

ENGINEERING (ENGR-UH)

ENGR-UH 1000 Computer Programming for Engineers (4 Credits)

Typically offered Fall and Spring

The objective of the course is for students to acquire the fundamental knowledge of computer programming, develop transferable programming skills, and learn to solve engineering problems via programming. The course is primarily based on the C++ programming language and an introduction to another programming language such as MATLAB (to demonstrate transferring programming knowledge from one language to another). The course explores the application of engineering computation in various engineering domains including mechanical, civil, computer, and electrical engineering. The following topics are covered: introduction to computer systems, standard input/output, file input/output, decision structures, loop structures, functions, arrays, addressing, dynamically allocated memory, structures, introduction to object oriented programming, problem solving via programming algorithm design, and applications in another programming language such as MATLAB.

Grading: Ugrd Abu Dhabi Graded

Repeatable for additional credit: No

Prerequisites: Restricted to First Year and Sophomore students only.

- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering
- Bulletin Categories: Interactive Media: Computational Media Elective
- Bulletin Categories: Sound Music Computing Minor: Required
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Interactive Media Minor: Required
- Crosslisted with: Interactive Media
- Crosslisted with: Sound Music Computing

ENGR-UH 1010 Engineering Ethics (1 Credit)

Typically offered Spring

Real-world engineering problems require engineers with theoretical mastery of their chosen field as well as dexterity with a broad range of conceptual and practical tools. Professional ethics as well as the concepts and practical applications of field research and ethnography are introduced. Students research, discuss, and analyze relevant aspects of engineering ethics case studies and apply learned techniques of cultural discovery to reflect on the challenges, opportunities, and aspirations of communities within which students will be embedded as active participant observers.

Grading: Ugrd Abu Dhabi Graded

Repeatable for additional credit: No

- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering

ENGR-UH 1021J Design and Innovation (2 Credits)

Typically offered Summer and January terms

This engineering course is an intensive introduction to innovation philosophies and practices around the broad realms of the iterative design process (discover, ideate, make, expose). The majority of the course revolves around hands-on team-based challenges that expose students to multiple engineering domains (electronic, software, mechanical, etc.) as well design domains (design thinking, visual-design, rapid prototyping, product-design, industrial-design). The course culminates in a final innovation and prototyping challenge, the outputs of which are presented in a public exhibition. The course touches on cultural, ethical, and economic factors that must inform the innovation process to maximize its positive social impact. Note: Only NYUAD students are eligible to take this course.

Grading: Ugrd Abu Dhabi Graded

Repeatable for additional credit: No

Prerequisites: ENGR-UH 1000.

- Bulletin Categories: Design Minor Electives
- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering
- Bulletin Categories: Interactive Media:Media Design Thinking Elective
- Crosslisted with: Design
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Interactive Media Minor: Required
- Crosslisted with: Interactive Media

ENGR-UH 1801 Bioengineering Principles (2 Credits)

Typically offered Spring

This introductory course is designed to give students a glimpse of a broad selection of bioengineering topics that are currently underway in the field of biomechanics, biomaterials, bioimaging, and bioinstrumentation as well as in mechanobiology and biophysics. Students will become familiar with bioengineering applications in the various areas and see how engineering principles can be applied to solve a variety of biological and biomedical problems. This course will also give students perspectives about the possibilities of working as bioengineers in academia and industry. This course is recommended for sophomore-level students.

Grading: Ugrd Abu Dhabi Graded

Repeatable for additional credit: No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering Required
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 2010Q Probability and Statistics for Engineers (2 Credits)*Typically offered Fall*

Introductory course in probability and statistics with an emphasis on how these topics are relevant in engineering disciplines. Topics in probability theory include sample spaces, and counting, random variables (discrete and continuous), probability distributions, cumulative density functions, rules and theorems of probability, expectation, and variance. Topics in statistics include sampling, central limit theorem, and linear regression. The course emphasizes correct application of probability and statistics and highlights the limitations of each method presented. NOTE: This course may be replaced with MATH-UH 1003Q or MATH-UH 2011Q

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

Prerequisites: MATH-UH 1012 or MATH-UA 121 or MATH-UA 122 or MATH-UA 123 or MATH-UA 221 or MATH-UA 211 or MATH-SHU 131 or MATH-SHU 201 or MATH-SHU 151 or MA-UY 1024 or MA-UY 1124 or MA-UY 1324 or MA-UY 1424 or equivalent.

- Bulletin Categories: Quantitative Reasoning
- Bulletin Categories: Required Mathematics Courses
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 2011 Engineering Statics (2 Credits)*Typically offered Fall*

This course introduces students to the field of mechanics through study of rigid bodies in static equilibrium. Knowledge and understanding of static equilibrium is essential for future study of topics as diverse as dynamics, solid mechanics, structures, robotics, and fluid mechanics. The methods, techniques, theory, and application of equilibrium in the solution of engineering problems are presented for two-dimensional systems. Topics covered include collinear forces, coincident forces, general equilibrium, moments and torques, analysis of trusses, frames and machines, Coulomb friction, centroid, center of mass, and moments of inertia.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Corequisites:** SCIEN-UH 1103 and SCIEN-UH 1201EQ.

- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering

ENGR-UH 2012 Conservation Laws in Engineering (2 Credits)*Typically offered Fall and Spring*

Conservation laws play a fundamental role in the analysis of engineering problems by providing a framework to derive the relationships between various physical properties of isolated systems. This course aims to introduce the students to these laws, namely, the conservation of mass, conservation of linear momentum, conservation of angular momentum, conservation of energy, and conservation of charge. These laws of conservation will be derived in integral forms and applied to selected case studies involving electrical, chemical, thermal, and fluid mechanical systems. In addition to the development of a unified framework for analysis of engineering problems, this course will also help the students develop a deeper understanding of the concepts of control volume and mass, work and heat, fluid pressure and hydrostatics, properties of pure substances, and the fundamental laws of thermodynamics.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Foundations of Science 1 & 2.

- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering

ENGR-UH 2013 Digital Logic (2 Credits)*Typically offered Fall and Spring*

This module provides a rigorous introduction to topics in digital logic design mostly focusing on combinational circuits but also touching upon basic concepts in sequential circuits. Introductory topics include: classification of digital systems, number systems and binary arithmetic, error detection and correction, and switching algebra. Combinational design analysis and synthesis topics include: logic function optimization, arithmetic units such as adders and subtractors, and control units such as decoders and multiplexers. A brief overview of sequential circuits by introducing basic memory elements such as flip-flops, and state diagrams concludes the module.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Sophomore standing or higher.

- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering

ENGR-UH 2017 Numerical Methods (2 Credits)*Typically offered Fall*

This course provides an introduction to the methods, techniques, theory, and application of numerical methods in the solution of engineering problems. Topics to be covered include the following: finding roots of equations, numerical differentiation and integration, time marching methods in solving ordinary differential equations, and optimization. MATLAB software is the primary computing environment.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering

ENGR-UH 2019 Circuits Fundamentals (2 Credits)*Typically offered Fall and Spring*

This module provides an introduction to electrical circuits. The topics covered include DC circuits, passive DC circuit elements, Kirchoff's laws, electric power calculations, analysis of DC circuits, nodal and loop analysis techniques, voltage and current division, Thevenin's and Norton's theorems, and source free and forced responses of RL, RC and RLC circuits.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Sophomore standing or higher.

- Bulletin Categories: Engineering Common Courses (ECC)
- Bulletin Categories: Engineering

ENGR-UH 2025 Fundamentals of Discrete Math (2 Credits)*Typically offered Spring*

The course covers discrete mathematics. Logic, truth tables, mathematical induction, and other proof techniques are covered. Sets, relations and functions, recursive functions, basic algorithms, counting techniques, inclusion-exclusion principle, and basic graph theory and trees are also covered. NOTE: This course may be replaced with CS-UH 1002

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

Prerequisites: MATH-UH 1012 or MATH-UA 121 or MATH-UA 122 or MATH-UA 123 or MATH-UA 221 or MATH-UA 211 or MATH-SHU 131 or MATH-SHU 01 or MATH-SHU 151 or MA-UY 1024 or MA-UY 1124 or MA-UY 1324 or MA-UY 1424 or equivalent.

- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Required Option
- Bulletin Categories: Required Mathematics Courses

ENGR-UH 2026 Partial Differential Equations for Engineers (2 Credits)*Typically offered Fall*

This course presents techniques for understanding the response behavior of partial differential equations (PDEs) through studying the three basic linear PDEs that commonly appear in engineering problems; namely the Heat equation, Laplace's equation, and the Wave equation. These equations will be solved in specific situations using separation of variables and the companion methods of Fourier Series, Laplace Transform, and the Fourier Transform. Techniques for homogenizing and solving inhomogeneous PDEs will also be presented.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

Prerequisites: MATH-UH 1024 or MA-UY 4254 or MATH-UA 268 or MATH-SHU 262 or equivalent.

- Bulletin Categories: Engineering: Bioengineering Required
- Bulletin Categories: Engineering: General Engineering Required Option
- Bulletin Categories: Engineering: Mechanical Engineering Required
- Bulletin Categories: Required Mathematics Courses

ENGR-UH 2027 Introduction to Data Analysis for Engineers (2 Credits)*Typically offered Fall*

This course introduces students to the fundamentals of data analysis. The course starts with tools used to summarize and visualize data. The focus then shifts to fitting and parameter estimation. The derivation of estimators of parameters using both maximum likelihood and least-squares techniques are covered. Analysis of the statistical properties of estimators is also covered. The course includes hands-on exercises using MATLAB.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

Prerequisites: ENGR-UH 2010Q or MA-UY 2224 or MATH-UA 235 or MATH-SHU 235 or equivalent.

- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Required Option
- Bulletin Categories: Required Mathematics Courses

ENGR-UH 2028 Tissue Engineering (2 Credits)*Typically offered Spring*

This is an introductory course in tissue engineering that covers fundamental topics in the field including the basis of growth and differentiation, in vitro control of tissue development, in vivo synthesis of tissues, stem cells, biomaterials in tissue engineering, tissue engineering scaffolds - fabrication and applications, transplantation of engineered cells and tissues, emerging technologies such as 3D Bioprinting and organ on-a-chip, and ethical, legal, and social aspects of engineered tissues and organs. Lab tours, experimental demonstrations and two lab sessions on 3D printing and bioprinting lab will be part of the course.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 2112 Engineers for Social Impact (2 Credits)*Typically offered Spring*

This course is intended for students who are highly motivated and seek the opportunity to investigate and co-develop transformative concepts and solutions wherein the application of engineering and design methodologies are put to productive use in affecting social impact. Students with the necessary background course work and who, in the opinion of the faculty, possess intellectual independence and ability may register for this course. The course includes a required fieldwork component to be completed during spring break with the supervision of the faculty involved in this course. Course application forms available from the instructor.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Sophomore standing.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 2113 Introduction to Manufacturing Processes (2 Credits)*Typically offered Fall*

This course introduces students to the various manufacturing processes and their basic principles. Topics in this course include overview of different manufacturing processes and their applications, metal-casting fundamentals and processes, metal-forming processes including rolling, forging, extrusion, drawing, sheet-metal and powder-metal processes, fundamentals and types of machining processes, welding and other joining processes. The last part of this course will cover non-conventional manufacturing processes such as electrochemical machining, electrical-discharge machining, and abrasive jet machining and additive manufacturing (3D printing). Lab tours, experimental demonstrations and one 3D printing lab session will be part of the course.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 1021J.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 2210 Engineering Dynamics (2 Credits)*Typically offered Spring*

This course introduces students to the principles of rigid dynamics. The course covers both kinematic (geometric aspects of motion) and kinetic (analysis of forces causing motion) approaches. The first section of the course focuses on particle dynamics, with rigid body dynamics covered in the second section. The applications of these methods to engineering problems are presented, and students have the opportunity for extensive practice in applying these principles. Specific topics include the following: rectilinear and curvilinear motion, equations of motion for a system of particles, work and energy for a system of particles, linear impulse and momentum for a system of particles, angular momentum, relative and absolute motion analysis, rigid body rotation, and general 2D rigid body motion.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2011.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 2211 Solid Mechanics (2 Credits)*Typically offered Spring*

Designed as a first course in the mechanics of materials, this course introduces students to the basic concepts of stress and strain in the normal and tangential directions, and the two dimensional transformations of stress and strain. Topics include stress-strain relationships for members subject to axial forces, torsion, bending moments, and shear forces.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2011.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 2212 Fluid Mechanics (2 Credits)*Typically offered Spring*

This course introduces students to the basic principles and equations of fluid mechanics. This course covers properties and definitions of fluids, hydrostatics, Bernoulli's Equation and the use of control volume analysis and conservation laws previously introduced in the curriculum. These concepts are applied to internal flows, such as within a pipe, duct, or channel and to external flows, such as over flat surfaces and airfoils. The course introduces dimensional analysis and flow similitude. Common methods used for flow measurement in closed systems and open channels are also introduced. This course is limited to incompressible flow regimes.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2012.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 2310 Advanced Digital Logic (2 Credits)*Typically offered Spring*

This course follows Digital Logic and tops it up by covering sequential circuit design. The course will involve in-depth discussions on memory elements such as various types of latches and flip-flops, finite state machine analysis and design, random access memories, FPGAs, and high-level hardware description language programming such as VHDL. The course touches upon concepts such as testing of logic designs.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2013 or CS-UY 2204 or CENG-SHU 201.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 2311 Advanced Circuits (2 Credits)*Typically offered Spring*

This course builds on the foundations of the Circuits Fundamentals Course. The topics covered include sinusoidal steady-state response, complex voltage, current and the phasor concept; impedance, admittance; average, apparent and reactive power; polyphase circuits; node and mesh analysis for AC circuits; frequency response; parallel and series resonance; and, operational amplifier circuits.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2019 or ECE-UY 2013 or EENG-SHU 251.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 2510 Object-Oriented Programming (2 Credits)*Typically offered Spring*

This intermediate-level programming course focuses on object oriented programming using C++. Classes and objects including constructors, destructors, member functions and data members. Topics in this course include data representation, pointers, dynamic memory allocation and recursion, inheritance and templates, polymorphism, the process of compiling and linking using makefiles, memory management, exceptional control flow, introduction to performance evaluation, and optimization.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 1000 or CSCI-UA 2 or CSCI-UA 101 or CS-UY 1114 or CS-UY 1122 or CSCI-SHU 11 or CSCI-SHU 101.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 2610 Fundamentals of Complex Variables (2 Credits)*Typically offered Spring*

The course covers functions of a complex variable. The topics covered are: derivatives and Cauchy- Riemann equations, Integrals and Cauchy integral theorem, harmonic functions, the exponential function, trigonometric functions, logarithmic functions, Contour integrals, anti-derivatives, Cauchy-Goursat theorem, Cauchy integral formula, Liouville's theorem, fundamental theorem of algebra, power and Laurent series, and residue theory.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** MATH-UH 1020 or equivalent.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 2810 Biomechanics (2 Credits)*Typically offered Fall*

This first undergraduate course in biomechanics introduces fundamentals principles of solid mechanics applied to related anatomical features excerpted from musculoskeletal physiology. Concepts of loading stresses, strains, stress-strain relationship, deformable bodies, contact mechanics, friction, and solving static equilibrium problems using free body diagram will be applied to bone, cartilage, and ligaments, and functional systems, highlighting biological composition, concepts of form versus function, and adaptation in musculoskeletal physiology.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2011.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 2811 Biotransport Phenomena (2 Credits)*Typically offered Spring*

Knowledge and understanding of transport processes is essential in characterizing physiological and cellular processes, designing biomedical devices, and developing new therapies. This course introduces students to transport phenomena in biological systems such as arteries and skin tissues through an integrated study of momentum, mass, and energy transfer using control volumes, conservation relations, boundary conditions, and dimensionless groups.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2012.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 2812 Bioimaging (2 Credits)*Typically offered Fall*

This introductory course to Bioimaging is designed to provide an understanding on how images of organs, tissues, cells and molecules can be obtained using different forms of penetrating radiation and waves. Students will learn the imaging techniques used for soft and hard tissue visualization such as X-ray, Computed Tomography (CT), Ultrasound (US), Magnetic Resonance Imaging (MRI), Spectroscopy and Optical Imaging. The course will give students an insight into the theoretical physics of imaging, real-life clinical applications of these modalities and demonstration of post-processing of the images using high-level programming.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering Required
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 3110 Instrumentation, Sensors, Actuators (4 Credits)*Typically offered Fall*

The course focuses on theory of measurement systems, selected electrical circuits and components for measurement, including passive and active filtering for signal conditioning, dynamic measurement system response characteristics, analog signal processing, analog to digital conversion, data acquisition, sensors, actuators and actuator characteristics. The laboratory involves topics related to the design of measurement systems pertaining to all disciplines of engineering such as data acquisition, operational amplifiers, sensors for the measurement of force, vibration, temperature etc. In addition, actuators will also be introduced, including electric motors and pneumatics. Design of virtual instrumentation systems using LabVIEW is also included.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2019.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Hardware Elective
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Required
- Bulletin Categories: Engineering: Mechanical Engineering Required
- Bulletin Categories: Heritage Studies: Mgt Research Methods Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Heritage Studies

ENGR-UH 3111 Analysis of Chemical and Biological Processes (4 Credits)*Typically offered Fall*

Many problems can arise in the design of a new process or in the analysis of an existing process. This course introduces basic concepts and methods to solve problems in chemical and biological processes. We will focus on using the principle of mass conservation to determine the amount of products when given amounts of raw materials and vice versa. We will also apply the principle of energy conservation to analyze processes involving reactive and non-reactive systems. This course will prepare students for their subsequent courses in the chemical and biological engineering major such as transport phenomenon, kinetics, and process separations.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Sophomore standing or higher.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 3120 Engineering Materials (2 Credits)*Typically offered Fall*

Designed as a first course in materials, this course introduces students to engineering properties of materials, applying basic principles of the atomic and crystal structure of solids to the study of properties as well as to the selection and use of engineering materials. The course content includes examination of engineering materials such as metals, plastics, and composites with an emphasis on material selection. Through an immersive laboratory component, the course has an emphasis on experiential learning of the basic structure and properties of metallic, polymeric, semiconducting, ceramic, and composite materials.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Sophomore standing or higher.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Required
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 3130 Quantitative Synthetic Biology (4 Credits)*Typically offered Spring*

The course focuses on the fundamental principles of biology from an engineering perspective. These principles are necessary to understand the basic mechanisms of living organisms. As the laws of nature governing these mechanisms are expressed as differential equations, the main goal of this course is to introduce and model biological processes using tools from dynamical systems theory, with particular focus on the role of feedback. Throughout this course, students will learn how biological functions can be analyzed and designed using mathematical models, and how to use these models along with tools from controls and dynamical systems theory to predict and engineer the dynamics of biological systems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Biology: Electives
- Bulletin Categories: Engineering: Bioengineering SCIENCE Electives
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: Computer Engineering Required Option
- Bulletin Categories: Engineering: General Engineering Required Option
- Bulletin Categories: Required Science Courses
- Crosslisted with: Biology Major: Required
- Crosslisted with: Biology
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 3210 Advanced Solid Mechanics (2 Credits)*Typically offered Spring*

The course introduces students to the fundamentals of structural components analysis thus enabling them to employ that knowledge for structural analysis and for design of structural members. Topics include: three-dimensional analysis of stress; torsion of thin-walled sections; inelastic torsion; analysis of composite and unsymmetric beams; inelastic bending; beam deflections; elastic buckling of columns; and strength failure criteria.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2211.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 3230 Finite Element Modeling and Analysis (4 Credits)*Typically offered Fall*

Students study the basic theory and equations involved in the finite element analysis (FEA) for simulating behavior of materials and structures. Topics include use of shape functions, numerical integration, assembly of finite elements into a structure, and solution of the resulting system of equations. The course emphasizes both theory and application of modeling for simulation. Students also learn to recognize modeling errors and inconsistencies that could lead to either inaccurate or invalid results.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 3331 Computer Vision (2 Credits)*Typically offered Fall*

An important goal of artificial intelligence (AI) is to equip computers with the capability of interpreting visual inputs. Computer vision is an area in AI that deals with the construction of explicit, meaningful descriptions of physical objects from images. It includes the techniques for image processing, pattern recognition, geometric modeling, and cognitive processing. This course introduces students to the fundamental concepts and techniques used in computer vision, which includes image representation, image pre-processing, edge detection, image segmentation, object recognition and detection, and neural networks and deep learning. In addition to learning about the most effective machine learning techniques, students will gain the practical implementation of applying these techniques to real engineering problems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Counts towards IM 2000-Level
- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: IM 2000-Level
- Bulletin Categories: Interactive Media: Computational Media Elective
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Interactive Media Minor: Required
- Crosslisted with: Interactive Media

ENGR-UH 3332 Applied Machine Learning (4 Credits)*Typically offered Fall*

Machine Learning is the basis for the most exciting careers in data analysis today. This course introduces students to the concepts of machine learning and deep learning. This course covers a broad introduction to machine learning techniques, which include both supervised learning and unsupervised learning techniques such as classification, support vector machines, decision trees, ensemble learning and random forests, dimensionality reduction, and neural networks and deep learning. In addition to learning about the most effective machine learning techniques, you will gain the practical implementation of applying these techniques to real engineering problems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Computer Science Major: Electives
- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Computer Science Major: Required
- Crosslisted with: Computer Science
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 3410 Structural Systems (2 Credits)*Typically offered Fall*

The course provides an in-depth coverage of structural analysis techniques. Topics in this course include: analysis of statically determinate beams, frames and trusses; influence lines for determinate beams and trusses; deflection calculations using geometrical and energy methods; analysis of statically indeterminate structures using superposition; slope deflection; moment distribution; and matrix analysis of structures. The course includes computer assignments using commercial structural analysis software.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3210.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 3411 Environmental Engineering (4 Credits)*Typically offered Spring*

This course introduces application of engineering and scientific principles to protect and preserve human health and the environment. It embraces broad environmental topics and concerns, including mass and energy transfer, environmental chemistry, mathematics of growth, water pollution, water quality control, air pollution, global climate change and solid waste management; and laboratory analysis of water and wastewater samples and treatment process tests. Students gain an understanding of the interrelatedness of environmental problems around the world and how different socioeconomic, technological, ethical, and other factors can impact both the environment and the approach to solving environmental problems. Factors and parameters affecting design of environmental systems are discussed and design in environmental engineering is introduced.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2212.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Bulletin Categories: Environmental Studies: Envr Science
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Environment
- Crosslisted with: Environmental Studies

ENGR-UH 3412 Geotechnical Engineering (4 Credits)*Typically offered Fall*

This course introduces soil mechanics and foundation engineering, including origin of soils; phase relationships; classification of soils; permeability; effective stress; seepage; consolidation; shear strength; slope stability; and bearing capacity. Design in geotechnical engineering is introduced and parameters affecting design are discussed.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3413 Transportation and Traffic Engineering (4 Credits)*Typically offered Fall*

The course introduces students to fundamental concepts that underlie highway design, traffic operations and control, and transportation systems. The course begins with vehicle performance and the role it has on road design. We later cover the fundamentals of traffic flow theory and operations. In combination with such fundamentals we also discuss the use and collection of traffic data, as well as more advanced concepts on traffic safety, public transportation, and traffic management and control. Moreover, we look at clear applications of the concepts covered in class with a real-world student led project.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3420 Project Management (2 Credits)*Typically offered Fall*

This course is designed to lay down the foundation of the different concepts, techniques, and tools for successful project management with an emphasis on construction projects. At the end of this course students will have a good understanding of the different project management knowledge areas, the phases required for successful project management, and the role of a project manager. The main contents of the course are summarized in the following topics: project and organization structures, scheduling, resource management, cost estimating, risk management, and interpersonal skills.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 3430 Steel Structures Design (2 Credits)*Typically offered Fall*

This course examines structural steel design principles and techniques based on the Load Resistance Factor Design (LRFD). A detailed treatment of material properties and design based on American Institute of Steel Construction (AISC) codes is provided. Topics include: design of tension and compression members; design of beams and beam-columns; design for serviceability limit states; and design of simple bolted and welded connections. The course includes a design project in which students work in groups to simulate and solve specific design problems using structural analysis and design software.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3410.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Design Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3431 Concrete Structures Design (2 Credits)*Typically offered Fall*

This course offers a detailed treatment of the design of reinforced concrete members. Topics include: material properties of reinforced concrete, American Concrete Institute (ACI) load and resistance factors; flexural design of beams and one-way slabs; shear and diagonal tension in beams; serviceability and reinforcement detailing; and design of reinforced concrete columns. The course includes a design project in which students work in groups to simulate and solve specific design problems using structural analysis and design software.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3410.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Design Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3432 Water and Wastewater Systems Design (2 Credits)*Typically offered Fall*

This course introduces students to the concepts of design related to solving problems in environmental engineering. It provides an exposure to real-world problems in water systems and wastewater treatment. Students work in small teams and experience the design process, including the definition of the design objectives and constraints, formation of the design concept, synthesis, and analysis of design options, as well as the development and testing of the proposed solution.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3411.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Design Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3433 Advanced Structural Design and Retrofitting (2 Credits)*Typically offered Spring*

The course offers a treatment of advanced topics in the analysis, design and retrofitting of structural systems. Topics include: (a) Advanced reinforced concrete (RC): continuous structures, torsion, two-way slabs, shear walls, introduction to prestressed concrete, introduction to design for earthquake resistance. (b) Fundamentals of plastic analysis and design of RC and steel structures. (c) Strengthening and seismic retrofitting of RC and other structures with advanced materials and techniques. The course includes assignments in which students work to simulate and solve design problems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3431.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Design Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3510 Data Structures and Algorithms (4 Credits)*Typically offered Fall*

This course presents an overview of fundamental data structures, which are commonplace in programming, as well as associated basic algorithms. Complexity analysis, linked lists, stacks, queues, trees, hashing, sorting, and basic graphs algorithms are covered. Core topics such as Floyd's algorithm, minimum spanning tree algorithms, and branch and bound techniques are also covered. Practical lab exercises complement the lectures. The students further specialize and consolidate their knowledge through lab projects to demonstrate the operation and applications of various data structures.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 1000 and CS-UH 1002.**Corequisites:** ENGR-UH 2510.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Sound Music Computing Minor: CS Engr Elec
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Sound Music Computing

ENGR-UH 3511 Computer Organization and Architecture (4 Credits)*Typically offered Fall*

The course introduces the principles of computer organization and basic architecture concepts. It discusses the basic structure of a digital computer and study in details formal descriptions, machine instruction sets design, formats and data representation, addressing structures, mechanization of procedure calls, memory management, arithmetic and logical unit, virtual and cache memory organization, I/O processing and interrupts, fundamental of reliability aspects. The course also covers performance and distributed system models. The labs emphasize experiential learning of computer organization and architecture concepts, and require students to use learned knowledge to create and build prototypes and evaluate their performance.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2310.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3512 Computer Networks (4 Credits)*Typically offered occasionally*

The course introduces the basic concepts of computer and communication networks, including flow control, congestion control, end-to-end reliability, routing, framing, error-recovery, multiple access, and statistical multiplexing. There is in-depth presentation of the different networking layers, with emphasis on the Internet reference model. Protocols and architectures such as the TCP, IP, Ethernet, wireless networks etc. are described in order to illustrate important networking concepts. The course includes an introduction to quantitative analysis and modeling of networks. The labs cover basic concepts of computer networking and applications, and require students to use existing networking APIs to create and build computer network prototypes and real-life applications.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3520 Operating Systems (4 Credits)*Typically offered occasionally*

This course discusses the operating systems that run computers. The course is designed to familiarize students with operating systems, user and program interfacing concepts. Topics include an overview of user interface, process structure, creation and context switching; system calls; process cooperation, memory management; virtual memory, I/O management; interrupt handling, file structures; directories, fault-tolerance. The course includes discussion of the role of the operative system in security systems and related ethical practice.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3530 Embedded Systems (4 Credits)*Typically offered Fall*

This course presents an overview of embedded systems, covering a selection of topics including microcontroller architecture, assembler programming, interrupts, peripheral interfacing, embedded system design, higher-level languages on embedded systems, as well as a brief introduction to real-time operating systems. Practical lab exercises complement the lectures. The students further specialize and consolidate their knowledge through semester-long hands-on projects.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Computer Engineering Required
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3610 Signals and Systems (4 Credits)*Typically offered Fall*

This module covers analytical techniques for analyzing, characterizing and synthesizing engineering systems. Systems approaches where the entire system or each of the sub-systems is considered as single units are introduced. Introductory topics in this course include: sinusoids, phase and time shift, and complex exponentials. Operations on sinusoidal signals include addition of signals with the same frequency via the phasor addition rule, conversion between time-shift and phase, and addition of signals with different frequencies via the introduction of the frequency spectrum concept. Topics on discrete time systems include: FIR and IIR filtering, impulse response, causality, linearity, time invariance, and convolution. Time and frequency domain representations of systems and conversions between these representations are also studied. Z-transform domain, the concept of poles and zeros, stability and their relevance to the time and frequency domains are also covered. Topics on continuous time systems include continuous-time convolution, the Laplace transform, Fourier analysis for continuous-time signals, and the Sampling theorem.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** MATH-UH 1012 or equivalent **Corequisite:** ENGR-UH 2610.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Sound Music Computing Minor: CS Engr Elec
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Sound Music Computing

ENGR-UH 3611 Electronics (4 Credits)*Typically offered Fall*

This course focuses on fundamentals of electronics theory and design. The topics covered include semiconductor physics, diodes, diode circuits such as limiters, clamps; bipolar junction transistors; small-signal models; cut-off, saturation, and active regions; common emitter, common base and emitter-follower amplifier configurations; field-effect transistors (MOSFET and JFET); biasing; small-signal models; common-source and common gate amplifiers; and integrated circuit MOS amplifiers. The laboratory experiments include the design, building and testing of diode circuits, including rectifiers, BJT biasing, large signal operation and FET characteristics, providing hands-on experience of design, theory and applications, with emphasis on small signal analysis and amplifier design. The course also covers the design and analysis of small-signal bipolar junction transistor and field-effect transistor amplifiers; and, diode circuits. The students are introduced to designing and analyzing circuits using the LTSPICE or Cadence simulation tool.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2019.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Computer Engineering Hardware Elective
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Physics: Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Physics Major: Required
- Crosslisted with: Physics

ENGR-UH 3613 Electromagnetics (4 Credits)*Typically offered Spring*

Electromagnetic wave propagation in free space and in dielectrics is studied starting from a consideration of distributed inductance and capacitance on transmission lines. Electromagnetic plane waves are obtained as a special case. Reflection and transmission at discontinuities are discussed for pulsed sources, while impedance transformation and matching are presented for harmonic time dependence. Snell's law and the reflection and transmission coefficients at dielectric interfaces are derived for normal and obliquely propagating plane waves. Guiding of waves by dielectric and by metal waveguides is demonstrated.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 3620 Analog and Digital Communication Theory (4 Credits)*Typically offered Spring*

The course introduces the principles of the various analog communication fundamentals. Topics covered include: analog modulation techniques such as FM, AM, and PM; noise performance of various receivers; and digital data transmission, data encoding, BER, modulation techniques such as ASK, FSK, PSK and QAM, and the effects of noise and bandwidth. The labs emphasize experiential learning of basic analog and digital communication theory concepts and applications, including experiments demonstrating analog and digital modulation techniques.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3610.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Pre-Professional Media, Culture Communication
- Bulletin Categories: Sound Music Computing Minor: CS Engr Elec
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Pre-Professional Media, Culture Communication
- Crosslisted with: Sound Music Computing

ENGR-UH 3710 Thermodynamics (2 Credits)*Typically offered Fall*

This course introduces students to the basic concepts of thermodynamics and their applications to engineering problems. The following topics are covered in this course: properties of pure substances; concepts of work and heat; closed and open systems; the fundamental laws of thermodynamics; Carnot and Clausius statements of the 2nd law; entropy and entropy production; heat engines, refrigerators, heat pumps; efficiencies, coefficients of performance.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2012.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 3720 Computer-Aided Design (2 Credits)*Typically offered Spring*

This course provides an introduction to computer-aided design (CAD) using solid modeling. Students learn to create solid object models using extrusions, revolutions, and swept paths, and learn to modify parts using cutting, patterns, fillets, chamfers, and other techniques. Assemblies of multiple parts are used to demonstrate the need for geometric tolerances, and students spend a large portion of class in hands-on use of software tools. The labs emphasize experiential learning of CAD concepts and applications using software tools.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Counts towards IM 2000-Level
- Bulletin Categories: Counts towards IM 3000-Level
- Bulletin Categories: Design Minor Electives
- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required
- Bulletin Categories: IM 2000-Level
- Bulletin Categories: IM 3000-Level
- Bulletin Categories: Interactive Media: Computational Media Elective
- Crosslisted with: Design
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Interactive Media Minor: Required
- Crosslisted with: Interactive Media

ENGR-UH 3730 Modeling and Analysis of Dynamical Systems (4 Credits)*Typically offered Fall*

This course presents techniques for developing and analyzing mathematical models of mechanical, electrical, electromechanical, fluid and thermal systems. Transient, steady-state, and frequency responses of single- or multi- degree of freedom systems with lumped parameters are determined using analytical and numerical methods. Linearization and state-space representation of Dynamical Systems are also presented. Linear free- and forced vibrations in single- and multi-degree-of-freedom systems are discussed and methods of vibration absorption and isolation are introduced.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 3751 Heat Transport (2 Credits)*Typically offered Fall*

This course introduces students to the basic principles and engineering applications of heat transfer. Fundamental concepts and principles of conduction, convection, and radiation heat transfer are introduced and the pertinent governing equations are developed. This is followed by the application of these equations in analysis of heat transfer systems such as fins and heat exchangers. The following topics are covered in this course: introduction to conduction, convection, and radiation; one-dimensional, steady-state conduction; multi-dimensional, steady-state conduction; introduction to convection; internal and external forced convection; principles of boiling heat transfer; and principles of radiative heat transfer.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 3810 Quantitative Physiology (2 Credits)*Typically offered Fall*

This course introduces students to developing a framework that allows them to build computational models to quantitatively describe physiology. Selected concepts from prerequisite courses are used to examine essential elements of physiology at various resolutions. We first begin by using the endocrine system to demonstrate hormone mediated cell-to-cell communication, following that is the examination on regulation of blood glucose-insulin levels achieved by the pancreas and the liver. Modeling methodologies will be imparted through studio-based learning and projects. Participants will additionally hone their skillsets in experimental planning, data interpretation and presentation of results.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Biology: Electives
- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Biology Major: Required
- Crosslisted with: Biology

ENGR-UH 3811 Neuroengineering (4 Credits)*Typically offered Fall*

Mind and bodily control of devices has long been a goal of mankind. Advancements in various disciplines including neuromodulation and prosthetics bring us closer to this goal. This course will delve into the latest technologies and research in peripheral and central nervous systems. Students will learn the basic structure and functions of the nervous system, engineering approaches for interfacing with the nervous system, and existing and emerging clinical therapies for specific disorders. Sessions will present a holistic view of the neuroengineering field, combining engineering, translational, and clinical perspectives.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Foundations of Science 1-2.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives

ENGR-UH 3812 Laser and Optics in Medicine (4 Credits)*Typically offered Fall*

This course covers the principles, methods and applications of lasers and optics in biomedical applications. The objective of the course is to understand the basic principles of light-tissue interactions and how this can be used to solve biological and medical problems. It will provide the student with detail of methods and procedures used in the design and application of light-based sensors and imaging systems. Furthermore, the use of lasers for clinical application (i.e., therapy) will be introduced. Upon successful completion of this course, students are expected to be able to explain common optical techniques for biomedical applications.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Foundations of Science 3-4 or PHYS-UH 2115.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 3813 Nanobiotechnology (2 Credits)*Typically offered Fall*

Nanobiotechnology is an exciting interdisciplinary field that combines principles from biology, physics, chemistry, and engineering to create new applications and technologies at the nanoscale. Nanoscale refers to materials that are measured in nanometers (nm), which is about 1-100 nanometers in size, and is much smaller than what can be seen with the naked eye. Nanobiotechnology has the potential to revolutionize many areas of biology and medicine, including cancer treatment, regenerative medicine, and gene therapy. Additionally, the development of new nanobiotechnology applications has significant implications for the environment, energy, and electronics sectors. In this course, we will cover the fundamentals of nanobiotechnology, including the properties of nanomaterials, their interactions with biological systems, and their applications in medicine and beyond. We will also explore the ethical and societal implications of nanobiotechnology and discuss its potential impact on the future of science and technology.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4011 Senior Design Capstone Project I (2 Credits)*Typically offered Fall*

Students learn about the process of design with measurable metrics, and how to incorporate appropriate engineering standards and multiple realistic constraints in the design process. Students learn how to clearly frame the design problem and follow the design process to result in an optimized solution. Students perform a review of the relevant literature, develop a preliminary design, generate solution concepts and selection criteria, and review and evaluate the chosen design. Students must consider social, economic, lifecycle, environmental, ethical, and other constraints, and must document the design process and the evolution of their design. This project culminates with a final report and presentation that proposes the actual design selected for further development and/or prototyping and testing in the subsequent semester.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Declared Engineering major and have senior standing**Corequisite:** Two credits of disciplinary elective course in senior Fall.

- Bulletin Categories: Engineering: Capstone

ENGR-UH 4020 Senior Design Capstone Project II (4 Credits)*Typically offered Spring*

The students finalize the proposed design solution, and test and verify the solution. Design modifications based on the test data are incorporated. If applicable, prototypes are built and tested. A final report for the project is prepared and the students make a presentation of their project to peers, faculty, and other professionals.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 4011.

- Bulletin Categories: Engineering: Capstone

ENGR-UH 4110 Engineering Research Seminar (1 Credit)*Typically offered Fall*

Exposing undergraduate students to the elements of the research necessary to solve many of the pressing world challenges is key to their educational experience. It builds their appreciation for the fundamental knowledge they are garnering through their undergraduate education, and delineates the methodologies needed to go from a simple hypothesis into an innovative solution through a process of searching, learning, testing, documenting, patenting, and publishing. Along this line, the goal of this research seminar is to expose students to the research of the faculty in the Engineering Division. This will be achieved by requiring enrolled students to attend at least nine research seminars delivered by selected faculty members from the division. Enrolled students are required to submit an essay summarizing the main findings of each seminar they attended. Students who intend to pursue the undergraduate honors research program must first enroll in this course. Note: this course counts as a general elective for all engineering disciplines.

Grading: Ugrd Abu Dhabi Pass/Fail**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses

ENGR-UH 4112 Engineering Honors Research (2 Credits)*Typically offered Fall and Spring*

Exposing students to the elements of the research necessary to solve many of the pressing world challenges is key to their educational experience. It builds their appreciation for the fundamental knowledge they are garnering through their undergraduate education, and delineates the methodologies needed to go from a simple hypothesis into an innovative solution through a process of searching, learning, testing, documenting, patenting, and publishing. Students perform a review of the relevant literature, undertake a mentored research project, and present their findings through a report and oral presentation. The final report must be submitted to the faculty mentor. The oral presentation is delivered in a public honor's research seminar in the final week of the semester. Students who decide to pursue the Engineering Honor's program must work with their research advisor to submit a two-page proposal for the approval of the program head before the beginning of the semester and preferably by the end of the of engineering honors seminar course. The program heads will communicate the approved proposals to the Associate Dean. Only students with approved proposals can register for the course.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Senior standing and a cumulative GPA of 3.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4141 Fundamentals and Applications of MEMS (4 Credits)*Typically offered occasionally*

This course introduces students to the multi-disciplinary and exciting field of Micro-Electro-Mechanical Systems (MEMS) technology. It covers several cases of existing MEMS devices, their applications and limitations. The course also covers fundamentals of micromachining and micro-fabrication techniques that are central to the production of MEMS devices. Furthermore, the course introduces the design and analysis principles of several MEMS devices such as capacitive, piezoelectric, electrostatic sensors and actuators, MEMS-based medical and surgical devices, and biomedical lab-on-a-chip device. The course includes several lectures on the concepts of MEMS design processes, assembly, and packaging. Several types of assignments are included during this course, such as analytical problems, simulation and design assignments, and seminars given by the students. Also, a project that involves design, simulation, and analysis of MEMS devices is a vital component of this course.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3110.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4142 Bio-sensors and Biochips (4 Credits)*Typically offered Fall*

This course covers the principles, technologies, methods and applications of biosensors and bioinstrumentation beginning with an examination of the ethical, legal, cultural, religious, and social implications of nanotechnologies. The objective of this course is to link engineering principles to understanding of biosystems in sensors and bioelectronics. The course provides students with detail of methods and procedures used in the design, fabrication, and application of biosensors and bioelectronic devices. The fundamentals of measurement science are applied to optical, electrochemical, mass, and pressure signal transduction. Upon successful completion of this course, students are expected to be able to explain biosensing and transducing techniques; design and construct biosensors instrumentation.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Corequisites:** ENGR-UH 3110 or ENGR-UH 3530.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Hardware Elective
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4143 Computer Vision and Pattern Recognition (4 Credits)*Typically offered Spring term of odd numbered years*

This advanced course in Computer Vision and Pattern Recognition is a focused offering within the expansive field of Artificial Intelligence (AI). The course aims to provide a comprehensive understanding of both foundational and advanced topics in computer vision. Foundational topics include image representation, image pre-processing, edge detection, and image segmentation. The course also covers a range of advanced topics such as image registration, object detection, object tracking, and 3D scene understanding with semantic interpretation. A significant emphasis is placed on the integration of machine learning methods, particularly neural networks and deep learning, to solve complex visual interpretation tasks. Students will engage in hands-on projects that apply these cutting-edge algorithms to real-world engineering challenges. By the end of the course, students will not only be proficient in the most effective machine learning techniques but will also have gained invaluable practical experience in applying these techniques to solve engineering problems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4160 Selected Topics in Biomedical and Health Systems (2-4 Credits)*Typically offered every year*

This course explores advanced topics of special interest in biomedical and health care systems and applications and is designed to aid students in gaining extra knowledge in an area not covered in the program's mainstay courses. The course may be repeated for credit. The course is open to junior and senior students. Students must obtain permission from their faculty mentor.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** Yes**Prerequisites:** Junior standing.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4230 Applied Optimization (4 Credits)*Typically offered Spring*

This course provides an introduction to systems optimization focusing on understanding system tradeoffs. The course introduces modeling methodology (linear, integer, stochastic, dynamic, and nonlinear programming), with applications in production planning, scheduling and manpower planning, time-phased planning, inventory and logistics management, supply chain network design, facility sizing and capacity expansion, capital budgeting models, assignment and matching, and transportation models. In this class, students learn powerful modeling and solution techniques for decision-making problems that are used today by thousands of successful companies to help them to reduce their operation costs and therefore saving millions of dollars. The course covers some of the optimization methods such as simplex method, duality analysis, branch-and-bound, and KKT Conditions for solving nonlinear convex programming problems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** MATH-UH 1023 and ENGR-UH 2010Q.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4231 Membrane Science and Engineering (2 Credits)*Typically offered Fall*

Modern membrane engineering is critical to the development of process-intensification strategies and to the stimulation of industrial growth. Membrane separation is an important process in water processing, food technology, pharmaceutical industry as well as the management of water resources and it has a large societal, economic and environmental impact. This course will give engineering students a solid grounding in membrane science and related separation processes from basic phenomena to the most advanced applications and future perspectives. It presents all types of pressure driven membranes including microfiltration, ultrafiltration, nanofiltration and reverse osmosis as well as other hybrid techniques used on both small and large scales in the industry. The students will also be introduced to major considerations in membrane engineering design. This will prove invaluable for a future career in many areas of engineering.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2212 or ENGR-UH 2811.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4320 Hardware Security (4 Credits)*Typically offered occasionally*

This course covers topics related to security and trustworthiness of electronic hardware. Lectures and in-class discussions on recent research papers cover the following topics: Trustworthiness of integrated circuits; counterfeit chips, hardware Trojans, reverse engineering and IP piracy. Design-for-Trust; hardware metering, logic encryption, split manufacturing, IC camouflaging. Encryption hardware; AES, DES, etc. Testability vs Security; misuse of test infrastructure to attack encryption hardware and countermeasures. Encrypted architectures; homomorphic encryption, privacy-preserving computation. Signal processing in the encrypted domain. Malware detection through hardware structures, side channel attacks, cyber-security for the smart grid. Lectures are complemented by hands-on lab exercises.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2310.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Hardware Elective
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4321 Introduction to Hardware Security (2 Credits)*Typically offered Fall*

This seminar-type course covers topics related to security and trustworthiness of electronic hardware and systems. Lectures and in-class discussions on recent research papers cover the following topics: Trustworthiness of integrated circuits; counterfeit chips, hardware Trojans, reverse engineering and IP piracy. Design-for-Trust; hardware metering, logic locking, split manufacturing, IC camouflaging; testability vs Security; misuse of test infrastructure to attack encryption hardware and countermeasures. Lectures are complemented by hands-on lab exercises. A comprehensive final exam will be used to assess the understanding of foundational concepts.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2310 with a Minimum Grade of C.

- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Hardware Elective
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4322 Introduction to Systems Security (2 Credits)*Typically offered Fall*

This seminar-type course covers topics related to security and privacy of hardware systems. Lectures and in-class discussions on recent research papers cover the following topics: Microarchitecture and analog side channels, fault-injection attacks, isolation, sandboxing, hardware-based intrusion detection, machine learning security, industrial control systems security, and privacy-preserving computation. Lectures are complemented by hands-on lab exercises.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Hardware Elective
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4330 Robotics (4 Credits)*Typically offered occasionally*

This course presents an overview of robotics, covering a selection of topics including controls, localization, motion planning, sensing, kinematics, and human-robot interaction, and related social-ethical issues. Practical lab and simulation exercises complement the lectures. The students further specialize and consolidate their knowledge through semester-long hands-on projects that involve the design, implementation, and testing of robotic systems and applications.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** MATH-UH 1023.

- Bulletin Categories: Counts towards IM 2000-Level
- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering ENGR Electives
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Bulletin Categories: IM 2000-Level
- Bulletin Categories: Interactive Media: Physical Computing Elective
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering
- Crosslisted with: Interactive Media Minor: Required
- Crosslisted with: Interactive Media

ENGR-UH 4423 Production and Logistics Management (4 Credits)*Typically offered occasionally*

This course provides an introduction to operations research models and techniques developed for a variety of problems arising in production and logistical systems. The course focuses on planning models for production, inventory, and distribution strategies. Topics include production planning, inventory management with deterministic demand, inventory management with stochastic demand, operations scheduling, facility location problems, and routing problems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2010Q or equivalent.

- Bulletin Categories: BOS: General Business Electives
- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Business, Organizations, and Society
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4424 Information Management and Modeling for Construction (2 Credits)*Typically offered Spring*

This course introduces current information modeling and management technologies applicable to the design and management of construction projects. Particular emphasis is given to the fundamentals of building information modeling (BIM), lean construction, and parametric modeling. The course will provide an introduction to 4D, 5D modeling, and different BIM Levels. Students will get a good understanding of how information modeling and management technologies can be an asset for the different parties involved in construction projects. Awareness of the associated risks is also addressed. This course introduces current information modeling and management technologies applicable to the design and management of construction projects. Particular emphasis is given to the fundamentals of building information modeling (BIM), lean construction, and parametric modeling. The course will provide an introduction to 4D, 5D modeling, and different BIM Levels.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** Junior or Senior standing.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4431 Foundation Engineering Design (2 Credits)*Typically offered every year*

This course introduces the development of foundation engineering, including site exploration, soil sampling, interpretation of boring logs, bearing capacity of footings, settlement of structures, lateral earth pressure. Design of retaining walls, design of braced excavations and sheet pile walls; and design of deep foundations are covered.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3412.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Design Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4433 Structure and Properties of Civil Engineering Materials (2 Credits)*Typically offered Fall*

In this course, students are introduced to the structure and properties of civil engineering materials such as asphalt, cements, concrete, geological materials (e.g. soil and rocks), steel, polymers, and wood. The properties range from elastic, plastic and fracture properties to porosity and thermal and environmental responses. Laboratory tests include evaluation of behavior of these materials under a wide range of conditions.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3120.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4434 Water Desalination Engineering (2 Credits)*Typically offered occasionally*

Desalination is an important process in the management of water resources and it has a large societal, economic and environmental impact. This course will give engineering students a solid grounding in desalination and related separation processes. It presents thermal desalination and reverse osmosis as well as other emerging techniques used on both small and large scales to desalt brackish water and seawater. The course introduces to the students a design concept of desalination processes. This will prove invaluable for a future career in many areas of engineering.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Design Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4460 Selected Topics in Urban Systems (2-4 Credits)*Typically offered occasionally*

This course explores advanced topics of special interest in smart cities and applications and is designed to aid students in gaining extra knowledge in an area not covered in the program's mainstay courses. It may be repeated for credit. The course is open to junior and senior students. Students must obtain permission from their faculty mentor.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** Yes**Prerequisites:** Junior standing.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4560 Selected Topics in Information and Computational Systems (2-4 Credits)*Typically offered every year*

This course explores advanced topics of special interest in information and computational systems and is designed to aid students in gaining extra knowledge in an area not covered in the program's mainstay courses. Different topics may be repeated for credit. The course is open to junior and senior students. Students must obtain permission from their faculty mentor. Topics: 1. Hardware Security: Computer Engineering electives; Computer Engineering Hardware electives, Electrical Engineering electives, General Engineering electives. 2. Machine Learning: Civil Engineering electives, Computer Engineering electives Electrical Engineering electives, General Engineering electives, Mechanical Engineering electives. 3. Introduction to Computer Vision: Computer Engineering electives, Electrical Engineering electives, General Engineering electives.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** Yes**Prerequisites:** Junior standing or higher and ENGR-UH 3332 Applied Machine Learning.

- Bulletin Categories: Computer Science Major: Electives
- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives
- Crosslisted with: Computer Science Major: Required
- Crosslisted with: Computer Science
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4610 Control Systems Engineering (4 Credits)*Typically offered Fall*

The course introduces the principles of dynamic system modeling, analysis, and feedback control design with extensive, hands-on computer simulation. Modeling and analysis of dynamic systems. Description of interconnected systems via transfer functions and block/signal-flow diagrams. System response characterization as transient and steady-state responses and error considerations. Stability of dynamical systems: Routh-Hurwitz criterion. Controller design using root-locus and Bode-diagrams (frequency domain). Introduction to modern state-space controller designs. Computer-aided feedback control design for mechanical, aerospace, robotic, thermo-fluid, and other electrical systems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** MATH-UH 1022 and MATH-UH 2010.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Electrical Engineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4620 Fundamentals of Photonics-I (2 Credits)*Typically offered occasionally*

This module provides an introduction to the fundamentals of photonics for students in Electrical and Computer Engineering at the senior level. It focuses on studying electromagnetic waves, polarization, laws of reflection and transmission, interference, diffraction, and optical beams. Light propagation in dielectric waveguides are studied. Finally, subject to lab availability, a set of lab experiments is conducted showcasing the optical theory discussed in classes.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** MATH-UH 1022.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4621 Wireless Communications (3 Credits)*Typically offered Spring*

This course provides the basics for the design and analysis of wireless communication systems. Topics covered include introduction to wireless communication systems and applications (basic terminology, wireless applications and requirements, overview of cellular system generations and wireless access standards), modeling and classification of wireless channels (path loss models, large-scale and small-scale fading), description of digital modulation techniques for wireless channels, performance measures of modulation techniques (temporal/spectral characteristics, energy efficiency, error rate), optimum receiver design for wireless channels, performance analysis of communication systems over fading channels, fading mitigation techniques (transmit diversity, receive diversity, multiple-input multiple-output communication), digital communication over frequency-selective wireless channels (equalization, multi-carrier transmission) and multi-user communications (cellular systems, multiple access). Examples will be provided from state-of-the-art cellular and wireless LAN standards.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3620.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Crosslisted with: Engineering Common Courses (ECC)
- Crosslisted with: Engineering

ENGR-UH 4660 Selected Topics in Communication and Electronic Systems (4 Credits)*Typically offered every year*

This course explores advanced topics of special interest in electronic systems and is designed to aid students in gaining extra knowledge in an area not covered in the program's mainstay courses. It may be repeated for credit. The course is open to junior and senior students. Students must obtain permission from their faculty mentor.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** Yes**Prerequisites:** Junior standing.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives

ENGR-UH 4701 Electrochemical Energy Devices (2 Credits)*Typically offered Spring*

Batteries and fuel cells devices are essential components of electromobility (e.g. electrical cars) and renewable energy. This course discusses the operation principles of these devices. The course topics include the application of thermodynamics and kinetics to these electrochemical power sources. This course will also provide an introduction to the fundamentals of the materials science behind the performance and reliability of these devices.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Computer Engineering Electives
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4710 Thermal Systems (2 Credits)*Typically offered Fall*

This course focuses on the analysis and design of energy-conversion systems. It introduces students to power generation systems. Topics covered include gas and vapor power systems and their components; refrigeration and heat pump systems; combustion; boiling heat transfer characteristics; design of heat exchangers and cooling systems. Students gain an understanding of the fundamentals of such systems and the issues related to their operation from economic, environmental, ethical and safety points of view. NOTE: Students following the 2018-2019 or earlier bulletin must take the 4-credit version of this course titled Thermal Energy Systems.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3751.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Required

ENGR-UH 4711 Compressible Flow (4 Credits)*Typically offered occasionally*

This course provides an introduction to conservation equations for inviscid flows, one dimensional flows, isentropic flow, normal shock waves, one dimensional flow with friction, one dimensional flow with heat addition, oblique shock waves, Prandtl-Meyer expansion waves, flow in nozzles and diffusers, inviscid flow in a converging-diverging nozzle, flow in diffusers, subsonic and supersonic airfoils, compressibility effects on lift and drag, critical and drag divergence Mach number, and wave drag. It will also cover analysis of unsteady one-dimensional and steady supersonic two-dimensional flows; including the method of characteristics; small-disturbance theory with applications to supersonic thin-airfoil theory.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2212, ENGR-UH 2017 Pre- or Corequisite: ENGR-UH 3710.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4712 Mechanics of Composite Materials (2 Credits)*Typically offered occasionally*

This course introduces students to the field of composite materials with emphasis on laminated fiber-reinforced polymer (FRP) composites. Unlike metals, laminated composites are heterogeneous, anisotropic and relatively brittle, all of which makes it more challenging to design with composites. Nonetheless, composites are increasingly used in the design of load bearing components due to their superior structural properties. Course topics include lamina and laminate stress analysis; manufacturing of FRP composite laminates; failure criteria; testing of FRP composites; and the impact of composite materials on the economy and the environment.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 3210.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Civil Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4760 Selected Topics in Mechanical Engineering (4 Credits)*Typically offered APP*

This course explores advanced topics of special interest in Mechanical Engineering and is designed to aid students in gaining extra knowledge in an area not covered in the program's mainstay courses. The course may be repeated for credit. The course is open to junior and senior students. Students must obtain permission from their faculty mentor.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** Yes**Prerequisites:** Senior standing.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4770 Micro-power Generation (4 Credits)*Typically offered occasionally*

This course introduces vibration and flow energy harvesting methods commonly used for powering remote sensors and sensor networks. Emphasis is placed on building the fundamentals necessary to model and analyze the response of energy harvesters. Theories of linear vibrations for discrete and simple continuous systems are detailed. Constitutive models of active materials and other electromechanical transduction mechanisms are covered. Basic theories of fluid-structure interactions are also highlighted.

Grading: Ugrd Abu Dhabi Graded**Repeatable for additional credit:** No**Prerequisites:** ENGR-UH 2011, ENGR-UH 2012, and ENGR-UH 2019.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Electrical Engineering Electives
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives

ENGR-UH 4810 Biomaterials (2 Credits)

Typically offered Fall

Introduction to the field of biomaterials used in applications for the challenging field of tissue engineering and regenerative medicine. Confined to discussions on synthetic or naturally derived biopolymers, the course will touch on bulk properties, degradation mechanisms, cell-material interactions and biocompatibility, material and immune response, techniques for biomaterials assessments, methods of processability and special considerations for in situ regeneration.

Grading: Ugrd Abu Dhabi Graded

Repeatable for additional credit: No

Prerequisites: ENGR-UH 2810 or ENGR-UH 3120.

- Bulletin Categories: Engineering Required Elective Courses
- Bulletin Categories: Engineering: Bioengineering Required
- Bulletin Categories: Engineering: General Engineering Electives
- Bulletin Categories: Engineering: Mechanical Engineering Electives