covered in these other core sophomore courses of ECE. *(PREQ: ENGR 0012 or 0016 or department consent)*

**ECE 0302 Data Structures and Algorithms (3 credits)** This course covers the fundamentals of data structures and algorithms. Topics include stacks, queues, trees, lists, heaps, and other widely used abstract data types. Students will learn how to implement these data structures using C++ and techniques for analyzing algorithms that contain them. Advanced applications of recursion, sorting, and searching algorithms and other algorithms that incorporate data structures will also be discussed. This course will also introduce topics in parallel computing, and students will learn how to solve problems using modern application programmer interfaces (API) for parallel programming. *(PREQ: ECE 0301, or (COE 0401 or CS 0401), or with special permission.)*

**ECE 0401 ECE Analytical Methods (3 credits)** This course provides the fundamental mathematical background to solve problems in electrical and computer engineering (ECE). The main objective is to cover topics from calculus, linear algebra, differential equations, and complex analysis most relevant to electrical and computer engineering. Primary topics include matrices, vectors, systems of equations, determinants, double integrals, first- and second-order ordinary differential equations, complex numbers, Eulers identity, phasor analysis, signal waveforms, Laplace transform, transfer functions, frequency response, and an introduction to the Fourier transform. Students also learn to solve mathematical problems based upon these topics, both analytically and using the MATLAB programming environment. *(Prerequisites: MATH 0220 and ENGR 0012 or ENGR 0016)*

**ECE 0402 Signals, Systems, & Probability (3 credits)** This is an introductory course covering the mathematical modeling and analysis of signals and input-output systems, probability and statistics, with an emphasis on ECE applications of these concepts. The signal-processing portion builds on existing knowledge of ordinary differential equations and Laplace transforms, to a complete treatment of continuous-time signals and systems, especially linear time-invariant systems, in the time and frequency domains. The latter portion of the course covers basic concepts in probability, including discrete and continuous random variables, probability density and mass functions, computation of expected values, conditional probability densities, as well as an introduction to hypothesis testing and statistical analysis. *(PREQ: ECE 0401)*

**IE 0015 Introduction to Information Systems Engineering (3 credits)** This course introduces students to the major components comprising information systems including databases, graphical user interfaces and telecommunication protocols. Students will use a visual programming language, a relational database management system, and a network protocol to learn how to develop desktop information systems for industrial and service applications. The course will

serve as a primer for advanced courses in each information system technology area. (*Prerequisite: ENGR 0012*)

**IE 1040 Engineering Economic Analysis (3 credits)** Discusses time value of money, interest rate calculations, economic equivalence concepts, cost of capital, comparison of alternate investments, evaluating economic life and replacement alternatives, inflation, depreciation, depletion, impact of taxes on engineering economic decisions. (*Prerequisite: MATH 0220*)

**IE 1071 Probability and Statistics for Engineers 2 (4 credits)** Review of joint distributions and estimation; Chi square, t, and F sampling distributions introduced; estimation hypothesis testing; multiple regression; empirical model building; analysis of variance and design of experiments; goodness-of-fit tests and contingency tables; introduction to statistical quality control. (*Prerequisite: ENGR 0020*)

**MEMS 0031 Electrical Circuits (3 credits)** The study of linear circuit networks, including constitutive equations for circuit elements and Ohm's and Kirchoff's laws. Mesh and node equations, Thevenin/Norton equivalents, maximum power transfer, transient and AC analyses, and operational amplifiers. *(Prerequisite: PHYS 0175. Co-requisite: MATH 0290)*

**MEMS 0051 Introduction to Thermodynamics (3 credits)** Synthesis of the basic concepts from thermodynamics and fluids, including: properties of pure substances, first law analysis, and introduction to the second law; fluid statics, kinematics, stress, and viscosity; and control volume analysis of the conservation equations. (*Prerequisites: PHYS 0174 and CHEM 0110. Co-requisite: MATH 0290*)

**MEMS 1014 Dynamic Systems (3 credits)** Modeling and analysis of physical systems. Time and frequency domain analysis. Transient and steady-state system response to various excitations. Transfer function and state space model representations. Laplace and Fourier transforms. (*Prerequisites: MATH 0280, ENGR 0012 and MEMS 0031*)

**MEMS 1051 Applied Thermodynamics (3 credits)** Thermodynamic processes, energy and entropy changes in real and ideal gases, vapors, and liquids, and mixtures of those fluids. Basic thermodynamic cycles (vapor and gas power, refrigeration, and heat pumps). Thermodynamic property relations. (*Prerequisite: MEMS 0051*)

**MEMS 1052 Heat & Mass Transfer (3 credits)** One and two-dimensional steady and unsteady-state conduction, empirical and practical relations for forced and natural convection. Principle of radiation using “radiation network" method. Heat exchangers and special topics. (*Prerequisite: MEMS 0051*)

**MEMS 1056 Energetics (3 credits)** Thermodynamics of solutions with applications to materials systems; heterogeneous phase equilibria; relations between free energy and phase diagrams; electrochemistry; rate processes; thermodynamics of surfaces. (*Prerequisites: ENGR 0022 and MEMS 0051*)

**MEMS 1058 Electromagnetic Properties of Materials (3 credits)** Review of basic principles quantum theory, band and zone theory. Transport, electrical, and thermal properties; semiconductors and semiconductor devices; magnetic materials hard and soft; dielectric and optical properties. (*Prerequisite: ENGR 0022*)

**MEMS 1072 Applied Fluid Dynamics (3 credits)** Kinematics of fluids. Navier-Stokes equations. Flow of incompressible, inviscid fluids. Dimensional analysis and similarity. Internal flows in pipes. Boundary layer theory. External flow past bodies. (*Prerequisite: MEMS 0051*)

## Other Courses

**BIOSC 0050 Foundation of Biology Lab 1 (1 credit)** This is the first course in a two-course sequence on the study of organisms in the laboratory. We will work with techniques that are important in biology and apply these techniques to illustrate basic biological principles emphasizing cell biology. BIOSC 0050 runs concurrently with BIOSC 0150, the lecture complement in introductory biology.

**BIOSC 0150 Foundation of Biology (3 credits)** This introductory course in biology is divided into two parts. The first part covers the cellular basis of life including a discussion of simple chemistry; cells as units of structure and function; and energy transformations. The second part includes an examination of those functions common to all organisms such as nutrition, gas and fluid transport, and hormonal and neuronal control. Throughout, the emphasis is on the mechanisms used to accomplish these basic functions.

**BIOSC 0370 Ecology (3 credits)** The objective of the course is to provide a broad introduction to the study of ecology at the undergraduate level, through the presentation of lectures dealing with organismal, population, community, and ecosystem levels of hierarchical organization. The contributions of laboratory and field investigations to the development of ecological knowledge will be considered. *(Prerequisite: BIOSC 0160 or 0716 or 0180 or BIOL 0102 or 0120)*

**BIOSC 1000 Biochemistry (3 credits)** This course is designed to provide students with a basic understanding of the principles and underlying themes of modern biochemistry. The course includes all the major topics in biochemistry in considerable depth including thermodynamics and enzymology, protein and nucleic acid structure, function, and synthesis, lipids and membranes as well as metabolic pathways. This course will require that you master a new vocabulary including chemical structures, and there is an emphasis throughout on experimental approaches, molecular mechanisms, and protein solving.

**BIOSC 1250 Human Physiology (3 credits)** After a general introduction on cell biology, physiology of nerves and muscle, and intercellular communication, this course will survey the function of the following systems: cardiovascular, respiratory, renal, and gastrointestinal. Each system discussed will be integrated into the larger function of homeostasis and their adaptation during pathology and challenges (e.g., exercise).

**BIOSC 1500 Cell Biology (3 credits)** This course will be devoted to a discussion of the current state of our understanding of cell structure and function. Eukaryotic cells will be emphasized with particular attention to animal cells. However, prokaryotic cells will be discussed for

comparative purposes. Course material will emphasize the experimental basis for our understanding of cell biology and the relationship between structure and function. Most of the techniques to be considered will involve biochemical and molecular biological approaches used in the study of cell function. Thus the course will assume a familiarity with the principles of biochemistry covered in the prerequisites and will not repeat this material. Topics will include membranes, the nucleus, mitochondria and chloroplasts, the cytoskeleton, cell motility, growth and division, endocytosis and exocytosis, and selected topics on the cellular biological aspects of cancer and the immune system.

**BIOSC 1850 Microbiology (3 credits)** This course will introduce students to the basic biology, diversity in types, and survival strategies of microorganisms. We will study basic topics, including microbial growth, metabolism, nutrition and genetics, as well as the relevance of microorganisms to human disease, biotechnology and environmental science. We will also pay some attention to the diverse types of jobs available to persons interested in microbiology. This course will provide the necessary foundation for future studies in various areas of microbiology. *(Prerequisites: (BIOSC 0160 or 0716 or 0180 or BIOL 0102 or 0120) and [CHEM 0120 or 0720 or 0101 or (0112 and 0114)])*

**BIOSC 1940 Molecular Biology (3 credits)** This course will examine the molecular basis of life processes, with a primary emphasis on genes (what they are, what they do, how they determine the properties of an organism). Topics covered will include replication of DNA, transcription of DNA into RNA, and translation of RNA into protein. Much of the course will be concerned with how these processes are regulated in response to changes in the environment, and how this regulation relates to the observed properties and behavior of the organism.

**COMMRC 0500 Argument (3 credit)** This course introduces students to fundamental principles of argument, and develops argument skills through in-class debates.

**COMMRC 0520 Public Speaking (3 credits)** This course is designed to develop rhetorical understanding and increased skill in public speaking. Students will learn to research, organize, compose and deliver public speeches.

**COMMRC 0540 Discussion (3 credits)** The purpose of this course is to learn and sharpen discussion and critical thinking skills, which are absolutely essential elements in the process of group decision making. There is a clear trend in the modern world to reduce the decision making power of individuals and increase the influence of groups. This is a hands-on course that will give students practical experience in the process of group decision-making, a valuable and highly marketable skill.

**ECON 0100 Introduction to Microeconomics (3 credits)** This is a standard introductory course in microeconomics. It focuses on the way the market system works. The decisions of households, firms, and governments are coordinated through markets in which prices adjust to keep buying plans and selling plans consistent. The U.S. economy relies mainly on markets to coordinate these decisions, although sometimes governments intervene. We will explore various social issues using the principles developed throughout the course. Upon completion of the

course students will have a better understanding of economic problems, efficiency, laws of demand and supply, consumer choice theory, market organization, production and cost.

**ENGCMP 0400 Written Professional Communications (3 credits)** In this course we will examine the contexts for and rhetorical dimensions of a variety of professional documents, including those documents students produce in the course itself. Major assignments include a set of career materials (resume, cover letter, career report); a correspondence packet that addresses a conflict; a proposal; and a longer report based on research and analysis. As we engage in this work we will explore the nature of professionalism, common features and efforts (enabling and disabling) of professional discourse, and strategies for negotiating the "borders" of specialized and non-specialized discourse.

**ENGCMP 0450 Research Writing (3 credits)** Fitting into the broader category of Cultural Studies, this course will engage the skills and methods of writing, researching, and thinking critically across the curriculum. In responding to the ideas of others, including your classmates, you will be expected to formulate and articulate opinions on a range of issues, orally and in print. We will discuss the ethics of research in writing, the use of traditional resources as well as electronic tools, and ways of integrating these materials for professional-quality reports and essays. Much of our class time will be devoted to discussion of the readings and films, along with workshop sessions during which we will critique student work and explore techniques that make for powerful, interesting, persuasive, and provocative communication.

**ENGCMP 0515 – Persuasive Writing (3 credits) -** In this course students will analyze and create the kinds of persuasive writing used in the fields of fundraising and advertising. Both types of writing attempt to influence the decisions people make about the money they spend, the attitudes they have, and the issues that shape our society.

**GEOL 0040 – Physical Geology (3 credits)** This class and its associated laboratory (GEOL 0055) are required for geology majors and recommended for civil and petroleum engineering students, and other science and engineering majors needing an introductory course in geology. The aim is to provide students with the fundamentals of geology. Topics covered are: (1) the description and origin of earth materials (minerals and rocks), (2) internal processes (i.e. volcanoes, earthquakes), (3) surface processes (i.e. erosion, deposition), (4) structural features of the earth, (5) resources.

**GEOL 0800 Geology (3 credits)** Geology is the study of how the Earth works. This class covers the classification and origin of basic rocks and minerals; examines the role of plate tectonics in shaping the Earth and producing such hazards as earthquakes and volcanoes; and examines the forces that shape beaches and rivers and sometimes threaten our lives and property. We also survey the evidence for changing climate and the future of such resources as groundwater, fossil fuels, and ores.

**GEOL 0860 Environmental Geology (3 credits)**
This course takes an integrated Earth systems approach to understanding our planet and its resources. We will investigate geologic processes and hazards (e.g., earthquakes, volcanoes, landslides, weather hazards), geologic resources (water, soil, minerals, energy) and the local and

global ramifications of human interaction with the Earth (e.g., air, soil and water pollution, ozone depletion, and climate change). GEOL 0860 also serves as an introductory course for three majors in the Department of Geology and Planetary Science.

**GEOL 1445 GIS, GPS, and Computer Methods (3 credits)** The goal of this course is to gain expertise in the methods of Geographic Information Systems using the GeoTRANS and ArcGIS software packages on PC based workstations. No previous computer classes are required. Students will be graded on the basis of approximately 5 computer assignments, in-class exercises, a project, and final exam. This course is a core course for the GIS Certificate.