

# GENERAL ENGINEERING (ENGR)

## **ENGR 500 Systems Engineering 3 Credit Hour(s)**

The course examines the principles of systems engineering, with emphasis on their application throughout the life cycle. Methodology is based on a total systems view of the user.

**Offered:** Online

## **ENGR 501 Numerical Methods 3 Credit Hour(s)**

Numerical solution of equations; error analysis; finite difference methods; numerical differentiation and integration; series expansions; difference equations; numerical solution of differential equations.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

## **ENGR 503 Advanced Differential Equations 3 Credit Hour(s)**

This course will provide general numerical methods for systems of nonlinear ordinary and partial differential equations (methods for stiff systems; basic theory in the finite difference and finite element methods; methods for parabolic, hyperbolic, and elliptic equations; analysis of stability and convergence; error estimates; current literature).

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

## **ENGR 504 Ordinary Differential Equations 3 Credit Hour(s)**

General single-step, multistep, multi-value, and extrapolation methods for systems of nonlinear equations; convergence; error bounds; error estimates; stability; methods for stiff systems; current literature.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

## **ENGR 505 Finite Element Analysis 3 Credit Hour(s)**

Introduction to the mathematical theory, formulation, and computer implementation of the finite element method. Application to one-and two-dimensional problems in engineering mechanics.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

## **ENGR 507 Fundamentals of Mechanics 3 Credit Hour(s)**

The aim of this course is to educate the student in the areas of 1) statics, 2) dynamics, and 3) strength of materials. The content will include Newton's Laws, forces, moments, torques, free body diagrams, equilibrium, kinematics of motion, velocity, acceleration, energy, momentum, stress, strain, and constitutive relationships.

**Registration Restrictions:** Consent of Instructor or pursuing a MS Engineering Non-Thesis or Thesis degree

**Offered:** Resident

## **ENGR 511 Linear Optimal Control 3 Credit Hour(s)**

This course discusses modern advanced graduate level control engineering techniques such as vector random process, robust stability and performance test, linear-quadratic regulator, and the linear-quadratic Gaussian controller design. The method is to provide a means of incorporating frequency domain specifications into control system designs.

**Registration Restrictions:** Consent of Instructor or pursuing a MS Engineering Non-Thesis or Thesis degree

**Offered:** Resident

## **ENGR 512 Computing Languages (Python, MATLAB, C, C++, Fortran) 3 Credit Hour(s)**

An introduction to programming language (Python, Matlab, C, C++, Fortran) specification and analysis. Additional topics include control structures, data types, and structures, run-time environments, binding strategies, compilers, and interpreters.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

## **ENGR 514 PLC Programming 3 Credit Hour(s)**

This course integrates fundamental concepts in Cyber-Physical Systems (CPS) Engineering and Programmable Logic Controllers (PLCs) with an emphasis on design and application to factory automation and process control.

**Registration Restrictions:** Consent of instructor

**Offered:** Resident

## **ENGR 515 User Interface Design for Embedded Systems 3 Credit Hour(s)**

This course introduces fundamental design principles relevant to the design of the human interface to embedded systems. The major topics to be discussed include universal design principles, user research methods, the characteristics of tasks supported by embedded systems, user interface design process, and methods for evaluating an interface design.

**Registration Restrictions:** Consent of Instructor or pursuing a MS Engineering Non-Thesis or Thesis degree

**Offered:** Resident

## **ENGR 516 Engineering Analysis of Transient Data 3 Credit Hour(s)**

This course aims to empower engineers to analyze and make conclusive assessments on the sufficiency and character of data streams from transient experiments and simulations. A myriad of mathematical tools and algorithms for data processing and analysis will be demonstrated. Successful students will be armed with the appropriate foundation to determine how and when to draw distilled and meaningful conclusions from volumes of seemingly random information.

**Registration Restrictions:** Student must have a BS in any of the following degrees: BS: Mechanical Engineering, BS: Chemical Engineering, BS: Civil Engineering, BS: Biomedical Engineering, BS: Mathematics, and BS: Physics. If the student does not have a conferred degree in these BS programs, they must have consent from the instructor to register.

**Offered:** Resident

## **ENGR 517 Advanced Thermodynamics 3 Credit Hour(s)**

Postulational treatment of the physical laws of equilibrium, thermostatics. Equations of state, processes, equilibrium stability, reactive systems, phase transitions.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

## **ENGR 519 Advanced Data Analysis and Machine Learning 3 Credit Hour(s)**

**Prerequisite:** Linear Algebra-MATH321 with a score of 5  
Machine learning introduces and emphasizes the methods that are used to provide computers the ability to perform various levels of artificial intelligence (AI) with the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs and algorithms as well as the underlying data requirements that can enable computers to teach themselves, self-organize objects, and to grow or change when exposed to new data or sensory information.

**Registration Restrictions:** It is the student's responsibility to ensure all course pre-requisite requirements are fulfilled before signing up or attending this course

**Offered:** Resident

**ENGR 520 Law for Engineers 3 Credit Hour(s)**

This course includes the study of contracts, Intellectual property law, patents, copyright, trademark, trade secrets, ethics and other legal matters important to engineers.

**Offered:** Online

**ENGR 521 Advanced Heat Transfer 3 Credit Hour(s)**

Condensation and boiling, analytical and numerical techniques for conduction and convection, gray-body and spectral-dependent radiation, transient and steady-state thermal modeling.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 525 Continuum Mechanics 3 Credit Hour(s)**

An introduction to the general theory of continuous media and its application to the theories of elasticity and fluid mechanics.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 527 Advanced Mechanics of Materials 3 Credit Hour(s)**

Stress, strain, stress-strain relationships, strain energy, failure theories, curved beams, unsymmetrical bending, shear center, torsion of noncircular sections, energy principles, Castigliano's theorem, inelastic behavior.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 531 Advanced Electromagnetics 3 Credit Hour(s)**

This course covers contemporary topics in advanced engineering electromagnetics. This includes topics relevant to electromagnetic field theory, radar systems, RF/microwave engineering, antenna design, and electromagnetic compatibility.

**Registration Restrictions:** Consent of instructor

**Offered:** Resident

**ENGR 541 Inelasticity 3 Credit Hour(s)**

This course covers plasticity, creep, viscoelasticity, and inelastic behavior in relation to microstructure-property relations, constitutive modeling at different length scales, and computational simulations.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 543 Damage and Fracture 3 Credit Hour(s)**

History of fracture and development of fracture mechanics principles. Linear elastic and elastic-plastic stress analysis of cracked bodies. ASTM standards and applications.

**Registration Restrictions:** Consent of Instructors

**Offered:** Resident

**ENGR 544 God, Science, and Creation 3 Credit Hour(s)**

This course aims to help the student unite the areas of God, Engineering, Math, and Science to integrate the Christian worldview in all engineering design and management decisions. Hence, we focus on various science areas (physics, biology, geology, etc.), engineering, and math to realize our goal.

**Offered:** Resident

**ENGR 545 Fatigue 3 Credit Hour(s)**

Prediction and prevention of fatigue failure in metallic material.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 547 Phase Transformations 3 Credit Hour(s)**

Stress, strain, stress-strain relationships, strain energy, failure theories, curved beams, unsymmetrical bending, shear center, torsion of noncircular sections, energy principles, Castigliano's theorem, inelastic behavior.

**Registration Restrictions:** Consent of Instructor; Enrollment in a Master of Science in Engineering program.

**Offered:** Resident

**ENGR 550 Human Factors and Ergonomics 3 Credit Hour(s)**

Human biological and psychological capabilities and limitations in the industrial setting. Topics include techniques and methods for applying the principles of human factors engineering and ergonomics to system design.

**Registration Restrictions:** Consent of Instructor or pursuing a MS Engineering Non-Thesis or Thesis degree.

**Offered:** Resident

**ENGR 555 Industrial Ergonomics 3 Credit Hour(s)**

This course will teach students the principles of industrial ergonomics. It focuses on physical ergonomics and ergonomic assessment tools. At the end of the course students will have used the most common ergonomic assessment tools and will be able to assess the risk of musculoskeletal injuries.

**Registration Restrictions:** Consent of Instructor or pursuing a MS Engineering Non-Thesis or Thesis degree

**Offered:** Resident

**ENGR 565 Introduction to Computer Networks 3 Credit Hour(s)**

Emphasis is placed on network transport services and key protocols to include TCP, IP, and UDP. Topics include application of network design and implementation of robust performance based computer networks, and an introduction to wireless and mobile networks.

**Registration Restrictions:** Consent of Instructor or pursuing a MS Engineering Non-Thesis or Thesis degree

**Offered:** Resident

**ENGR 590 Strategic Planning 3 Credit Hour(s)**

Students will focus on strategic planning and goal setting and how external environments and internal dynamics affect the planning process.

**Registration Restrictions:** Should be taken within the final 6 hours of program requirements

**Offered:** Online

**ENGR 595 Directed Individual Study in Engineering 3 Credit Hour(s)**

Research-oriented project or an independently completed course of study in a specially designed area as approved and supervised by the instructor. May be repeated for up to 6 credits.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 596 Graduate Orientation/Seminar Series 3 Credit Hour(s)**

Course provides a graduate program orientation and lecture series which includes visiting lecturers.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 597 Special Topics in Engineering 3 Credit Hour(s)**

Title to be arranged. This course is to be used on a limited basis to offer developing subject matter areas not covered in existing courses. (Courses limited to two offerings under one title within two academic years).

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 604 Managing Change and Innovation 3 Credit Hour(s)**

This course examines the concepts and approaches to leading for innovation and change within diverse and complex organizations and systems – focusing on application to both manufacturing and service sectors.

**Offered:** Online

**ENGR 606 Computational Fluid Dynamics 3 Credit Hour(s)**

Elementary aspects of computational fluid dynamics (CFD); review of numerical analysis and fluid mechanics as pertinent to CFD; numerical solution to selected fluid dynamic problems.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 608 Multiphase Flows 3 Credit Hour(s)**

The aim of this course is to educate the student about the many facets of jointly flowing immiscible phases, in terms of 1) physics, 2) applications, and 3) simulations. The content will span the four possible combinations of gas-liquid (g-l), liquid-solid (l-s), gas-solid (g-s), and gas-liquid-solid (g-l-s). In the case of solids, the focus is on the behavior of particulate matter as an aggregate and not solid mechanics. For the first three (g-l, l-s, and g-s), course material will cover both volume fraction extrema e.g., nearly all gas g-l and nearly all liquid g-l. Interphase turbulence will be discussed.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 609 Advanced Compressible Flows 3 Credit Hour(s)**

The aim of this course is to educate the student about the diverse world of compressible flows with respect to 1) physics, 2) applications, and 3) simulations. We will discuss foundations subjects, such as shock waves and the effects of friction and heat transfer. Additionally, we will address complex components of compressible flows, including shock-capturing in CFD along with shock-turbulence interactions. Material in this course will synergize with other graduate course offerings at LU, most specifically advanced thermodynamics, computational fluid dynamics, and the physics and modeling of turbulence.

**Registration Restrictions:** Consent of the instructor

**Offered:** Resident

**ENGR 610 Physics and Modeling of Turbulence 3 Credit Hour(s)**

This course will demystify “turbulence” and train students in the art of turbulence assessment and quantification. We will provide a foundation in the nature of turbulence, along with an appreciation of the impacts of turbulence in nearly limitless fluid mechanics scenarios.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 615 Bio-Inspired Design 3 Credit Hour(s)**

Provides an overview of non-conventional mechanical approaches in nature and shows how this knowledge can lead to more creativity in mechanical design and to better (simpler, smaller, more robust) solutions than with conventional technology.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 616 Design Optimization 3 Credit Hour(s)**

Introduction to optimality criteria and optimization techniques for solving constrained or unconstrained optimization problems. Sensitivity analysis and approximation. Computer application in optimization. Introduction to MDO.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 622 Cyber-Physical Systems Engineering 3 Credit Hour(s)**

Cyber-physical systems (CPS) are engineered systems that are built from, and depend upon, the seamless integration of computation and physical components. The integration of artificial intelligence with CPS, especially for real-time operation, creates new research opportunities with major societal implications. This course is not feasible for remote students.

**Registration Restrictions:** Consent of instructor; Proficiency in Numerical Methods and Differential Equations is required.

**Offered:** Resident

**ENGR 624 Robotics Software Engineering 3 Credit Hour(s)**

This course integrates fundamental concepts in Cyber-Physical Systems (CPS) Engineering and Robotics with an emphasis on the design and development of software applications for robotics systems control and development. This course is not feasible for Remote Students.

**Registration Restrictions:** Consent of instructor; Proficiency in C++ or Python programming language is required.

**Offered:** Resident

**ENGR 631 Composite Materials 3 Credit Hour(s)**

Stress, strain, constitutive relations for anisotropic material, lamina properties, laminate properties, composite beams and plates.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 633 Polymers and Polymer Nanocomposites 3 Credit Hour(s)**

To provide an introductory exposition to the composition-process-structure-property relationships related to polymers and polymer nanocomposites. This course will be divided in two parts: (I) starting with a review on electron configuration and bonding, the first part will cover polymer chemistry, structure, and configuration. Mechanical, electrical, optical, thermal, magnetic, ion transport, and other properties of polymers will be discussed. (II) The second part of the course will focus solely on polymer nanocomposites, particularly on, (a) the multiplicative contributions of matrix and dispersed phases, and (b) the factors that affect the interaction between the two phases: dispersion, interfacial region, solubility, loading, size and geometrical effects. Applications and manufacturing processes for PNCs will be outlined as well.

**Registration Restrictions:** Consent of Instructor or pursuing a MS Engineering Non-Thesis or Thesis degree

**Offered:** Resident

**ENGR 635 Materials Processing Methods 3 Credit Hour(s)**

The fundamental linkages between processing, structure and properties will be addressed with emphasis on micro- and nano-structural impacts on properties.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 637 Materials Characterization Methods (SEM, OM) 3 Credit Hour(s)**

Characterization of advanced material behaviors for pavement subgrades, bases and surface courses, Stress dependency, viscoelasticity, repeated load moduli, and stabilization are central behaviors of interest.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 639 Mechanical Metallurgy 3 Credit Hour(s)**

The mechanical and metallurgical fundamentals of metals are discussed. Mechanical fundamentals cover the stress and strain relationships and metallurgical fundamentals cover the Microstructure.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 643 Statistical Analysis for Engineering Operations 3 Credit Hour(s)**

This course introduces statistical analysis tools and techniques foundational to excellence in engineering operations. Students will gain the knowledge base and skill set needed to apply improvement and control processes such as Six Sigma and Lean.

**Offered:** Online

**ENGR 651 Integrated Computational Materials Engineering (ICME) 3 Credit Hour(s)**

Survey course of various length scale computational analysis related to materials modeling. Emphasis upon projects and exercises.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 652 Six Sigma and Lean for Engineering Operations 3 Credit Hour(s)**

**Online Prerequisite:** ENGR 643

This course examines the concepts and techniques of Six Sigma and Lean tools for process improvement and how they are applied in various settings. The steps of the DMAIC process will also be introduced.

**Offered:** Online

**ENGR 687 Thesis Research in Engineering 3 Credit Hour(s)**

Thesis research and proposal development.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 688 Thesis Research in Engineering 6 Credit Hour(s)**

Thesis research and proposal development.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 689 Thesis Research in Engineering 9 Credit Hour(s)**

Thesis research and proposal development.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 690 Thesis Defense in Engineering 0 Credit Hour(s)**

Students will publicly defend their thesis research project.

**Registration Restrictions:** Consent of Instructor

**Offered:** Resident

**ENGR 695 Directed Research 3 Credit Hour(s)**

**Offered:** Resident