Engineering Program

in cooperation with Trine University

Faculty

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ENGINEERING PROGRAM

In order to meet the growing number of students interested in engineering as a major field of study, Grace College partners with Trine University in Angola, Indiana, to offer engineering degrees. Trine University's engineering graduates have strong job placement of 95-100 percent over the last 10 years. Engineering graduates enter the workforce in numerous avenues through tackling the ever increasing demands on our infrastructure and security, utilizing energy production, and designing revolutionary technology.

Grace College in partnership with Trine University, will offer a dual degree program that students can complete in 4 years. Students who finish this program will graduate with a Trine degree (Bachelor of Engineering or Bachelor of Science in Design Engineering Technology) and a Grace College Bachelor of Science in Applied Physics.

Engineering students will complete all Grace College Core classes under the guidance of Grace College professors. At the same time, they have the opportunity to study engineering with Trine University professors on the Grace College campus.

The Trine University program offered on the Grace College campus enables students to live on the Grace campus and become part of the Grace campus community while also completing the highly regarded Trine engineering degree. The advantage goes beyond the community living experience at Grace; students also get to reap the benefits of living in the "Orthopaedic Capital of the World."

Purpose and Goals

The purpose of the engineering program is to promote the application of science and technology by preparing graduates for the practice of engineering and engineering technology at the professional level. The program will:

- Provide quality preparation for the practice of engineering and engineering technology at the professional level.
- Provide graduates with the opportunities to pursue graduate studies, lifelong learning, and to offer service to their profession.
- Provide technical and educational services to the community.

DEGREES AND MAJORS IN THE ENGINEERING PROGRAM

BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING MANAGEMENT / BACHELOR OF SCIENCE IN APPLIED PHYSICS - dual degree program

Mechanical engineering is, perhaps, the most diverse and general of all the engineering fields. Mechanical engineers can be found working in almost any company. Manufacturing, transportation, health care, and insurance are some of the types of firms that employ mechanical engineers. No other field of engineering provides a better professional base for interdisciplinary activities.

Mechanical engineers design machines of all types, from paper clips to space shuttles. They plan, design, and direct the manufacture, distribution, and operation of these machines. Mechanical engineers also design the power sources needed to operate the machines and provide for the environment in which they function. In fact, mechanical engineering involves all phases of energy production and utilization: engines, power plants, electrical generation, heating, ventilating, and air conditioning.

The Bachelor of Engineering – Mechanical Engineering Management is a uniquely designed degree that gives graduates a broad foundation of mechanical engineering and management skills.

Bachelor of Engineering – Mechanical Engineering Management – Program Goal:

The goal is to enable students to become productive mechanical engineers, to advance to leadership roles in the profession, and to provide service to society.

Bachelor of Engineering – Mechanical Engineering Management - Program Objectives

Objective #1
Graduates have the ability to communicate ideas clearly and effectively in writing, orally, and graphically

Objective #2
Graduates have an awareness of the engineer's social responsibilities with an appreciation of human achievements and insight into human behavior and culture

Objective #3
Graduates have knowledge of multivariate calculus and differential equations and familiarity with linear algebra and statistics and the ability to apply this knowledge to the solution of engineering problems

Objective #4
Graduates have fundamental knowledge of natural phenomena and their quantitative expression in chemistry and physics

Objective #5
Graduates have knowledge of the engineering sciences, including electrical science, and the ability to apply this knowledge creatively

Objective #6
Graduates have an ability to work professionally in the areas of both thermal and mechanical systems design

Objective #7
Graduates have the ability to integrate technical knowledge through tradeoff studies leading to an engineering design

Objective #8
Graduates have a broad knowledge of contemporary analytical, computational, and experimental practices

Objective #9
Graduates have a broad competence in experimental design, data collection, data analysis, and the use of computational tools

Students who choose this option will complete the following:

General Education Requirements: 45 credits
- Grace Core – 39 credits
- Other requirements – 6 credits
  - MAT 3200 Probability & Statistics
  - EG 1330 Technical Communication

Dual Major Requirements: 88 credits

- Math and Science – 26 credits
- MAT 1230/1240 Calculus I and Lab
- MAT 1250/1260 Calculus II and Lab
- MAT 2250 Calculus III
- MAT 2280 Differential Equations
- CHM 1610/1620 Chemistry I and Lab
- PH 2240/2250 University Physics I and Lab
- PH 2340/2350 University Physics II and Lab
- Management –15 credits
- MGT 3230 Leadership
- LW 2030 Business Law
- BUS 3480 Operations & Production Management
- BUS 3050 Business Spreadsheet Applications
- BUS 2430 Principles of Management

- Engineering Science – 23 credits
- ES 2130 Statics
- ES 2230 Dynamics
- ES 2330 Engineering Materials
- ES 2430 Solid Mechanics
- ES 2530 Electrical Science
- ES 3130 Thermodynamics
- ES 3230 Fluid Mechanics

ES 3820 Engineering Economics (not required with Biomedical Engineering Management minor)

Mechanical Engineering Stem – 24 credits
EGR 1430 Engineering Graphics
MAE 2010 Intro to Programming MATLAB
MAE 2020 Mechanical Engineering Analysis
MAE 2430 Manufacturing Process & Equipment
MAE 3030 Mechanics of Machinery
MAE 3531 Machine Component Design
MAE 3730 Computer-Aided Machine Design
MAE 4630 Measurement Laboratory
GE 4030 Engineering Project

Applied Learning credits are met within the core and major requirements – 12 APL

BIOMEDICAL ENGINEERING MANAGEMENT MINOR: 17 additional credits (optional)

BIO 3210/3220 Anatomy & Physiology I and Lab
BIO 3310/3320 Anatomy & Physiology II and Lab
BME 1140 Introduction to Biomedical Engineering
BME 4103 Introduction to Biomechanics
BME 4203 Introduction to Biomaterials

NOTE: Course descriptions for BIO, CHM, and MAT can be found in the Department of Science and Mathematics course listings. Course descriptions for BUS can be found in the Department of Business course listings.

BACHELOR OF SCIENCE IN DESIGN ENGINEERING TECHNOLOGY / BACHELOR OF SCIENCE IN APPLIED PHYSICS - dual degree program

Bachelor of Science in Design Engineering Technology degree program prepares graduates with the applied problem solving knowledge and hands-on skills necessary to meet the engineering design challenges of the future with flexibility and creativity. Utilizing state of the art computers and industry focused design based software, the program offers challenging, applied learning experiences in three dimensional, graphic communication. The curriculum is relevant to current engineering practice and to those elements of management and general education program required for a well- rounded education.

Bachelor of Science in Design Engineering Technology - Program Goal:

The goal is to provide graduates with applied knowledge and technological competencies necessary for professional engineering careers in industry with the potential to advance to leadership positions.

Bachelor of Science in Design Engineering Technology - Program Objectives

Objective #1: Graduates will demonstrate competency in applying mathematical, scientific, critical thinking, technological knowledge, techniques and skills and modern tools to engineering technology projects.

Objective #2: Graduates will demonstrate teamwork, leadership skills and commitment to contributing to their profession.

Objective #3: Graduates will recognize professional, ethical, societal and global impacts of their practice in engineering technology.

Objective #4: Graduates will demonstrate effective communication, in both written and oral form.

Objective #5: Graduates will be prepared to pursue a lifetime of self-directed learning and professional development.

Objective #6: Graduates will demonstrate a commitment to quality, timeliness, and improved effectiveness.

Students who choose this degree will complete the following:

General Education Requirements: 45 credits

Grace Core – 39 credits
Other requirements – 6 credits
MAT 1120 College Algebra
PSY 1100 Introduction to Psychology

Dual Major Requirements: 85 credits

Math and Science – 22 credits
MA 123 Trigonometry
MAT 1230/1240 Calculus I and Lab
MAT 3200 Probability & Statistics
CHM 1610/1620 General Chemistry I and Lab
PHY 2510/2520 General Physics I and Lab
PHY 2610/2620 General Physics II and Lab

Management – 15 credits
BUS 3050 Business Spreadsheet Applications
BUS 3400 Organizational Management
BUS 3480 Operations & Production Management
EG 1330 Technical Communication
MGT 4130 Management of Quality

Engineering Fundamentals – 48 credits
ETD 1030 Basic Technical Drawing
ETD 1130 Geometric Dimensioning & Tolerance
ETD 1230 Manufacturing Materials & Processing
ETD 1630 Environmental Health & Safety
ETD 1730 Computer Aided 3-D Modeling
ETD 2030 Basic Mechanisms
ETD 2330 Engineering & Manufacturing Systems
ETD 2630 Design, Analysis & Prototyping
ETD 2730 Electrical Fundamentals
ETD 3130 Design for Manufacturing & Assembly
ETD 3330 Statics & Strength of Materials
ETD 3630 Elements of Machines
ETD 4330 Computer Numerical Control

ETD 4630 Senior Design Project I
ETD 4730 Senior Design Project II
EGR 4530 Advanced Parametric Design

Applied Learning credits are met within the core and major requirements – 12 APL

NOTE: Course descriptions for BUS can be found in the Department of Business course listings. Course descriptions for CHM, MAT, and PHY can be found in the Department of Science and Mathematics course listings. Course descriptions for PSY can be found in the Department of Behavioral Science course listings.

BACHELOR OF SCIENCE IN APPLIED PHYSICS (offered only as a dual degree with the Trine University engineering majors listed previously.)
This major connects general physics topics with practical technology. Following the study of discoveries and theories of physics, applications are considered in multiple engineering fields including biomedical, civil, and physical mechanics. Courses provide a broad introduction to each of these areas. Major requirements are listed with the engineering degrees above.

ADMISSION REQUIREMENTS

Bachelor of Engineering (BE):

- Minimum high school GPA of 3.0 and top half of graduating class.
- ACT composite score of at least 21, with at least 23 in the math section.
- SAT minimum combined score of 1000 in the math and reading sections, and at least 550 in the math section.

Bachelor of Science in Design Engineering Technology (BSDET):

- Minimum high school GPA of 2.75 and top half of graduating class
- ACT composite score of at least 19, with at least 21 in the math section
- SAT minimum combined score of 900 in the math and reading sections, and at least 500 in the math section.

ACCREDITATION

Trine University and Grace College are accredited by the Higher Learning Commission of the North Central Association of Colleges and Schools.

COURSE DESCRIPTIONS

ENGINEERING SCIENCE

ES 2130 Statics
The first course in engineering mechanics. Subjects covered include; force and moment vectors, equivalent systems, trusses, frames, and machines, equilibrium of particles and rigid bodies, static friction, centroids and moments of inertia. Co-requisite: PH 2240, MAT 1250. Three credit hours.

ES 2230 Dynamics
Kinematics of absolute and relative motion of particles and rigid bodies. Subjects include; kinetics of particles and particle systems. Principles of work and energy, impulse and momentum, and impact. Kinetics of rigid bodies in plane motion. Prerequisite: Grade of C or better in ES 2130, MAT 1250 and PH 2240. Three credit hours.

ES 2330 Engineering Materials
A study of the structure and properties of materials. Materials covered include metals, ceramics, polymers, and composites. Mechanical properties are emphasized, electrical properties, thermal properties, and environmental interactions are addressed. Structural features at the atomistic level, the crystal structure level, and the microstructure level of single and polyphase materials are studied in terms of their effects on material properties. Prerequisite: CHM 1610/1620; Co-requisite: PH 2240. Three credit hours.

ES 2430 Solid Mechanics
Concepts of stress and strain in engineering materials. Subjects include; Hooke's law and Poisson's relationship, analysis of axial, shear, flexural, and torsional stresses, combined stress, shear and moment distribution in beams, and deformation of structural members. Prerequisite: Grade of C or better in ES 2130. Three credit hours.

ES 2530 Electrical Science
Basic voltage-current-energy relationships in circuit elements. Fundamental circuit laws. Resistive networks and network theorems. Sinusoidal steadystate response and phasors. Power and energy in AC circuits. Prerequisites: MAT 1230, PH 2240. Three credit hours.

ES 3130 Thermodynamics
Introduction to properties of substances and ideal gases by use of tables. Introduction to thermodynamic concepts of systems, control volumes, heat, work and internal energy. Formulation of the First and Second Laws of Thermodynamics with engineering applications, Vapor Water Systems Ranking cycle, First and Second Law analysis of power plant cycles. Prerequisites: Grade of "C" or better in MAT 1250, PH 2240, and ES 2130. Three credit hours.

ES 3230 Fluid Mechanics
Fundamental properties of fluids. Fluid statics. Kinematics of fluid motion. Conservation of mass, energy and momentum as applied to compressible and incompressible fluids. Similitude. Introduction to laminar and turbulent boundary layers. Prerequisite: ES 2130; Co-requisite: MAT 2250. Three credit hours.

ES 3820 Engineering Economics
An introduction to the economics component of design and problem solving. Application of economic concepts from present and future value of money, depreciation, and taxes to problems involving replacement studies and selection between alternative uses of capital. Methods include equivalent worth, rate of return, and incremental techniques. Two credit hours.

BIOMEDICAL ENGINEERING

BME 1140 Introduction to Biomedical Engineering
An introduction or overview of biology, chemistry (including organic chemistry), and physiology as they relate to biomedical engineering. Prerequisites: CHM 1610/1620, MA 1230. Three credit hours.

BME 4103 Introduction to Biomechanics
An introduction to the kinematic geometry of human motion and the kinematics of individual human joints. Quantitative and qualitative descriptions of the action of muscles in relation to human and animal movement. Muscle models, receptors, and reflexes with application to control of multi-joint movement. Forward and inverse dynamics of multi-joint, muscle-driven systems. Prerequisites: BME 2013 and ES 2230. Three credit hours.

BME 4203 Introduction to Biomaterials
Introduction to the study of both biological materials (bone, muscles, etc.) and materials for medical applications. Topics include structure-property relationships for skin, bone, ligaments, tendons, muscle, and organs; the effects of pathology and age on material properties of tissues and organs; interactions between biological tissues and biomaterials; biocompatibility; design constraints, failure modes, and manufacturing limitations, ASTM and ISO standards for biomaterial. Prerequisites: CHM 1610/1620, BME 2013, and ES 2330. Three credit hours.

MECHANICAL ENGINEERING

EGR 1430 Engineering Graphics
Graphical communication for engineers using sketching and computer-aided drafting. The fundamentals of orthographic projection, isometric projection and descriptive geometry are taught. An introduction to three dimensional models using solid modeling computer software is also covered. Emphasis is placed on developing the skills needed for mechanical engineering design. Three credit hours.

LW 2030 Business Law
This course is an introduction to the American legal system. It includes a survey of courts, legal procedures, torts, and criminal law. It involves an intensive study of the common law of contracts, including contract formation, performance, breach and remedies, as well as a study of the law of sales under the Uniform Commercial Code. Three credit hours.

MAE 2010 Introduction To Programming in MATLAB
An introduction to numerical methods for solving engineering problems. Introduction to programming in MATLAB. Prerequisite: MAT 1230, Corequisites: EGR 1430, MAE 2020. One credit hour.

MAE 2020 Mechanical Engineering Analysis
An introduction to analytical and numerical methods of solving mechanical engineering problems. An introduction to various topics of mechanical engineering focusing on the interrelationship between mathematics, natural sciences, and engineering design. Prerequisite: MAT 1230, Corequisite: EGR 1430. Two credit hours.

MAE 2430 Manufacturing Processes and Equipment
An examination of commonly used engineering materials and the manufacturing processes and machines used in processing these materials. Demonstrations of: sand molding, metal casting, metal removal processes (turning, milling, drilling, grinding), and deformation processes. Introduction to CNC machining. Prerequisites: ES 2330, ES2430. Three credit hours.

MAE 3030 Mechanics of Machinery
Topics include: study of the kinematics and dynamics of mechanisms. Fundamentals of displacement, velocity, and acceleration analysis of rigid bodies as a basis for the study of mechanisms. Motion analysis of linkages, cams, and gearing. Static and inertia force in machines. Balancing of rotating and reciprocating masses. Prerequisite: ES 2230. Three credit hours.

MAE 3531 Machine Component Design
Topics include: stress analysis of machine parts, combined stresses, working stress, stress concentration, theory of failure for both static and fatigue loadings, design of machine elements. Prerequisites: ES 2330, ES 2430; Co-requisite: MAT 2280. Three credit hours.

MAE 3730 Computer-Aided Machine Design
Use of computer applications software as a part of the engineering design process. Introduction to the finite element method for stress analysis. Software packages, such as nonlinear solvers, finite element analysis, solid modeling, and kinematic simulation, will be introduced. Design work using these tools will be a major component of the course. Corequisite: MAT 2280, Prerequisites: EGR 1430 and ES 2430. Three credit hours.

MAE 4630 Measurement Laboratory
Principles of dimensional measurement and the measurement of deflection, stress, strain, and vibration. Transducer theory and signal conditioning. Use of computer data acquisition and signal analysis. Analysis of experimental error and construction of test plans. Laboratory work leading to an experimental project. Prerequisites: ES 2530, MAT 3200, MAE 3530. Three credit hours.

MGT 3230 Leadership
This course examines leadership, influence, and power across a variety of disciplines, with a strong emphasis on ethics. Historical, literary, and contemporary examples of successful leaderships provide a framework for examining the theories and practice of leadership and power. Three credit hours.

PH 2240/2250 University Physics I and Lab
Underlying principles of measurement, vectors, translatory, rotary, uniform, circular, and harmonic

motion, work, power, energy, and physical properties of liquids, solids, gases, and statics. Also the fundamentals of heat: thermometry, expansion of liquids, solids and gases, calorimetry, heat transfer, elementary thermodynamics, and fluids. Experimental investigation of selected topics. Prerequisite: Calculus I. Four credit hours.

PH 2340/2350 University Physics II and Lab

Study of vibrations and wave motion: different types of simple harmonic motion, sound. Also the fundamentals of electric fields, Gauss's Law, electric potential, capacitance, magnetism, direct, and alternating currents and circuits. Electromagnetic wave propagation and optics. Experimental investigation of selected topics. Prerequisites: Calculus II and University Physics I. Four credit hours.

GE 4030 Engineering Project

A design or capstone project, with industrial or real-world application, producing all necessary and appropriate documentation, and if applicable, models and prototypes. The project should entail a minimum of 3 hours of work per week. The project must be pre-approved by the lead faculty from the school. Three credit hours

DESIGN ENGINEERING TECHNOLOGY

EG 1330 Technical Communication

Emphasizes written and oral communication in professional situations for technical fields. Concentration on project-oriented instruction and assessment, which includes creating technical documents (email, reports, proposals, instructions, et. al.) and adapting them to specific audiences and tasks. Three credit hours.

EGR 4530 Advanced Parametric Design

An introduction to Unigraphics NX design software which includes modeling basics as well an an in depth look at the advanced capabilities of the software as it applies to engineering design. Prerequisite: EGR 1430 or ETD 2630. Three credit hours.

ETD 1030 Basic Technical Drawing

A course in the fundamentals of drafting. Use of instruments and materials, lettering and techniques of penciling. Primary emphasis is on shape and size description of three-dimensional objects. Preparation of drawings for various reproduction processes. Application of drawing geometry and study of sections and conventional practices. Three credit hours.

ETD 1130 Geometric Dimensioning and Tolerancing

Introduction to geometric dimensioning and tolerancing including advanced applications of dimensioning principles, tolerances and precision dimensioning. Introduction to part measurement techniques as it relates to geometric dimensioning and tolerancing. Prerequisite: ETD 1030. Three credit hours.

ETD 1230 Manufacturing Materials and Processes

Physical properties of ferrous and nonferrous materials, such as wood products, plastics, and rubber. Heat treating and testing of metals. Industrial practice in the working of metals and plastics. Fundamentals of metallurgy, machining, casting, welding and forming. Three credit hours.

ETD 1630 Environmental Health and Safety
This introductory level course investigates safety philosophy and the principles of safety. The student will study occupational safety and industrial hazard control with a focus on the basic principles of accident prevention. The analysis of safety performance, cost and identification of accident potential is also studies. Emphasis is placed on concepts and techniques proven useful in reducing accidents and injuries. Three credit hours.

ETD 1730 Computer Aided 3-D Modeling
An introductory course which studies the concept of parametric modeling and its application in industry. In this course students will learn the fundamentals of 3D parametric modeling, detail drawing creation, and assembly modeling using industry standard parametric modeling software. Prerequisite: ETD 1030. Three credit hours.

ETD 2030 Basic Mechanisms
Introduction to simple mechanisms and their kinematics. Study of linkages, cams, gearing, and belts. Prerequisites: MA 1230 and PH 1540. Three credit hours.

ETD 2330 Engineering & Manufacturing Systems
A study of engineering and manufacturing systems such as engineering documentation systems, design control and lean manufacturing technologies. Prerequisites: ETD 1730. Three credit hours.

ETD 2630 Design, Analysis, and Prototyping
The use of the CAD system as an engineering tool for the presentation of engineering problem solving. The set-up and maintenance of CAD systems. A study of the advanced techniques that are available on typical CAD systems and their applications in industrial systems. Prerequisite: ETD 2330. Three credit hours.

ETD 2730 Electrical Fundamentals
Electrical circuit principles. Basic circuit laws, motors, generators, controls, distribution systems, and electrical codes are presented. Theory of electricity and magnetism, electrical phenomena, and measurements. Circuits, power, AC phenomena, capacitance, and conduction are studied. Prerequisites: MAT 1120, PH 1540. Three credit hours.

ETD 3130 Design for Manufacture and Assembly
Principles and methodologies for designing parts and products for: ease and efficiency of manufacture and assembly; maintenance and usability during the service life, along with disposal and recycling at the end of service life. Students will be able to apply DFMA principles to lower the cost of designing, commissioning, and using new products. Prerequisite: ETD 1230, ETD 2330. Three credit hours.

ETD 3330 Statics and Strength of Materials
Principles of statics, analysis of structures, graphic methods, and friction as applied to the inclined plane and wedge. Simple direct and combined stresses, determination of structural sizes as function of unit stress, and physical properties of the materials. Prerequisites: MA 1230. Three credit hours.

ETD 3630 Elements of Machines
Design principles and calculations of machine elements. Consideration of economy, loads, stresses, deformations, and environment. Prerequisite: ETD 2430, PH 1540. Three credit hours.

ETD 4330 Computer Numerical Control Principles
History of numerical control and comparison with conventional machining systems. Standard coding system and control terminology. Prerequisites: ETD 1230, ETD 2630. Three credit hours.

ETD 4630 Senior Design Project I
Introduction to product analysis, development and design. Conceptual design, design for manufacture, reverse engineering, concurrent engineering, designing for special needs, prototyping, and product safety. Integration of previous work into complete product design project. Prerequisite: Senior Standing. Three credit hours.

ETD 4730 Senior Design Project II
Study of advanced design methods as used in engineering design. A study of the design process as practiced in the industrial setting. The procedures used from the start of a design until its final production including presentations and design reports. Prerequisites: ETD 4630. Three credit hours.

MA 123 Trigonometry
Topics include: Trigonometric functions, identities, inverses, unit circle, solutions of triangles, trigonometric equations, complex numbers, radian measure, angular velocity.

MGT 4130 Management of Quality
This course examines principles of quality management and continuous improvement in manufacturing and services enterprises. The focus is on using key quality tools, including statistical process control, pareto charts, flow charts, cause-effect diagrams, etc. Three credit hours.