Sustainable Design Engineering

Overview

The Faculty of Sustainable Design Engineering at UPEI offers a progressive and innovative four-year Bachelor of Science in Sustainable Design Engineering degree which recognizes the need for a broad and balanced engineering education. The program follows current trends in engineering education and focuses on student outcomes. Small class sizes within an activity-based learning environment allow faculty and staff to be student-centric and to provide specific and timely input to individual students.

Students are exposed to a broad base of knowledge and skills in engineering science, natural science, mathematics, and complementary studies in concert with an applied project-based design stream simulating the engineering profession. Students entering the degree program will be actively engaged in the profession of engineering from day one, providing creative and sustainable solutions to society's problems. The degree program is designed to provide a highly flexible learning environment that is responsive to the dynamic needs of students and the industries that employ them.

In addition to fundamental science, engineering science and mathematics courses, students are required to develop skills in engineering design, communication, analysis, project management, professional ethics and more. With a solid grounding in these fundamentals, students in Program Years 3 and 4 can enhance their technical knowledge by choosing an engineering focus area:
Engineered by Design

It is increasingly recognized that understanding basic science and mathematics are only two of the many areas that are essential to professional engineering practice. Engineering students in this program must make responsible decisions based on good judgment and an ability to justify decisions within a structured analytical framework. Based on this generalist philosophy, this program is designed to develop a student’s ability to think. This fundamental requirement of engineers to think critically in response to ever-changing and complex situations is accomplished through a design stream core which relies heavily on inquiry-based learning supported by traditional lecture-based knowledge. The progression in complex thinking skills occurs over the duration of the four-year program and beyond through appreciation of lifelong learning and professional development.

An integrated, project-based professional practice (PBPP) stream provides an applied foundation where students work on real community and industry-based projects in every semester of their program. Traditional content courses are delivered via an integrated and timely approach with the PBPP courses so that professional practice skills are developed in a simulated workplace environment. This program emphasizes design as an essential element of engineering as reflected in the Community Design Program (Year 1), and the Junior Design (Year 2) and Senior Design (Years 3 and 4) Clinics.

The following core design courses must be taken in succession to support the students’ developing skills.

**Community Design Program (Program Year 1)**

1. Engineering 1210—Engineering Communication
2. Engineering 1220—Engineering Analysis

**Junior Design Clinic (Program Year 2)**

3. Engineering 2210—Engineering Projects I
4. Engineering 2220—Engineering Projects II

**Senior Design Clinic (Program Years 3 and 4)**

5. Engineering 3710—Project-Based Professional Practice I
6. Engineering 3720—Project-Based Professional Practice II
7. Engineering 4710—Project-Based Professional Practice III
8. Engineering 4720—Project-Based Professional Practice IV

**Degree**

Students are strongly encouraged to meet with a faculty advisor early in the program to review course selection. Please refer to the [first-year advisement info](#) [1] to help with first-year registration, and the [four-year degree course matrix](#) [2] and [five-year degree course matrix](#) [3] for planning.
The following is the course sequence for the four-year degree. Please note that a 60% minimum grade is required in each of the following courses to proceed to the next course: Engineering 1210, 1220, 2210, 2220, 3710, 3720 and 4710.

**Program Year 1—Term 1**

- Engineering 1210—Engineering Communications
- Engineering 1310—Computer Programming with Engineering Applications
- Physics 1110—General Physics I
- Chemistry 1110—General Chemistry I
- Mathematics 1910—Single Variable Calculus I
- UPEI 1010—Writing Studies (or UPEI 1020, or UPEI 1030)

**Program Year 1—Term 2**

- Engineering 1220—Engineering Analysis
- Engineering 1520—Engineering and the Biosphere
- Physics 1120—General Physics II
- Chemistry 1120—General Chemistry II
- Mathematics 1920—Single Variable Calculus II
- Statistics 1210 (formerly Statistics 2210)—Introductory Statistics

**Program Year 2—Term 3**

- Engineering 2210—Engineering Projects I
- Engineering 2310—Strength of Materials
- Engineering 2610—Thermo Fluids I
- Engineering 2810—Electric Circuits I
- Mathematics 2610—Linear Algebra
- Mathematics 2910—Multivariable and Vector Calculus

**Program Year 2—Term 4**

- Engineering 2220—Engineering Projects II
- Engineering 2340—Engineering Dynamics
- Mathematics 3010—Differential Equations
- Two (2) technical electives*
- One (1) humanities elective (courses typically offered by the Faculty of Arts, except basic languages and economics)

**Program Year 3—Term 5**

- Engineering 3710—Project-Based Professional Practice I
- Engineering 3220—Engineering Measurements
- Engineering 3260—Materials, Mechanics, and Manufacturing
- Engineering 3810—Systems Engineering
- One (1) introductory engineering focus area elective**

**Program Year 3—Term 6**
• Engineering 3720—Project-Based Professional Practice II
• Engineering 3270—Machines & Automatic Controls
• Engineering 3630—Thermofluids III with Heat Transfer
• Engineering 3820—System Dynamics with Simulation
• One (1) engineering focus area elective**

Program Year 4—Term 7

• Engineering 4710—Project-Based Professional Practice III
• Engineering 4210—Facilitated Study & Experimental Practice
• Engineering 4230—Technology Management & Entrepreneurship
• One (1) engineering focus area elective**

Program Year 4—Term 8

• Engineering 4720—Project-Based Professional Practice IV
• One (1) engineering focus area elective**
• One (1) science or business elective
• One (1) humanities elective (courses typically offered by the Faculty of Arts, except basic languages and economics)

Students should consult with a faculty advisor before choosing electives.

*Any two of the following technical electives may be taken in Program Year 2 – Term 4:

• Engineering 2120—Geology for Engineers
• Engineering 2240—Introduction to Structural Engineering
• Engineering 2250—Materials Science
• Engineering 2350—Kinematics and Dynamics of Machines
• Engineering 2420—Fundamentals of Environmental Engineering
• Engineering 2430—Engineering Economics
• Engineering 2520—Fundamentals of Process Engineering
• Engineering 2620—Thermo Fluids II
• Engineering 2820—Electric Circuits II
• Computer Science 1610—Digital Systems

** The first engineering focus area elective (Program Year 3, Term 5) must be the introductory elective course in either mechatronics, sustainable energy, or bio-resources. The remaining engineering focus area electives in Terms 6, 7 and 8 can be selected from any of the following courses in any of the three focus areas. At least one of the engineering focus area electives must be at the 4000 level.

• Engineering 3370 - Mechatronic System Integration and Interface Design
• Engineering 3380 - Real-time Embedded Systems
• Engineering 3390 - Introduction to Mechatronic Computer-Aided Product Development, Modelling and Simulation
• Engineering 3450 - Wind and Water Power
• Engineering 3460 - Solar Energy and Electricity Storage
• Engineering 3490 - Chemical Energy Conversion
• Engineering 3570 - Engineering Applications of Biological Materials
• Engineering 3580 - Soil Mechanics
• Engineering 3850 - Engineering Applications of Numerical Methods
- Engineering 4310 - Advanced Fabrication Techniques and Computer-Integrated Manufacturing
- Engineering 4320 - Control System Design
- Engineering 4330 - Innovations in Biomedical Engineering
- Engineering 4350 - Advanced Robotic Dynamics and Control
- Engineering 4370 - Fluid Power Control
- Engineering 4410 - Macro Energy Systems
- Engineering 4440 - Advanced Energy Storage
- Engineering 4450 - Fluid Loads on Energy Structures
- Engineering 4470 - Micro Grids
- Engineering 4510 - Geoinformatics in Bioresources
- Engineering 4530 - Fundamentals of Agricultural Machinery
- Engineering 4550 - Chemical and Biological Processes

* Technical Electives (Program Year 2, Term 4)

Any two of the following technical electives may be taken in Program Year 2, Term 4:

- Engineering 2120—Geology for Engineers
- Engineering 2240—Introduction to Structural Engineering
- Engineering 2250—Materials Science
- Engineering 2350—Kinematics and Dynamics of Machines
- Engineering 2420—Fundamentals of Environmental Engineering
- Engineering 2430—Engineering Economics
- Engineering 2520—Fundamentals of Process Engineering
- Engineering 2620—Thermo Fluids II
- Engineering 2820—Electric Circuits II
- Computer Science 1610—Digital Systems

**Engineering Focus Area Electives (Program Years 3 and 4)

Mechatronics focus area

Fall Semester

- Engineering 3340—Introduction to Mechatronics Engineering
- Engineering 4310—Advanced Fabrication Techniques and Computer-Integrated Manufacturing
- Engineering 4330—Innovations in Biomedical Engineering

Winter Semester

- Engineering 3370—Mechatronic System Integration and Interface Design
- Engineering 3390—Introduction to Mechatronic Computer-Aided Product Development, Modelling and Simulation
- Engineering 3850—Engineering Applications of Numerical Methods
- Engineering 4350—Advanced Robotic Dynamics and Control

Sustainable Energy focus area

Fall Semester

- Engineering 3440—Introduction to Sustainable Energy Engineering
- Engineering 4330—Innovations in Biomedical Engineering

**Winter Semester**

- Engineering 3490—Chemical Energy Conversion
- Engineering 3850—Engineering Applications of Numerical Methods

**Bioresources focus area**

**Fall Semester**

- Engineering 3540—Introduction to Bioresources Engineering
- Engineering 4330—Innovations in Biomedical Engineering

**Winter Semester**

- Engineering 3570—Engineering Applications of Biological Materials
- Engineering 4550 (formerly 3590)—Chemical and Biological Processes
- Engineering 3850—Engineering Applications of Numerical Methods

**Careers:** Automotive Engineer  
Energy Engineer  
Product Designer  
Developer  
Mechanical Engineer  

**Example Courses:**  
ENGN 111 - Geomatics  
ENGN 291 - Design III: Reliability and Safety  
ENGN 311 - Strength of Materials  
ENGN 382 - System Dynamics

**Course Level:** 1000 Level  

**Courses:**  
**ENGN-1210 Engineering Communications**  
This course is a basic introduction to the profession, to the design process, and to the way that engineers communicate through drawing, writing and speaking. The course stresses the importance of creativity and social responsibility in engineering. Topics include basic engineering concepts, simple engineering design projects, presentation of graphical material for engineering designs, and technical reporting, which includes verbal, written, and graphical means. There is an emphasis on group work in engineering. Three hours lecture and three hours of design studio per week  
PREREQUISITE: Admission to the Engineering Program, Math 1910 and Physics 1110  
3 hours credit

**ENGN-1220 Engineering Analysis**  
This course is a continuation of the design process and engineering professionalism introduced in Engineering 1210. Emphasis is placed on the development of a structured problem solving capability that can be generally applied in most industrial environments. As with all UPEI design courses, the content is delivered primarily through facilitated exercises and a project based learning environment. Students are expected to be self directed and are required to analyze situations in a systematic and scientific manner. In order to perform engineering analysis, a basic understanding of math and
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Published on Programs and Courses (http://www.upei.ca/programsandcourses)

engineering science (i.e. statics, strength of materials, material science, material balance, fluid mechanics, thermodynamics, circuits, measurements, etc.) is required and an overview of these areas is provided. Students are also expected to integrate the knowledge and skills from other engineering science, math and general science courses. Computer aided tools introduced include Microsoft Excel, DataStudio, MatLab and Simulink. Demonstration of design concepts during end of year industry expo is required. Three hours lecture and three hours of design studio per week
PREREQUISITE: ENGN-1220L; Engineering 1210 with a grade of at least 60%. ; ENGN-1310
3 hours credit

**ENGN-1310 Computer Programming with Engineering Applications**
This course is a study of computer programming as it relates to engineering. Topics include problem solving, algorithm design, software standards, operating systems, computer components, data types, control structures, repetition, loops, nested structures, modular programming and arrays. Several programming languages and programs are used including MS Excel, Matlab and C. (Formerly ENGN-1320) Three lecture hours and two lab hours per week. Restriction: Acceptance into the Engineering Program
PREREQUISITE: Engineering 1310 Lab Section
3 hours credit

**ENGN-1410 Sustainability in Engineering Design**
This course introduces the principles of sustainability in engineering design as they relate to the interactions among humans, living systems, the natural environment and the engineered world. Physical, chemical, biological, ecological, social, economic and life-cycle concepts, and their relevance to sustainable engineering design, are emphasized. 3 hours of lecture and 3 hours of lab per week
PREREQUISITE: ENGN-1410L;
3 hours credit

Course Level: 2000 Level
Courses: **ENGN-2120 Geology for Engineers**
This course provides a basic overview of key geological processes and principles with emphasis on practical aspects of geology as they apply to engineering and related disciplines. Topics include rock types, rock formation, plate tectonics, glaciation, erosion, earth materials, geological mapping, stratigraphy and structural geology. An appreciation for ore forming processes, mineral resources, geothermal energy, environmental geology, and groundwater resources is also development. Laboratory activities focus on basic mineral and rock identification, and interpretation of topographic and geological maps. Three lecture hours per week
3 hours credit

**ENGN-2210 Engineering Projects I**
This course is the first in a two-course sequence, which provides a complete community design experience. In 2210, students go through a self-selecting team and project based process in response to request for proposals prepared by community partners. Students are required to research and analyze the client's situation (internal/external) and develop detailed analytical proposals and conceptual design options for their community partner. Concepts are developed into detailed designs and prototypes in Engineering 1220. End of term client presentation are used as hold points and to provide focus and direction for the second term. Three hours lecture and three hours of design studio per week
PREREQUISITE: Engineering 1220 with a grade of at least 60%. ; ENGN-2210L
3 hours credit

**ENGN-2220 Engineering Projects II**
A continuation of Engineering 2210, students will complete detailed paper designs of their concepts, in-depth engineering analysis, as well as develop a physical model or demonstration to support the recommended design solution. Working closely with community partners and faculty, students will learn how to manage a complex client oriented project, supported by accurate numerical analysis and professional documentation. Client interaction and presentations occur at selected hold points and demonstration of concept at a public industry expo is required. Three hours of lecture and three hours of design studio per week
PREREQUISITE: Engineering 2210 with a grade of at least 60%
3 hours credit

**ENGN-2240 Introduction to Structural Engineering**
This course is an introduction to the field of structural analysis as an applied discipline. Building on deflection and truss analysis from previous mechanics courses, students are exposed to concepts of influence, flexibility, stiffness, impact and other analytical techniques and dynamic loading in rigid structures. The National Building Code and material resistance is also introduced. Three hours of lecture and three hours of lab per week
PREREQUISITE: Engineering 2240 Lab Section ; Engineering 2310
3 hours credit

**ENGN-2250 Materials Science**
This course is an introduction to the properties and behaviour of engineering materials. Topics include atomic structure and bonding, crystalline structures, deformation, metallic structures, hardening and annealing, phase diagrams, ceramics, polymers, composites, electrical and optical properties. Computer applications are used. Three hours lecture and three hours lab per week
PREREQUISITE: Engineering 2250 Lab Section ; Chem-1110 and Math-1920
3 hours credit

**ENGN-2310 Strength of Materials**
This course is an introduction to the study of stress, strain and deformation of a solid body subjected to static forces. Topics include elastic and plastic stress, strain, Mohr's circle, torsion, behaviour of beams and columns. Computer applications and hands-on laboratory experiments are used. Three hours lecture and three hours lab per week
PREREQUISITE: Engineering 2310 Lab Section ; Engineering 1220 and Math 1920
3 hours credit

**ENGN-2340 Engineering Dynamics**
This course is a study of mechanics concerned with the state of motion of rigid bodies that are subject to the action of forces. The course considers the kinematics and kinetics of motion applied particles and rigid bodies particularly as it relates to engineering applications and design. Topics include rectilinear and curvilinear motions, normal and tangential coordinates, dependent motion, Newton's Laws of Motion, energy and momentum methods. Three hours lecture and three hours lab per week
PREREQUISITE: Engineering 2340 Lab Section ; ENGN-1220 and Math-1920
3 hours credit

**ENGN-2350 Kinematics and Dynamics of Machines**
This course introduces fundamental concepts in the analysis of linkages and other aspects of complex machinery. Using graphical and analytical methods and relying on static and dynamic principles previously learned, students are exposed to a variety of cams, gears and trains in an applied context. Simple gyroscopic effects are also introduced. Three hours lecture and three hours of laboratory per week
PREREQUISITE: Engineering 2340 and Math 1920; Engineering 2350 Lab Section
3 hours credit

**ENGN-2420 Fundamentals of Environmental Engineering**
This course is an introduction to the field of environmental engineering with a focus on understanding the effects of man-made pollutants on natural systems (physical, chemical). Particular emphasis is placed on the identification, analysis and design of solid and wastewater management systems in a sustainable and responsible manner. Three hours of lecture and two hours of tutorial per week
PREREQUISITE: Engineering 2420 Tutorial Section ; Engineering-1410 and Chem-1120
3 hours credit

**ENGN-2430 Engineering Economics**
This course provides students with the fundamentals of engineering economics and finance financial aspects in the context of professional engineering practice. Topics include the time value of money, project screening, cost estimation, and discounting analysis techniques. Economic analysis of depreciation, maintenance, replacement and upgrading and the impact of taxes, inflation and time on infrastructure development. Relevant software and projects are used. Three hours lecture and three-hour tutorial per week
PREREQUISITE: Engineering 2430 Tutorial Section
3 hours credit

**ENGN-2520 Fundamentals of Process Engineering**
The main objective of this course is to develop the student’s ability to perform mass and energy balances on reactive and non-reactive processes. Introductory topics include systems of units and a study of process variables such as temperature, pressure, and flowrate. Also covered are fundamental properties of multiphase systems: phase equilibrium, vapour pressure, phase rule, Raoult's and Henry's Laws, and colligative properties. Emphasis is placed on developing problem-solving skills. Three lecture hours and two tutorial hours per week
PREREQUISITE: Engineering 2520 Tutorial Section; Engineering 2610

3 hours credit

**ENGN-2610 Thermo Fluids I**
This course is designed to provide the student with a basic understanding of the fundamental concepts and principles of thermodynamics (first and second laws) and the application of these principles to engineering problems. Topics included are: the nature and forms of energy; basic concepts of systems, properties, states and processes; energy transfer as work and heat; energy and The First Law of Thermodynamics; entropy and The Second Law of Thermodynamics; and heat engine cycles. The analysis of various systems for power generation or refrigeration is also included. Three hours lecture and three lab hours per week
PREREQUISITE: Engineering 2610 Lab Section; Take Math-1920 and Chem-1120.

3 hours credit

**ENGN-2620 Thermo Fluids II**
This course is an introduction to the field of fluid mechanics. Topics covered include properties of fluids, forces on submerged surfaces, stability of floating objects, ideal fluid flow, and momentum and energy methods. Concepts of similitude are introduced and fundamental scaling parameters in real fluids. Turbulence is introduced; pipe flow problems and lift/drag problems are solved. Three hours lecture and three lab hours per week
PREREQUISITE: Engineering 2620 Lab Section; Engineering 2610 and Math 2910

3 hours credit

**ENGN-2810 Electric Circuits I**
This course is a study of topics such as Ohm's laws, Kirchoff's laws, equilibrium, equations, Thevenin's and Norton's theorems, transient circuit sinusoidal steady state response, complex impedance, complex frequency, and magnetically coupled circuits. Three hours lecture and two hours tutorial per week
PREREQUISITE: Engineering 2810 Tutorial Section; Math-1920 and Physics 1120

3 hours credit

**ENGN-2820 Electric Circuits II**
This course is a continuation of Engineering 2810, expanding upon concepts introduced in the first course. This will include two port networks, Fourier series and Fourier transforms, Laplace transforms, Bode and Polar plots, and Filters. Three hours lecture and two hours tutorial per week
PREREQUISITE: Engineering 2820 Tutorial Section; Engineering 2810

3 hours credit

**Course Level:** 3000 Level

**Courses:** **ENGN-3220 Engineering Measurements**
This course covers the basic types of measurement of many fundamental physical phenomena, including time, distance, displacements, speed, rates, force, flow, temperature, pressure, stress and strain, and frequency. An introduction to digital and analog electronics is a component of the course, but the focus is on understanding ways to sense physical parameters. This course has a significant field component. Three hours lecture and three hours lab per week
PREREQUISITE: Engineering 3220 Lab Section; Engineering 2810 and Math 3010

3 hours credit

**ENGN-3260 Materials, Mechanics, and Manufacturing**
This course covers the basic theory and practice of modern manufacturing processes in an applied context. Students will experience machining, forming, and casting of objects using a variety of
materials. Material properties are investigated and mechanical properties analyzed with consideration for optimal performance. Students will produce parts using CAD/CAM/CNC tools and assess part quality to predefined specifications and tolerances. Lab periods will include hands-on machining and industrial field tours. Three lecture hours and three lab hours per week

**PREREQUISITE:** Engineering 3260 Lab Section ; Engineering 2310

3 hours credit

**ENGN-3270 Machines and Automatic Control**

This course introduces students to the complexity of automating machines. Building on previous machine design and electric circuit's courses, students will investigate and experiment with all aspects of electrical systems, mechanical systems and automatic control. Topics covered include: history of machines, how machines work, concept of control, human interaction, instruments and measurements, control schematics, AC/DC machines and transformers, programmable technology, power electronics, electric motors, protection systems, and industrial safety. Labs involve reverse engineering exercises and industrial field trips are used to enhance understanding. Three lecture hours and three lab hours per week

**PREREQUISITE:** Engineering 3270 Lab Section ; Engineering 3220 and Engineering 2810

3 hours credit

**ENGN-3340 Introduction to Mechatronics Engineering**

This course covers fundamental skills associated with the development of computer-controlled intelligent systems and processes. Following a modern approach to mechanical engineering design, students will attempt synergistic integration of electronics, control systems, and mechanical components in a controlled laboratory environment. Students must demonstrate skills related to the selection, integration and/or calibration of sensors, actuators, signal conditioning, control algorithms, computer software, and hardware systems used to manage complexity, uncertainty, and communication in robotic systems. Three hours of lecture and three hours of lab per week

**PREREQUISITE:** Engineering 3340 Lab Section ; Engineering 3710

3 hours credit

**ENGN-3370 Mechatronic System Integration and Interface Design**

This course focuses on the fundamentals of human and mechatronic system interaction and a systematic approach to its interface design. Signal generation, transmission, and interface design are the main topics of this course. Integration of the Mechatronics system focuses on the use of embedded electronics to control and monitor mechanical behavior in a mechatronic system. Following a user-centered design and observational philosophy, students will learn to evaluate the execution efficiency of typical voice, command and graphical(GUI)user interfaces to interact with the mechatronic system with the specific aim of monitoring and control. Topics include: transducers, motors and actuators I/O and signaling, signal transmission philosophy and design, conducting user studies, evaluation techniques, information structure, and programming for interactive systems. Labview and Simulink interface software development packages are used. Three hours of lecture and three hours of lab per week

**PREREQUISITE:** Engineering 3370 Lab Section ; Engineering 3340 or Engineering 3440, or Engineering 3540.

3 hours credit

**ENGN-3380 Real-Time Embedded Systems**

This course will provide students with an overview of how different hardware components are interconnected and how embedded systems are programmed. Students will learn how to determine the functions of given function units, and construct small scale logic circuits based on their functional specifications. Students will also learn to explain the stages involved in decoding and executing instructions, to illustrate basic concepts of interfacing to external devices, and to compare different set architectures. Students will study how to do programming for real-time embedded systems. Three hours of lecture and three hours of lab per week

**PREREQUISITE:** ENGN 3380L; Engineering 3340, or Engineering 3440 or Engineering 3540

3 hours credit

**ENGN-3390 Mechatronics Computer-Aided Product Development, Modelling, and Simulation**

This course reinforces students' skills in solid modelling and expands into computational simulation. Utilizing advanced CAD/CAM/CAE simulation software such as SolidWorks, CATIA, Altair Hyperworks, ANSYS Workbench, and Stratsys Insight 3D printing software, and in a controlled environment, students
engaged in developing skills required to work in today's industrial and integrated computer-aided product
development. The course focuses on a hands-on approach to product innovation and the effective use of
computational simulation technology. The course covers aspects of structural and mechanical CAE/FEA
as well as thermal management CAE/CFD simulations when designing intelligent mechatronics products.
Three hours of lecture and three hours of lab per week
PREREQUISITE: Engineering 3390 Lab Section; Engineering 3340 or Engineering 3440 or Engineering
3540
3 hours credit

**ENGN-3440 Introduction to Sustainable Energy Engineering**
This introductory course considers current and promising future energy systems. Topics introduced
include available resources, energy conversion technologies and end use applications and technologies.
An emphasis is placed on meeting the needs of a future of global energy supply and its associated
challenges. Students will develop a technical and analytical framework with which they can evaluate
energy supply alternatives in the context of political, economic, environmental and social goals. Life
cycle analysis is also considered. Topics introduced in this course may be covered in greater depth in
other sustainable energy focus-area electives. Three hours of lecture and three hours of lab per week
PREREQUISITE: Engineering 3440 Lab Section; Engineering 3710
3 hours credit

**ENGN-3450 Wind and Water Power**
This course explores the engineering of wind- and water-based renewable energy conversion
technologies such as wind turbines, tidal turbines, wave energy converters, and hydroelectric dams.
Students will develop an understanding of the current state of technology and gain an appreciation for
related issues of resource assessment, stakeholder engagement, and environmental impact. The
underlying fluid mechanics principles will be emphasized to appreciate device operating principles and
performance drivers. The challenge of satisfying energy demand with intermittent supply will be
reviewed to further contextualize the different resource potentials, and related fluid-based storage
technologies will be discussed. Three hours of lecture and three hours of lab per week
PREREQUISITE: ENGN-3440 or ENGN-3340 or ENGN-3540; ENGN 3450L
3 hours credit

**ENGN-3460 Solar Energy and Electricity Storage**
This course covers the fundamentals of solar power generation and associated energy storage systems.
Course emphasis surrounds the electrical nature of solar photovoltaic energy generation associated
energy/power conversion and storage systems. Students will develop a technical understanding of the
underlying core technologies as well as how the technologies are productized. Topics covered may
include: Solar photovoltaic (PV) generation, electric power converters for solar PV, battery storage
technology, off-grid solar power conversion systems and small solar home systems. Lab projects may
consist of studying various scales of PV power products and technologies. Three hours of lecture and
three hours of lab per week
PREREQUISITE: ENGN-3440 or ENGN-3340 or ENGN-3540; ENGN 3460L
3 hours credit

**ENGN-3490 Chemical Energy Conversion**
This course covers fundamentals of thermodynamics, chemistry, flow and transport processes as
applied to energy systems. Topics include analysis of energy conversion in thermochemical and
thermomechanical processes as seen in existing power and transportation systems, and ways these
processes may be improved in the future. Systems utilizing fossil fuels, biofuels, hydrogen, and other
chemical energy sources over a range of sizes and scales are discussed. Applications include fuel
reforming, hydrogen and synthetic fuel production, combustion, thermal power cycles, fuel cells and
catalysis. The course also deals with combustion emissions and environmental impacts, optimal source
utilization and fuel-life cycle analysis. Three hours of lecture and three hours of lab per week
PREREQUISITE: Engineering 3490 Lab Section; ENGN-3440 or ENGN-3340 or ENGN-3540
3 hours credit

**ENGN-3540 Introduction to Bioresources Engineering**
Growing environmental problems created by unsustainable use of fossil resources is forcing us to move
from a synthetic-based economy to a bio-based one. This introductory course will provide the
fundamental skills in developing environmental technologies to enable students to pursue career
opportunities in a range of industries. Looking into different resources available within the biosphere, students will learn to apply engineering knowledge for its sustainable use. Concepts of a bio-refinery will be introduced for developing fundamental understanding of integrated conversion processes (thermal, chemical and biological). Understanding the concepts of enzymatic and cellular kinetics, students will learn to design bioreactors. This course will also review the fundamental concepts of life-cycle analysis and explore the application of it to selected environmental projects. Three hours of lecture and three hours of lab per week

**ENGN-3570 Engineering Applications of Biological Materials**
This course will focus on the understanding of the basic molecular structures of biological materials, such as wood, bioplastics, biocomposites and biofuels, and their engineering applications. It will develop the fundamental understanding of relationships between composition, structure and properties of various materials of biological origin. It will also address molecular design of new biological materials applying the molecular structural principles. The long-term goal of this course is to teach molecular design of new biological materials for a broad range of applications. A brief history of biological materials and its future perspective as well as its impact to the society will also be discussed. Three hours of lecture and three hours of lab per week

**ENGN-3580 Soil Mechanics**
This course explores the fundamentals of soil mechanics and their applications in engineering practice. Students will develop an understanding about the physical properties of soils, and will examine the behavior of soil masses subjected to various forces. The list of topics to be covered in this course include: soil composition and texture, physical properties of soils, classification of soils, permeability and seepage, consolidation, settlement, shear strength, vertical stresses in soils, soil exploration, bearing capacity and slope stability of soils. Three hours of lecture and three hours of lab per week

**ENGN-3630 Thermofluids III with Heat Transfer**
This course advances student knowledge across the related fields of thermodynamics, fluid mechanics, and heat transfer. Generalized relationships are reviewed including ideal and real gas effects, gas tables, equations of state and generalized compressibility, enthalpy, and entropy charts. Applied experimentation with refrigerators, air conditioning and heat pumps is used to further enhance focus on conversion efficiency and performance. Flow in constant area ducts with friction and heat exchange, steady and unsteady heat conduction, convection and radiation phenomena with application to selected problems in several fields of engineering is also introduced. Three lecture hours and three lab hours per week

**ENGN-3710 Project-Based Professional Practice I**
This course is the first of a four-course project-based stream that simulates the practice of a professional engineer. Students working closely with faculty supervisors and industry partners will experience an actual research and development project where they are expected to research the problem and develop a highly technical solution that is not patented or commercially available. Following best practices in project management, students will develop detailed project proposals, conceptual designs, and proof of concepts within the ethical and safety considerations that are fundamental to the profession. Concepts are further developed into operational prototypes during the second semester. Six lecture hours and six design studio hours per week

**ENGN-3720 Project-Based Professional Practice II**
A continuation of Engineering 3710, students will complete detailed designs of their concepts, build full-scale operational prototypes( where possible) and test them in a controlled laboratory and industrial
environment (where possible). Working closely with faculty and industry partners, students will prepare patent applications and develop commercialization plans for the products or processes developed. Demonstration of concept during an end of year industry expo is required. Six lecture hours and six design studio hours per week

**ENGN-3810 Systems Engineering**

This course introduces students to the interdisciplinary field of systems engineering and a systems approach to analyzing complex problems. Specific subjects covered include: logistics, reliability, safety, performance, and risk management. Open-ended problems are used and students are expected to classify, categorize, and illustrate physical and functional relationships using schematic diagramming techniques. Modeling of performance is introduced, but is covered in greater depth in the systems dynamics course to follow. Systems considered in the course include human, ecological, transportation, communication, mechanical, electrical, and mechatronic. This course utilizes a problem-based experiential teaching method with a significant field component. Three hours lecture and three hours lab per week

PREREQUISITE: Engineering 3810 Lab Section; Engineering 2220
6 hours credit

**ENGN-3820 System Dynamics With Simulation**

This course introduces the analysis and control of dynamic systems, with concepts and examples drawn from all disciplines. It includes development and analysis of differential equation models for mechanical, electrical, thermal, and fluid systems, including some sensors. Systems are primarily analyzed using Laplace transforms and computer simulation methods. Analysis concepts cover first, second, and higher order differential equations, transient characteristics, transfer functions, stability, dominance, and frequency response. Properties of systems include time constant, natural and damped frequency, and damping ratio. Three hours lecture and three hours lab per week

PREREQUISITE: Engineering 3820 Lab Section; Engineering 3810 and Engineering 3220
3 hours credit

**ENGN-3850 Engineering Applications of Numerical Methods**

This course focuses on the use of numerical techniques and engineering tools, including industrial statistical tools for the design of experiments (DOE), to solve complex real world engineering problems. Students are introduced to numerical algorithms with primary objective of the course to be development of the basic understanding of the construction of applicability and limits of these algorithms and their appropriate use. Recommended list of topics includes accuracy and efficiency of numerical approximation, root finding of nonlinear equations, interpolation and approximation, numerical differentiation, numerical integration and quadrature, Fourier Transform and its applications and solution of differential equations and boundary value problems. Extensive use of high level programing tools like MATLAB is expected. Three hours of lecture and three hours of lab per week

PREREQUISITE: Math 3010 and Engn-1310; Engineering 3850 Lab Section
3 hours credit

**Course Level**: 4000 Level

**Courses**: **ENGN-4210 Facilitated Study and Experimental Practice**

This course provides an individual assessment of the students' engineering knowledge to date in the context of their assigned industry-sponsored project. Students in consultation with faculty will determine knowledge and skill requirements of their project and develop a study and experimentation plan to fill gaps in the students' knowledge and experience. The content of the course will be customized to each student and his or her individual needs.

PREREQUISITE: Engineering 4710 must be taken concurrently.
3 hours credit

**ENGN-4230 Technology Management & Entrepreneurship**

This course provides an overview on how to start and sustain a technology-oriented company. Topics discussed will include the role of technology in society, intellectual property, patents, business plans,
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financial planning, sources of capital, business structure, liability, tax implications, sales, marketing, operational and human resource management. This course will be taught using problem-based and experiential learning strategies with involvement from real life entrepreneurs as motivators and facilitators. (Formerly ENGN-4430) (Cross-listed with Computer Science 3840 and SDE 8230)

PREREQUISITE: Engineering 3710 must be completed or taken concurrently.
3 hours credit

ENGN-4310 Advanced Fabrication Techniques and Computer-Integrated Manufacturing
This course concentrates on manufacturing knowledge with a focus on advanced fabrication techniques (AFT) and Computer Integrated Manufacturing (CIM). Students will expand their knowledge of traditional processes including CAD/CAM, forming, welding, milling, etc. leading into innovative advanced fabrication techniques in additive and precision manufacturing, next generation electronics, robotics and smart automation (CIM), and sustainable and green manufacturing modeling and simulation in the manufacturing process developed through lectures and labs. Integration of CIM into supply chain design and management is emphasized based on synergistic application of mechatronics approach and philosophy. Three hours of lecture and three hours of lab per week
PREREQUISITE: Engineering 4310 Lab Section; Engn-3340 or Engn-3440 or Engn-3540 and Engn-3260
3 hours credit

ENGN-4320 Control System Design
This course will provide students with an overview of system modelling and control methodologies of single/multiple input/output systems, e.g., energy transport control, reactor control, heat exchanger control, power production, and mechatronic systems. Students will learn classical control methods e.g., feedforward, feedbacks, cascade, decoupling to modern control methods, LQR, predictive control, optimal and robust control. Students will be equipped with knowledge and skills for analyzing stability, controllability and observability of state-space representation modelled systems. Three hours of lecture and three hours of lab per week
PREREQUISITE: Engn-3340 or Engn-3440 or Engn-3540 and Engn-3820; ENGN 4320L
3 hours credit

ENGN-4330 Innovations in Biomedical Engineering
This course introduces the study of medicine by focusing on innovations in medical devices, and future trends in materials, especially the increasing use of bio-resources, informatics, and mechatronics engineering applications in orthopedic, rehabilitation, simulation and education technologies. In its broader context, this course focuses on four areas of biotechnology, biomechanics, biomaterials and biosignals. Through a hands-on approach, the course focuses on innovative product development related to bio-signal, instrumentation, sensing, and image processing. Students will also gain an appreciation for the collaborative, interdisciplinary nature of engineering in medicine and its potential impact on society. (Cross-listed with SDE-8330). Graduate project will be defined). Three hours of lecture and three hours of lab per week
PREREQUISITE: Engineering 4330 Lab Section; Engineering 3710
3 hours credit

ENGN-4350 Advanced Robotic Dynamics and Control
This course advances the fundamentals of robotics through exposure to in-depth knowledge and understanding of kinematics, dynamics, control and trajectory with applications to autonomous vehicles, automated manufacturing and processing and mobile robotics. Areas of interest include: position transformation and control, rigid body motion, kinematic control, compliance and force control. Three hours of lecture and three hours of lab per week
PREREQUISITE: Engineering 4350 Lab Section; ENGN-3340 or ENGN-3440 or ENGN-3540
3 hours credit

ENGN-4370 Fluid Power Control
This course covers the analysis and design of basic hydraulic and pneumatic circuits and systems. Topics include a review of the fundamentals of fluid mechanics including flow through valves, fittings, and pipe; classification of hydrostatic pumps and motors; control valves; hydraulic accumulators; sizing of practical hydraulic circuits; thermal and energy considerations; electrohydraulic control and modeling of hydraulic control systems. The latter part of the course focuses on pneumatic systems including pneumatic cylinders and motors, control valves, and compressor technology. The application of Programmable Logic Controls (PLCs) to industrial automation and the sequential control of pneumatic...
actuators is also addressed. Three hours of lecture and three hours of lab per week

PREREQUISITE: Engn-3340 Or Engn-3440 Or Engn-3540 and Engn-3820; ENGN 4370L
3 hours credit

**ENGN-4410 Macro Energy Systems**
This course covers methods for analyzing energy supply, conversion processes, and end-use at the system level. Aspects considered include the dynamics of energy supply and demand, efficiencies of energy conversion, characteristics of energy currencies, and energy needs across different sectors. Students will characterize methods of delivering energy services such as heat, light, industrial power and transportation. Exergy analysis will be introduced and used to build a quantitative framework for integrating techno-economic analysis of energy system components, with emphasis on elements such as fossil fuels and nuclear power. Students will gain an enhanced, quantitative appreciation for the sustainability, emissions, cost and energy intensity aspects of energy services delivery. Three hours of lecture and three hours of lab per week

PREREQUISITE: ENGN-3340 or ENGN-3440 or ENGN-3540; ENGN 4410L
3 hours credit

**ENGN-4440 Advanced Energy Storage**
This course considers advanced technical analysis of energy storage systems. A comprehensive overview of all industrially relevant energy storage systems is reviewed and emphasis is placed on promising energy storage technologies of the future. Chemical, thermal and kinetic storage technologies will be discussed in detail. Three hours of lecture and three hours of lab per week

PREREQUISITE: ENGN-3340 or ENGN-3440 or ENGN-3540; ENGN 4440L
3 hours credit

**ENGN-4450 Fluid Loads on Energy Structures**
This course is an introduction to the loads applied on structures from wind, waves, and currents, and their heightened relevance to structures designed for energy conversion. Phenomena to be discussed include lift and drag, boundary layers, vortex-induced vibrations, wakes, hydrostatic loading, and water waves. A selection of engineering methods will be introduced and brought to bear on these topics, such as potential flow theory, blade-element theory, Airy wave theory and Morison's equation. Dimensional analysis will be introduced to characterize flow problems. Design implications will be discussed for a selection of relevant energy conversion structures such as aircraft wings, wind turbines, breakwaters, marine vessels, and offshore energy platforms. Three hours of lecture and three hours of lab per week

PREREQUISITE: ENGN-3340 or ENGN-3440 or ENGN-3540; ENGN 4450L
3 hours credit

**ENGN-4470 Mico Grids**
This course focuses on the concept, operation and optimization of renewable-energy-based micro-grids. Concepts introduced and considered include renewable energy resources, integration technologies, grid-connected operation, islanded grid operation, energy storage integration and the optimal dimensioning and mixing of multiple energy sources where some are stochastic in nature and some are dispatchable. Existing and future energy storage technologies will be also be discussed. This course is based on energy flow analysis and makes extensive use of software simulation tools. Students will develop a framework for performing techno-economic assessments of micro-grid architectures and designs. A strong background in electrical power systems is not necessarily required. Three hours of lecture and three hours of lab per week

PREREQUISITE: ENGN-3340 or ENGN-3440 or ENGN-3540; ENGN 4470L
3 hours credit

**ENGN-4510 Geoinformatics in Bioresources**
This course covers the theory and practice of geoinformatics and their applications to problems in bioresources using digital mapping and spatial analysis. Hands on laboratories will provide students with an experience to collect georeferenced data using differential global positioning system, followed by mapping and analysis in geographical information system. Topics include datums, map projections and transformations, vector and raster data, geo-spatial analysis, geo-statistics and interpolation techniques. This course will also cover the fundamentals of remote sensing, data collection with sensors, and spatial and temporal aspects of the bio-resources attributes. Three hours of lecture and three hours of lab per week

PREREQUISITE: ENGN 4510L; ENGN-3340 or ENGN-3440 or ENGN-3540
3 hours credit

**ENGN-4530 Fundamentals of Agriculture Machinery**
This course highlights the fundamentals of mechanized agriculture machinery from soil preparation, planting, and crop management to mechanical harvesting. The machines and their unit operation are analyzed with respect functions, work rates, material flow and power usage. The machine performance relating to work quality and environmental effects will also be evaluated. The labs will emphasize on safety, basic maintenance, adjustment, calibrations of equipment and performance testing. This course also covers the variable rate applicators for site-specific application of inputs, auto guidance system, data acquisition and management for intelligent decision making for machines, and precision agriculture technologies. Three hours of lecture and three hours of lab per week
PREREQUISITE: ENGN 4530L; ENGN-3340 or ENGN-3440 or ENGN-3540

3 hours credit

**ENGN-4550 Chemical and Biological Processes**
Processes used in the chemical and biological industries, which emphasize underlying physical, chemical, and biological principles, will be introduced. By carrying out the mass and energy balances, student will conduct design and economic assessment of major chemical and biological engineering processes. Introduction to modelling of chemical processes will be covered in this course. (Formerly ENGN-3590) Three hours of lecture and three hours of lab per week
PREREQUISITE: ENGN 4550L; ENGN-3340 or ENGN-3440 or ENGN-3540

3 hours credit

**ENGN-4710 Project-Based Professional Practice III**
This course builds on concepts and knowledge learned throughout the third year of the program. Fourth-year students will assume a leadership role in dual cohort (third and fourth year) project teams. Working closely with industry partners and faculty supervisors, students must develop innovative and technology-based solutions with a high level of technical sophistication. Lessons learned from previous project experiences must be applied and students will rely heavily on knowledge content and skills acquired through their engineering science courses. Lab hours will include professional development exercises in isolation of, and preparation for industry projects. Design concepts are further developed into operational prototypes during the second semester. As with all project-based courses, professional responsibility/accountability and an appreciation for best practices and ethical behaviour must be demonstrated. Six lecture hours and six design studio hours per week
PREREQUISITE: Engineering 4710 Lab Section ; Engineering 3720 with a grade of at least 60%, Engineering 3270, Engineering 3630, and Engineering 3820. Engineering 3260 must be completed or taken concurrently, Engineering 4210 must be taken concurrently.; Engineering 3720 with a grade of at least 60%, Engineering 3270, Engineering 3630, and Engineering 3820. Engineering 3260 must be completed or taken concurrently.

6 hours credit

**ENGN-4720 Project-Based Professional Practice IV**
A continuation of Engineering 4710, this course is the capstone and culmination of all that has been learned in the program. Students will complete detailed designs of their concepts, build full-scale operational prototypes (where possible) and test them in a fully operational industrial involvement. Working closely with industry clients, students will prepare patents and attempt commercialization of products or processes developed. Students are exposed to all aspects of project management, engineering economics, law, ethics, and safety; and capability outcomes are closely monitored in this class. Demonstration of concept during an end of year industry expo is required. Six hours of lecture and six hours of design studio per week
PREREQUISITE: Engineering 4720 Lab Section; Engineering 4710 with a grade of at least 60%

6 hours credit

**ENGN-4810 Directed Studies in Engineering**
Available to advanced engineering students at the discretion of the department. Entry to the course, course content, and the conditions under which the course may be offered will be subject to the approval of the Chair of the Department and the Dean of the Faculty. (See Academic Regulation 9 for Regulations Governing Directed Studies.)
PREREQUISITE: Third or fourth year standing and 12 credit hours in the Department of Engineering

3 hours credit
ENGN-4820 Directed Studies in Engineering
Available to advanced engineering students at the discretion of the department. Entry to the course, course content, and the conditions under which the course may be offered will be subject to the approval of the Chair of the Department and the Dean of the Faculty. (See Academic Regulation 9 for Regulations Governing Directed Studies.)
PREREQUISITE: Third or fourth year standing and 12 credit hours in the Department of Engineering
3 hours credit

ENGN-4910 Special Topics in Engineering
This course provides students with an opportunity to pursue special topics in engineering. The course content and its offering in any one semester will be at the discretion of the Department. Interested students should contact the Department to confirm the details of the course and its offering.
3 hours credit

ENGN-4920 Special Topics in Engineering
This course provides students with an opportunity to pursue special topics in engineering. The course content and its offering in any one semester will be at the discretion of the Department. Interested students should contact the Department to confirm the details of the course and its offering.
3 hours credit

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