DEPARTMENT OF ENGINEERING

Dr. S. Birmingham, Chair, Department of Engineering; Dr. Mohr, Chair, Department of Electrical and Computer Engineering; Dr. Allison, Chair, Department of Mechanical Engineering; Dr. E. Anderson, Dr. Archibald, Dr. Bardy, Dr. W. Birmingham, Dr. Bright, Dr. Cavicchi, Dr. Christman, Dr. Clauss, Dr. Duda, Dr. Fair, Dr. Reuber, Dr. Ulrich.

The Department of Engineering is composed of the Electrical and Computer Engineering division and the Mechanical Engineering division. Each of these divisions offers a four-year program leading to a Bachelor of Science (BSEE or BSME) degree. Additionally, these programs are separately accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET). The freshman curricula for Electrical and Computer Engineering and Mechanical Engineering are similar (although not identical), and provide a measure of flexibility to an incoming student and allow time for an engineering career choice to be finalized.

ENGINEERING CORE COURSES (ENGR)

156. INTRODUCTION TO ENGINEERING. Introduces students to the engineering profession and the design process. Course lectures and assignments include the design process; problem definition and solution; oral and written communications; group dynamics; public responsibility; current global engineering challenges; and engineering ethics. The course includes exposure to engineers in industry via plant tours and/or guest speakers. A group design project is required. For electrical engineering students, this course is taken concurrently with Computer Science 141. For mechanical engineering students, this course is taken concurrently with Mechanical Engineering 120.
Semester course, two hours.

274. MATHEMATICAL METHODS IN ENGINEERING. A course for engineering and science majors covering selected topics from probability and statistics, linear algebra and discrete mathematics as applied to the solution of problems in engineering and science. Students who receive credit for Mathematics 211 or Mathematics 213 and Mathematics 222 may not receive credit for Engineering 274. Prerequisite: Mathematics 261. *Semester course, three hours.*

390. SPECIAL ENGINEERING TOPICS. Special topics in the areas of new engineering development based on student demand and faculty interest. Specific subject matter varies each semester with prerequisites and credit hours announced in advance of registration. *Semester course, one, two, three or four hours.*

402. BUSINESS FOR TECHNICAL PROFESSIONALS. Principles and methods for analyzing the economical feasibility of engineering projects including interest, depreciation, rate-of-return, economic life, replacement costs, and comparison of alternative designs. Key business and financial concepts and how they relate to engineering will also be presented. Topics to be discussed include basic accounting principles, an introduction to common financial statements, cash flow issues, an overview of commonly used business performance measures, a discussion of variable and fixed costs, and management of working capital. Prerequisite: Mathematics 141 or 161; junior or senior standing. *Spring semester only, three hours.*

ELECTRICAL AND COMPUTER ENGINEERING

Electrical Engineering Department Mission Statement, Objectives, and Outcomes

Electrical and Computer Engineering (ECE) is the analysis, design, and application of devices and systems for conversion, processing, and transmission of electrical energy and information. Electrical and Computer Engineering now covers such basic topics as electrical circuits; electronics; electrical machines and power distribution; and digital systems as well as advanced topics in communication systems, computer systems, and control systems. Electrical and computer engineers practice in the field in a variety of professional duties including research, design and development, management, sales, field service, testing, manufacturing, and education.

The Electrical and Computer Engineering Department at Grove City College offers a program leading to the Bachelor of Science in Electrical Engineering (BSEE) degree. The program is accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET).

Proficiency in writing and speaking skills is essential to a productive career in any branch of Electrical and Computer Engineering. To that end, all majors take Electrical Engineering 401 (Introduction to Design), as a Writing Intensive (WI) and Speaking Intensive (SI) course. In addition, all graduates need to know how to obtain, evaluate, and use technical information related to the field of Electrical and Computer Engineering. Instruction and practice in these Information Literacy (IL) skills is provided in the combination of the following required courses: Electrical Engineering 201, 202, 204, 251, 252, 351, 401, 451, and 452.

Electrical Engineering Program Objectives

1. Graduates will be prepared with the technical abilities required for successful employment as an electrical engineer and/or participation in engineering graduate studies, having a good understanding of the basic theoretical concepts of electrical engineering as well as experience in using some of the practical tools employed by electrical engineers.
2. Graduates will be prepared with the knowledge and skills required for their technical abilities to be applied in a way that effectively benefits human beings, while conducting themselves according to Christian convictions.
3. Graduates will be prepared to display initiative, creative thinking, and a love of learning that will enable them to grow in their effectiveness throughout their professional careers.

ECE Program Outcomes

To ensure fulfillment of the ECE Department objectives, graduates of the ECE program shall demonstrate:

a. An ability to apply knowledge of mathematics, science, and engineering (supports program objective 1).
b. An ability to design and conduct experiments as well as to analyze and interpret data (supports program objective 1).
c. An ability to design a system, component, or process to meet desired needs (supports program objectives 1 and 3).
d. An ability to function on multi-disciplinary teams (supports program objective 2).
e. An ability to identify, formulate, and solve engineering problems (supports program objective 1).
f. An understanding of professional and ethical responsibility in a Christian context including recognition of the fundamental worth of individuals as creations of God, resulting in a consistent commitment to the safety and health of individuals, honesty, and impartiality in all affairs and faithfulness in serving both employers and clients (supports program objective 2).
g. An ability to communicate effectively. This outcome includes the ability to write clearly and cohesively about technical subjects, communicate mathematical analyses in a comprehensible form, and orally communicate on technical subjects with people at all different levels of technical ability (supports program objective 2).
h. The broad education necessary to understand the impact of engineering solutions in a global and societal context. The following liberal arts areas are considered important in giving the Christian student a background for making judgments concerning engineering solutions: history of civilization, Biblical revelation, philosophy, literature, visual art, music, and modern civilization in international perspective (supports program objective 2).
i. Recognition of the need for and an ability to engage in life-long learning (supports program objective 3).
j. Knowledge of contemporary issues including both social and engineering (supports program objectives 1 and 2).
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (supports program objective 1).
l. An understanding of the character qualities needed to conduct oneself honorably and with distinction in a professional career. Character qualities of particular interest include personal integrity; honesty; strong work ethic; self-driven motivation with an enthusiasm to tackle challenges; persistence; endurance; and versatility (supports program objectives 2 and 3).

Inherent in the ECE curriculum at Grove City College is the inculcation of design experience. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process applying basic science, mathematics, and engineering science to use available resources to optimally meet stated objectives. In the ECE program, engineering design is assured via design problems and projects integrated throughout the ECE curriculum.

Freshman Year - The *Introduction to Engineering* (ENGR 156) course introduces the profession of engineering and the design process. Students work in teams on a design-related project and present results in written and oral reports.

Sophomore and Junior Years - ECE students are afforded additional opportunities to solve relevant design problems through homework and group design projects in various courses in the sophomore and junior years. Design projects that incorporate course-specific topics along with techniques introduced in the freshman *Introduction to Engineering* course are assigned in *Digital Logic Design* (ELEE 204) in the sophomore year, *Embedded Systems* (ELEE 310) in the junior year, and other courses as appropriate. These projects are presented in written and/or oral reports.

Senior Year - The integrated design experience in ECE at Grove City College culminates in the senior year with the ***Senior Experience in Electrical Design*** (SEED). The SEED program is a capstone design experience comprised of a combination of research and proposal writing in *Electrical Engineering Design* (ELEE 401) in the fall semester of the senior year and hands-on implementation and documentation of that design in *Experimental Electrical Engineering* (ELEE 452) in the spring semester. The project must incorporate one or more advanced topics chosen from the senior-level stem sequences in Communication Systems, Computer Systems, or Control Systems (students choosing the CE concentration must include the Computer Systems Sequence). Since stem courses build on fundamentals presented in previous ECE courses, the SEED program assures that all ECE graduates complete a major design experience drawing on fundamental concepts as well as advanced ECE topics. While seniors are asked to present various oral and written updates throughout the SEED experience, the climax of SEED comes in the second semester of the senior year when students present oral and written reports to engineering professionals from nearby industries who judge the teams on various aspects of their designs.

Course Requirements for Bachelor of Science Degree in Electrical Engineering (ELEE)

Electrical Engineering/Computer Core (33 hours)
Computer Science 141 and 220.
Electrical Engineering 201, 202, 204, 238, 251, 252, 301, 321, 351, 401, 451, and 452.
Engineering Core (5 hours)
Engineering 156, and 402.
Math/Science Core (33 hours)
Chemistry 105.
Mathematics 161, 162, 261, and 262.
Engineering 274*.
Physics 101 and 102.
Math/science elective—choose one course from the following:
Biology 101, 102; Chemistry 227, 241, 345; Mathematics 211**, 213**, 222, 331; Physics 206, 232, 234.

*Students who take Mathematics 211 or 213, and also Mathematics 222 and 331, are exempt from the Engineering 274 requirement.
** Students cannot receive credit for both Math 211 and Math 213.

Concentration Area (35 hours) —choose one:

Electrical Engineering Concentration (EEEE)

Electrical Engineering 302, 303, 304, and 352 (11 hours).

Intermediate electives** (6 hours):

Choose two courses from Computer Science 222, 342, 450, Electrical Engineering 306, 310, 333, 390, Engineering 390, or choose one course from this list and one additional course from the math/science electives.

Advanced electives** (18 hours):

Eight hours from Electrical Engineering 422, 432, or 442.
Ten hours from Electrical Engineering 390, 404, 421, 431, 441, 499, or Engineering 390.

***No course can be used to satisfy both the intermediate and advanced elective requirements.*

.

Computer Engineering Concentration (EECE)

Electrical Engineering 306, 310, 333, 353, 441, 442, and Computer Science 222 and 450.
Four hours from Electrical Engineering 422 or 432.
Seven hours from Electrical Engineering 390, 404, 421, 431, 499, or Engineering 390.

Courses that count in the ELEE major quality point average (MQPA):
All courses with "ELEE" prefix; ENGR 390; COMP 220, 222, and 342. A minimum MQPA of 2.00 is required to graduate.

ELECTRICAL ENGINEERING (ELEE) MAJOR
FOUR-YEAR PLAN

FRESHMAN YEAR	**1st Sem.**	**2nd Sem.**	**SOPHOMORE YEAR**	**1st Sem.**	**2nd Sem.**
Mathematics 161-162	4	4	Mathematics 261-262	4	3
Chemistry 105	4	-	Electrical Engineering 201-202	3	3
Physics 101-102	4	4	Electrical Engineering 251-252	1	1
Computer Science 141	-	3	Computer Science 220*	3	-
Engineering 156	-	2	Electrical Engineering 204	-	3
Humanities 101-102	3	3	Electrical Engineering 238	2	-
Physical Education	1	1	Math-Science Elective*	-	3
	16	17	Humanities 201-202	3	3
				16	16

JUNIOR YEAR | **SENIOR YEAR**

ELEC. ENGR. CONCENTRATION | **ELEC.ENGR. CONCENTRATION**

Electrical Engineering 301	3	-	Advanced Electives	10	8
Elec. Eng. 302	-	3	Electrical Engineering 401	3	-
Elec. Eng. 303	3	-	Engineering 402	-	3
Elec. Eng. 304	-	4	Electrical Engineering 451-452	1	2
Electrical Engineering 321	4	-	Humanities 301-302	3	3
Electrical Engr. 351-352	1	1		17	16
Intermediate Electives	3	3			
Social Science/SSFT	3	3			
Engineering 274	-	3			
	17	17			

JUNIOR YEAR			SENIOR YEAR		
COMP. ENGR. CONCENTRATION			**COMP. ENGR. CONCENTRATION**		
Electrical Engineering 301	3	-	Elec. Eng. 441-442	3	4
Elec. Eng. 306	-	3	Advanced Electives	7	4
Comp. Sci. 222	3	-	Electrical Engineering 401	3	-
Comp. Sci. 450	-	3	Engineering 402	-	3
Elec. Eng. 310	-	4	Electrical Engineering 451-452	1	2
Electrical Engineering 321	4	-	Humanities 301-302	3	3
Electrical Engr. 351-353	1	1		17	16
Elec. Eng. 333	3	-			
Social Science/SSFT	3	3			
Engineering 274	-	3			
	17	17			

*Computer Science 220 and the Math-Science elective can be taken in either semester.

Students are expected to contact their advisors for a detailed schedule of courses recommended to meet requirements for a major.

ELECTRICAL ENGINEERING (ELEE)

201. LINEAR CIRCUITS I. An introduction to the analysis and design of electrical circuits composed of linear elements. The course begin with time domain analysis of the steady state and transient behavior of linear circuits and progresses to sinusoidal steady state analysis using the phasor method. Computers are introduced as an aid to analysis and design of circuits via the use of circuit simulation software. Prerequisites: Physics 102 and Mathematics 162. *Fall semester only, three hours.*

202. LINEAR CIRCUITS II. Continued study in techniques for analyzing and designing circuits composed of linear elements, including the Laplace Transform, convolution, and Fourier analysis methods. Applications of linear circuits to electric power systems and frequency selective systems are examined. Computers are used as an aid to analysis and design via the use of circuit simulation software. Prerequisites: Electrical Engineering 201. *Spring semester only, three hours.*

204. DIGITAL LOGIC DESIGN. An introduction to digital circuit analysis and design methods. Combinational circuit topics include the use of Boolean algebra, map minimization methods, and circuit implementation with logic gates and standard integrated circuits. Sequential circuit design is explored, and implementation with flip-flops and standard integrated circuits is investigated. Programmable logic implementation of both combinational and sequential circuits is introduced. A group design project is required. *Spring semester only, three hours*.

210. ELECTRICAL ENGINEERING. A survey for non-electrical engineering majors covering the basic principles of circuit analysis, electronics, instrumentation, and electromechanical energy conversion, with computer applications. Prerequisites: Mathematics 162, Physics 102, and Computer Science 141.
Spring semester only, three hours.

238. NUMERICAL METHODS FOR ENGINEERS. An introduction to MATLAB computer programming with an emphasis on numerical methods common to electrical engineering applications. Prerequisite: Computer Science 141. Corequisite: Electrical Engineering 201. *Fall semester only, two hours.*

251. LINEAR CIRCUITS LABORATORY. A laboratory course intended to acquaint the student with basic techniques of instrumentation, measurement, design, and troubleshooting for linear analog circuits. Laboratory investigation of basic Electrical Engineering concepts is integrated with design and implementation of practical circuits to meet specifications. Corequisite: Electrical Engineering 201.
Fall semester only, one hour.

252. DIGITAL CIRCUITS LABORATORY. A laboratory course intended to acquaint the student with hardware and software tools used for the design and implementation of digital circuits. A variety of digital design techniques are investigated, including gate-level circuits, programmable FPGA devices, and hardware definition languages (VHDL). CAD software, a hardware target system, and lab equipment are used to design, simulate, program, and verify the operation of digital circuits. Computers are used to design and simulate circuits and to program digital devices to implement those designs. Corequisite: Electrical Engineering 204. *Spring semester only, one hour.*

301. ELECTRONICS I. A study of semiconductor device characteristics, diodes, bipolar junction transistors (BJTs), field-effect transistors (FETs), BJT and FET amplifier circuits, bias stability, and DC power supplies. Prerequisites: Electrical Engineering 202 and Mathematics 262. *Fall semester only, three hours.*

302. ELECTRONICS II. A study of the frequency response characteristics of transistor amplifiers, integrated-circuit operational amplifiers, fundamentals of feedback and stability, oscillators, active filters, quasi-linear circuits, pulsed waveforms and timing circuits. Prerequisites: Electrical Engineering 301. *Spring semester only, three hours.*

303. ELECTRICAL MACHINES. Theories of transformers, DC machines, induction motors, synchronous motors and generators, stepping motors, and single-phase motors are developed and applications are explored. Prerequisite: Electrical Engineering 202.

Fall semester only, three hours.

304. ELECTROMAGNETIC THEORY. Fundamentals of electromagnetic theory, including static electric fields; dielectrics; energy and forces in the electric field; magnetic fields in free space and in magnetic materials; time-varying fields; and Maxwell's equations with applications. Computer techniques are used to solve a problem involving Laplace's Equation. Prerequisites: Electrical Engineering 202; Mathematics 262.

Spring semester only, four hours.

306. DIGITAL ELECTRONICS. A study of semiconductor devices and their use in digital integrated circuits. Characteristics of semiconductor devices will be explored followed by an investigation of their application to the design of digital logic circuits and systems. Prerequisite: Electrical Engineering 204 and 301.

Spring semester only, three hours.

310. EMBEDDED SYSTEMS. An introduction to the skills required to design and program systems that incorporate embedded microprocessors or microcontrollers. Topics include microprocessor circuitry and architecture, programming using assembly and higher-level languages, and interfacing the microprocessor with external devices. Three lectures and one lab per week. Prerequisites: Electrical Engineering 202 or 210, and Electrical Engineering 204. *Spring semester only, four hours.*

321. SIGNAL ANALYSIS. The mathematical representation of continuous and discrete systems including Fourier Series and transforms; Laplace transforms; z-transforms; continuous and discrete convolution; and digital computer techniques such as FFT's and digital filtering. Prerequisite: Electrical Engineering 202; Mathematics 262.

Fall semester only, four hours.

333. SYSTEM SOFTWARE. A study of the basic principles of operating system design and implementation, focused on the Linux environment and an overview of compiler and database management system principles. Operating system features include memory management, process management, file management, basic Linux commands and shell scripts. Compiler features include basic processing flow and optimization techniques. Database features include relational design and table manipulation. Prerequisite: Computer Science 220. Corequisite: Computer Science 222.

Fall semester only, three hours.

351. INTERMEDIATE LABORATORY I. A hands-on experience in the use of electronic devices including discrete active and passive components and sub-assemblies; test equipment; and instrumentation. Assignments are oriented toward the analysis and design of analog electronic circuits and systems. Computer software is used for the circuit simulation and analysis. Familiarization with the technical resources available in the library is also provided. Corequisite: Electrical Engineering 301.

Fall semester only, one hour.

352. INTERMEDIATE LABORATORY II. A hands-on experience in the use of electronic and electrical devices including transformers, motors, and generators as well as discrete active and passive components, test equipment, and instrumentation. Assignments are oriented toward the analysis and design of analog electronic circuits, networks, and electrical machines. Computer software is used for circuit simulation and analysis. Prerequisite: Electrical Engineering 301 and 351. Corequisites: Electrical Engineering 302 and 303. *Spring semester only, one hour.*

353. INTERMEDIATE DIGITAL LABORATORY. A hands-on experience in the use of electronic devices including discrete active and passive components, integrated circuits, test equipment, and instrumentation. Assignments are oriented toward the analysis and design of digital electronic circuits and networks. Computer software is used for circuit simulation and analysis. Prerequisites: Electrical Engineering 204, 301, and 351. Corequisite: Electrical Engineering 306. *Spring semester only, one hour.*

390. SPECIAL TOPICS IN ELECTRICAL ENGINEERING. Special topics, based on student demand and faculty interest, in the areas of new electrical engineering development. Specific subject matter varies each semester. Prerequisites and credit hours announced in advance of registration.
Semester course, one, two, three, or four hours.

401. ELECTRICAL ENGINEERING DESIGN. A study of the principles and methods of designing electrical engineering systems in today's society, including the design process; the creative process; decision making in design; design optimization; design tools; probability, statistics, and reliability analysis as applied to electrical engineering design; ISO standards; concurrent engineering; analysis and verification of performance; and environmental impact. A design project is required. The senior design project is initiated, defined, and documented. Extensive technical writing and oral presentation skills are employed. Electrical Engineering 401 is designed to fulfill the requirements for both a Writing Intensive (WI) and a Speaking Intensive (SI)course in the Electrical Engineering major. Prerequisite: Senior standing in electrical engineering.
Fall semester only, three hours.

404. ELECTROMAGNETIC ENERGY TRANSMISSION. The analysis of the transmission of electromagnetic energy including radiation of electromagnetic energy, guided waves in transmission lines, and antennas. Each student completes an antenna design project as part of this course. Prerequisite: Electrical Engineering 304.
Fall semester only, four hours.

421. CONTROL THEORY. A study of the analysis and design of feedback control systems. Topics include: modeling of dynamic systems, linearization, transducers, parameterization of step responses, reduction of multiple subsystems, steady-state error, brief overview of root locus, Bode analysis/stability margins, Bode compensator design, programmable logic controllers (including RSLogix500; RSView32 software and SLC-500 hardware and projects controlling actual hardware), state-space representation, solution of state equations, review of z-transform, and sampling. Extensive Matlab/Simulink simulations. Prerequisite: Electrical Engineering 321.

Fall semester only, four hours.

422. DESIGN OF CONTROL SYSTEMS. Analysis and design of primarily digital control systems. Topics include: relation of z-transform to Laplace transform under sampling; more PLC projects; sampled-data closed-loop systems/effects of sampling; system reduction using Mason's gain rule; discrete-time state equations/their solution; digital filter realizations in software and ICs; steady-state error for sampled-data control systems; frequency domain techniques for digital control system compensator design; state/output feedback/observer theory for digital control systems; optimal control (theory behind and examples of linear quadratic regulators including incorporation of nonzero setpoint); and fuzzy logic controllers. Extensive Matlab/Simulink simulations. Prerequisites: Electrical Engineering 401 and 421. *Spring semester only, four hours.*

431. COMMUNICATION SYSTEMS I. Fundamentals of digital communication systems including signals/systems review; correlations/PSD; channel capacity; E_bN_0; baseband systems (PCM/companding, DPCM, source coding, scrambling, intersymbol interference/RRC, bit synchronization, and TDM); brief introductions to xDSL, N/B-ISDN, ATM, Ethernet, SONET; antennas and propagation/signal degradation; frequency allocations; link budget analysis; complex envelope; PSD of bandpass signals; circuits for communication systems (filters, amplifier types, oscillators, nonlinear analysis/THD, mixers, and phase-locked loops/frequency synthesizers); superheterodyne systems; digital television; and binary bandpass signaling. Extensive Matlab/Simulink simulations. Optional accompanying digital communication labs distinct from Electrical Engineering 451. Prerequisites: Electrical Engineering 321; Mathematics 262.

Fall semester only, three hours.

432. COMMUNICATION SYSTEMS II. Binary bandpass signaling continued (ASK, BPSK, DPSK, BFSK, QPSK, p/4 DQPSK, MPSK, QAM, and MSK/GMSK); vector-space signal representation; orthogonal signaling; probability/random process review; bandpass random processes; noise temperature/figure; PSD of digital stochastic signals; matched filters; probability of error for digital communication systems; block FEC coding (through BCH/Reed-Solomon codes and Berlekamp decoding algorithm); and introduction to spread spectrum/cellular systems. Extensive Matlab/Simulink simulations. Optional accompanying digital communication labs distinct from Electrical Engineering 451. Prerequisites: Electrical Engineering 401 and 431.

Spring semester only, four hours.

441. COMPUTER I. A study of the functional organization and sequential operations of digital computers including number representation and digital arithmetic; instruction format and repertoire; computer elements and their functions; micro-operations and sequences by which instructions are carried out; and control and command logic. A design project is required. Prerequisite: Electrical Engineering 204 and 310.

Fall semester only, three hours.

442. COMPUTER II. An advanced study of computer architectures including parallel processors and the design of computing structures. Assigned projects include the design of a complete computer structure including both the hardware and software. A design project is required. Prerequisites: Electrical Engineering 401 and 441.

Spring semester only, four hours.

451. EXPERIMENTAL ELECTRICAL ENGINEERING I. An advanced lab course requiring the student to design and perform experiments in control systems, communication systems, and computers. Prerequisite: Senior standing in electrical engineering. *Fall semester only, one hour.*

452. EXPERIMENTAL ELECTRICAL ENGINEERING II. Participation in a small group in association with (a) faculty advisor(s) to complete a practical engineering design project with emphasis on problem definition, design of solutions, synthesis of solutions, analysis, and evaluation. Written reports and oral presentations are required. Prerequisites: Electrical Engineering 451; Senior standing.

Spring semester only, two hours.

499. HONORS IN ELECTRICAL ENGINEERING. Seniors who have shown special aptitude in electrical engineering may, with consent of the department, undertake special research problems. Not to exceed three hours each semester.

Semester course, one, two or three hours.

MECHANICAL ENGINEERING

Mechanical Engineering Department Mission Statement, Objectives, and Outcomes

Mechanical Engineering (ME) is the analysis and design of devices and systems that convert energy from one form to another and that perform useful work. It is an engineering specialty that includes such diverse topics as materials science, thermodynamics, solid and fluid mechanics, heat transfer, manufacturing processes, control theory, vibration analysis, and project management. Mechanical engineers enjoy employment in a wide variety of areas including research, design, manufacturing, sales, education, and management.

The ME Department at Grove City College offers a program leading to the Bachelor of Science in Mechanical Engineering (BSME) degree. The program is accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET).

The mission of our program is to produce graduates who can pursue leadership roles in the mechanical engineering profession. The following program ***objectives*** enable GCC mechanical engineers to meet this mission in the years following graduation:

1. Graduates will possess a Christian perspective on the profession of mechanical engineering; this includes the fostering of “intellectual, moral, spiritual, and social development consistent with a commitment to Christian truth, morals, and freedom.”

2. Graduates will apply math and science fundamentals to the solution of engineering problems.
3. Graduates will apply engineering science and design to the solution of engineering problems.
4. Graduates will apply a “practice-oriented” approach to problem solving that emphasizes engineering practice over funded research.
5. Graduates will analyze, design, and produce finished products through knowledge of the manufacturing process.

Our graduates possess the following program ***outcomes*** upon graduation:

a) An ability to apply knowledge of mathematics, science, and engineering.
b) An ability to design and conduct experiments as well as to analyze and interpret data.
c) An ability to design a system, component, or process to meet desired needs.
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
f) An understanding of professional and ethical responsibility in a Christian context including recognition of the fundamental worth of individuals as creations of God, resulting in a consistent commitment to the safety and health of individuals, honesty, and impartiality in all affairs and faithfulness in serving both employers and clients.
g) An ability to communicate effectively. This outcome includes the ability to write clearly and cohesively about technical subjects, communicate mathematical analyses in a comprehensible form, and orally communicate on technical subjects with people at different levels of technical ability.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context. The following liberal arts areas are considered important in giving the Christian student a background for making judgments concerning engineering solutions: history of civilization, Biblical revelation, philosophy, literature, visual art, music, and modern civilization in international perspective.
i) Recognition of the need for and an ability to engage in life-long learning.
j) Knowledge of contemporary issues from a Christian perspective.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
l) Knowledge of chemistry and calculus-based physics with depth in at least one.
m) The ability to apply advanced mathematics through multivariate calculus and differential equations.
n) A familiarity with statistics and linear algebra.
o) The ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems.

These outcomes are met over a 4-year curriculum that starts with an exposure to the fundamentals of science and engineering and culminates in our senior capstone design experience.

Freshman Year – Introduction to the fundamentals of chemistry, physics, calculus, engineering computations, the profession of engineering, and the design process.

Sophomore Year – Emphasis on the analysis of problems in statics/dynamics, materials science, and thermodynamics, and on the design and manufacturing process; students are exposed to modern machine shop practice through the fabrication of their own Stirling engines. They also learn to use Pro/Engineer, a state-of-the-art CAD tool.

Junior Year – Analysis skills are honed in engineering math, circuit analysis, fluid mechanics, heat transfer, and mechanics of materials. Sound experimental and design techniques are reinforced in the required laboratory sequence. Students receive a solid grounding in dynamic systems analysis and simulation, machine design, and stress analysis. Opportunities for international study and travel are offered through our partnership with the engineering school at the University of Nantes, in Nantes, France.

Senior Year – A major, year long capstone design experience includes the design and realization of an engineering product. Extensive computer-aided design and manufacturing includes the use of Pro/Engineer to document, analyze and fabricate designs. Advanced manufacturing techniques covered include conventional and investment casting, injection molding, CNC machining, and TIG/MIG welding. To assure the ability to work professionally in both the thermal and mechanical systems areas, seniors choose a minimum of two electives from each area. At least three of the electives must be 400-level courses.

<u>Thermal Systems electives:</u>
MECE 321 Advanced Thermodynamics
MECE 391 Special Mechanical Engineering Topics
MECE 414 Principles of HVAC
MECE 416 Design of Thermal Systems
MECE 421 Applied Fluid Mechanics
MECE 499 Honors in Mechanical Engineering

<u>Mechanical Systems electives:</u>
MECE 314 Kinematics and Dynamics of Machinery
MECE 318 High-Technology Ventures
MECE 390 Special Mechanical Engineering Topics
MECE 407 Control Systems
MECE 408 Mechanical Vibrations
MECE 415 Finite Element Analysis
MECE 417 Design of Optimal Structures
MECE 418 Human-Powered Vehicle Design
MECE 498 Honors in Mechanical Engineering

*Additional electives may be offered at the discretion of the department.

Course Requirements for Bachelor of Science Degree in Mechanical Engineering (MECE)

Mechanical Engineering Core (48 hours)
Mechanical Engineering 120, 201, 208, 210, 211, 212, 214, 251, 252, 311, 312, 316, 325, 326, 351, 352, 401, 402, 451, and 452.

Engineering Core (8 hours)
Engineering 156 and 402, Electrical Engineering 210.

Math/Science Core (33 hours)
Chemistry 105.*
Engineering 274.**
Mathematics 161, 162, 261, and 262.
Physics 101 and 102.
Math/science elective—choose one course from the following:
Biology 101, 102; Chemistry 227, 241, 345; Mathematics 211***, 213***, 222, 331; Physics 206, 232, 234.

Mechanical Engineering Electives (12 hours)
Choose a minimum of two courses from each of the following areas, for a total of 12 hours. At least three electives must be 400-level courses.

Thermal Systems electives
Mechanical Engineering 321, 391, 414, 416, 421, and 499.

Mechanical Systems electives
Mechanical Engineering 314, 318, 390, 407, 408, 415, 417, 418, and 498.

Courses that count in the MECE major quality point average (MQPA):
All courses with "MECE" prefix; ELEE 210; ENGR 156, 390, and 402. A minimum MQPA of 2.00 is required to graduate.

**Students who take Chemistry 101 and 102 are exempt from the Chemistry 105 requirement.*
***Students who take all three of the courses Mathematics 211, 222, and 331 are exempt from the Engineering 274 requirement.*
**** Students cannot receive credit for both Math 211 and Math 213.*

MECHANICAL ENGINEERING (MECE) MAJOR FOUR-YEAR PLAN

FRESHMAN YEAR	1st Sem.	2nd Sem.	SOPHOMORE YEAR	1st Sem.	2nd Sem.
Mathematics 161-162	4	4	Mathematics 261-262	4	3
Chemistry 105	4	-	Mech. Engineering 211-212	3	3
Physics 101-102	4	4	Mech. Engineering 208-210	3	3
Mech. Engineering 120	-	3	Mech. Engineering 201	3	-
Engineering 156	-	2	Mech. Engineering 214	-	3
Humanities 101-102	3	3	Mech. Engineering 251-252	1	1
Physical Education	1	1	Humanities 201-202	3	3

	16	17		17	16

JUNIOR YEAR			SENIOR YEAR		
Mech. Engineering 311-312	3	3	Mech. Engineering Electives	9	3
Mech. Engineering 316	-	3	Mech. Engineering 401-402	3	3
Mech. Engineering 325-326	3	3	Mech. Engineering 451-452	1	1
Mech. Engineering 351-352	1	1	Engineering 402	-	3
SSFT/Social Science	3	3	Humanities 301-302	3	3
Engineering 274	3	-	General Elective	-	3
Elec. Engineering 210	-	3		16	16
Math/Science Elective	3	-			
	16	16			

Students are expected to contact their advisors for a detailed schedule of courses recommended to meet requirements for a major.

MECHANICAL ENGINEERING (MECE)

120. NUMERICAL COMPUTING FOR MECHANICAL ENGINEERS. This course introduces students to applied numerical computation, with an emphasis on solving typical mechanical engineering problems. Sequential logic programming is taught using Matlab. Topics include array and scalar operators, program control elements, graphic and text I/O, internal and user-defined functions. Students are introduced to numerical methods such as root finding, solutions to systems of linear equations, linear regression, and numerical integration and differentiation. Spreadsheet programming is also taught. *Spring semester only, three hours.*

201. FUNDAMENTALS OF MATERIAL SCIENCE. Models of crystalline and molecular structures are presented to explain the diverse properties of metallic; polymeric and ceramic materials; including atomic bonding and crystal structure; elastic and plastic deformation; phase of equilibria and transformation; thermal processing; and corrosion. Prerequisite: Chemistry 105. *Fall semester only, three hours.*

208. ENGINEERING GRAPHICS WITH SOLID MODELING. A study of the principles of engineering drawing using sketching and computer-aided techniques; pictorial and orthographic representations; auxiliary and section views; dimensioning; tolerancing (including an introduction to geometric dimensioning and tolerancing). Introduction to mechanical CAD solid modeling using Pro/Engineer software, including basic and advanced geometry creation, assemblies and drawings.
Fall semester only, three hours.

210. DESIGN FOR MANUFACTURING. Introduction to manufacturing processes, including part characteristics, economic production quantities, materials, and design recommendations. Introduction to computer-aided manufacturing including tool design and NC programming. A design-for-manufacturing project is required. Prerequisite: Mechanical Engineering 201 and 208. *Spring semester only, three hours.*

211. MECHANICS I. Static equilibrium of particles and rigid bodies; analysis of structures, trusses, and cables; friction; centroids and moments of inertia; methods of virtual work; and energy. Engineering applications. Prerequisites: Physics 101, Mathematics 162. *Fall semester only, three hours.*

212. MECHANICS II. A study of rectilinear and curvilinear motion of particles and rigid bodies; kinetics of particles and rigid bodies; relative motion, work, and energy; impulse and momentum. Engineering applications. Prerequisite: Mechanical Engineering 211. *Spring semester only, three hours.*

214. THERMODYNAMICS. The study of the fundamental principles and some applications of classical thermodynamics. Topics include properties of pure substances; heat, work, and mass transfer; first law of thermodynamics; second law of thermodynamics; entropy; gas power cycles; vapor power cycles; and refrigeration cycles. Prerequisite: Mathematics 261. *Spring semester only, three hours.*

251. MECHANICAL SYSTEMS LABORATORY I. A lab course designed to introduce students to engineering practices including dimensioning, gaging and measuring, machining operations, manufacturing processes, and engineering standards for fasteners, threads, etc. Hands-on application will be taught through fabrication of a model Stirling engine. Mechanical Engineering 251 is designed to fulfill the requirements for an Information Literacy (IL) course in the Mechanical Engineering major. Prerequisite: sophomore mechanical engineering standing.
Fall semester only, one hour.

252. MECHANICAL SYSTEMS LABORATORY II. A lab course designed to introduce students to engineering experimental techniques, including planning, controls, basic instrumentation, basic data analysis, and report writing. Includes experiments on material science, statics and dynamics. Prerequisite: sophomore mechanical engineering standing. *Spring semester only, one hour.*

311. MECHANICS OF MATERIALS. Fundamentals of mechanics of materials, including stress and strain; axial loading; Hooke's Law and Poisson's ratio; torsion; bending; transverse loading; stress and strain transformations; beam analysis; energy methods; and buckling. Prerequisites: Mathematics 262 and Mechanical Engineering 212. *Fall semester only, three hours.*

312. STRESS ANALYSIS AND DESIGN OF MACHINE COMPONENTS. Application of stress analysis to static, fatigue, and surface fatigue failures. Design of shafts, including limits and fits and bearing selection. Design and selection of machine elements such as screws, bolted joints, weldments, springs, gears, brakes, etc. Prerequisite: Mechanical Engineering 311. *Spring semester only, three hours.*

314. KINEMATICS AND DYNAMICS OF MACHINERY. Modeling, analysis, and design of linkages, cams, and gear trains, including machine dynamics. Introduction to dynamic systems modeling using computer-aided analysis, including Pro/ENGINEER. Prerequisite: Mechanical Engineering 311.

Offered periodically, semester course, three hours.

316. SYSTEM DYNAMICS. Modeling and analysis of dynamic systems consisting of mechanical, electrical, electromechanical, fluid, and thermal elements. Development of system models using transfer functions, block diagrams, and state variable methods. System analysis in the time and frequency domains. Includes Matlab/Simulink simulations. Prerequisites: Mathematics 262, Mechanical Engineering 212.

Spring semester only, three hours.

318. HIGH-TECHNOLOGY VENTURES. The purpose of this course is three fold: to introduce students to the process of technological innovation within a business; to learn to work effectively within a multidisciplinary team; and, to design and prototype a product working with a local company. Students experience what it takes to bring a product (or prototype) from concept to market. The class is centered on product development and writing a business plan to support the product. Students will spend time in lecture and laboratory, and will make off-site visits to the partner company. Prerequisites: junior or senior standing and instructor approval. *Semester course, three hours.*

321. ADVANCED THERMODYNAMICS. Application of thermodynamic principles. Topics include reviewing equations of state, properties, conservation of mass, conservation of energy, second law of thermodynamics, and cycles; exergy; property relationships; gas and gas-vapor mixtures; air conditioning; chemical reactions; chemical and phase equilibrium; and compressible-fluid flow. Prerequisite: Mechanical Engineering 214. *Fall semester only, three hours.*

325. FLUID MECHANICS. The study of steady and unsteady flow of mainly incompressible fluids; the application of the conservation laws of mass, momentum, and energy to fluid systems; the control volume approach to distributed systems; and the application of experimental techniques to problems. Prerequisites: Mathematics 262, Mechanical Engineering 214. *Fall semester only, three hours.*

326. HEAT TRANSFER. The fundamentals of heat transfer by conduction, convection, and radiation; application to practical heat transfer devices; engineering analysis of heat exchangers; and design problems solved by analytical, numerical, and computer methods. Prerequisite: Mechanical Engineering 325. *Spring semester only, three hours.*

351. INSTRUMENTATION LABORATORY. A lab course that reinforces the lab techniques introduced in Mechanical Engineering 251-252. Experiments chosen from stress analysis, vibration analysis, and control of mechanical systems. Mechanical Engineering 351 is designed to fulfill the requirements for a Writing Intensive (WI) course in the Mechanical Engineering major. Corequisite: Mechanical Engineering 311.

Fall semester only, one hour.

352. THERMAL/FLUIDS LABORATORY. A lab course that reinforces the lab techniques introduced in Mechanical Engineering 251-252. Experiments chosen from thermodynamics, fluid mechanics, and heat transfer. Corequisite: Mechanical Engineering 326. *Spring semester only, one hour.*

.

390. SPECIAL MECHANICAL ENGINEERING TOPICS. Special topics in mechanical engineering based on student demand and faculty interest. Specific subject matter varies each semester with prerequisites and credit hours announced in advance of registration. This course can be used to satisfy a portion of the mechanical systems elective requirements in Mechanical Engineering.
Semester course, one, two, three or four hours.

391. SPECIAL MECHANICAL ENGINEERING TOPICS. Special topics in mechanical engineering based on student demand and faculty interest. Specific subject matter varies each semester with prerequisites and credit hours announced in advance of registration. This course can be used to satisfy a portion of the thermal systems elective requirements in Mechanical Engineering. *Semester course, one, two, three or four hours.*

401. CAPSTONE DESIGN I. Completion of the senior design project. A study of the principles and methods of designing mechanical engineering systems in today's society, including the design process; decision making in design; engineering economics; analysis and verification of performance; and environmental impact. Corequisite: Mechanical Engineering 451, prerequisite: senior mechanical engineering standing.
Fall semester only, three hours.

402. CAPSTONE DESIGN II. Completion of the senior design project. A study of the principles and methods of designing mechanical engineering systems in today's society, including the design process; decision making in design; engineering economics; analysis and verification of performance; and environmental impact. Corequisite: Mechanical Engineering 452, prerequisite: Mechanical Engineering 401.
Spring semester only, three hours.

407. CONTROL SYSTEMS. A study of the design and analysis of feedback control systems. Topics include: modeling of dynamic systems (mechanical, electro-mechanical, thermal and fluid), a review of Laplace transform techniques, steady-state error, stability, root locus design methods, Bode analysis/stability margins, and Bode compensator design. Introduction to state-space techniques and the digital implementation of controllers. Includes Matlab/Simulink simulations. Prerequisites: Electrical Engineering 210, Engineering 274, and Mechanical Engineering 316.
Spring semester only, three hours.

408. MECHANICAL VIBRATIONS. A study of the dynamic response of lumped parameter systems with one and two degrees of freedom subjected to periodic and non-periodic excitation; applications to the control of undesirable vibrations in machines; theory of seismic instruments; and an introduction to distributed parameter systems. Prerequisites: Mechanical Engineering 311 and 316. *Fall semester only, three hours.*

414. PRINCIPLES OF HEATING, VENTILATING, AND AIR CONDITIONING. Analysis and design of components and systems used to condition air in buildings.

Topics include air-conditioning systems, psychrometrics, conditioning processes, indoor air quality, heat transfer, solar radiation, heating loads, cooling loads, annual energy usage, pumps and piping, fans and ducts, heat exchangers, and refrigeration equipment. Prerequisite: Mechanical Engineering 326. *Fall semester only, three hours.*

415. FINITE ELEMENT ANALYSIS. A study of the finite element method and its application to mechanical engineering problems. Topics include basic concepts; stiffness matrices; truss structures; flexure elements; method of weighted residuals; interpolation functions; and applications to heat transfer, fluid mechanics, solid mechanics, and structural dynamics. Prerequisites: Engineering 274, Mechanical Engineering 312 and 326. *Fall semester only, three hours.*

416. DESIGN OF THERMAL SYSTEMS. Design of systems using thermodynamic, fluid-mechanic, and heat-transfer concepts. Topics include modeling thermal and fluid processes and equipment, simulation of thermal and fluid systems, and optimization procedures. A design project is required. Prerequisite: Mechanical Engineering 326.
Spring semester only, three hours.

417. DESIGN OF OPTIMAL STRUCTURES. Methods and techniques for designing optimal structures for high-performance applications in which stiffness, strength, and light weight are paramount. Includes load-case analysis, stress visualization and computation, FEM-based structural optimization, and advanced materials and processes. Prerequisites: senior mechanical engineering standing.
Offered periodically, semester course, three hours.

418. HUMAN-POWERED VEHICLE DESIGN. Computer-aided modeling, analysis, and design of human-powered vehicles for land, water, and air. Includes analysis of vehicle dynamics and handling, performance predictions, and CAD-based design tools integrating dynamic models with Pro/ENGINEER models. Two lectures and one laboratory per week. Prerequisites: Mechanical Engineering 311 and 325.
Fall semester only, three hours.

.

421. APPLIED FLUID MECHANICS. Application of basic equations of thermal science to turbo machinery; design of axial flow pumps; radial flow machines; turbines; heat exchangers and piping systems; and introduction to unsteady flow. Prerequisites: Mechanical Engineering 325 and 326. *Fall semester only, three hours.*

451. CAPSTONE DESIGN LABORATORY I. An advanced lab course requiring the student to complete the senior group design project. Includes 3-D computer-aided design and manufacturing techniques and experiments related to the senior project. Written reports and oral presentations are required. Mechanical Engineering 451 is designed to fulfill the requirements for a Speaking Intensive (SI) course in the Mechanical Engineering major. Prerequisites: senior standing in Mechanical Engineering; Mechanical Engineering 351 and 352. *Fall semester only, one hour.*

452. CAPSTONE DESIGN LABORATORY II. An advanced lab course requiring the student to complete the senior group design project. Includes 3-D computer-aided design and manufacturing techniques and experiments related to the senior project. Written reports and oral presentations are required. Mechanical Engineering 452 is designed to fulfill the requirements for a Speaking Intensive (SI) course in the Mechanical Engineering major. Prerequisites: senior standing in Mechanical Engineering; Mechanical Engineering 451. *Spring semester only, one hour.*

498. HONORS IN MECHANICAL ENGINEERING. Seniors (and in some instances, juniors) who have shown special aptitude in mechanical engineering may, with consent of the department, undertake special research and design problems. This course can be used to satisfy a portion of the mechanical systems elective requirements in Mechanical Engineering. Cannot be repeated for more than a total of three credit hours. *Semester course, one, two or three hours.*

499. HONORS IN MECHANICAL ENGINEERING. Seniors (and in some instances, juniors) who have shown special aptitude in mechanical engineering may, with consent of the department, undertake special research and design problems. This course can be used to satisfy a portion of the thermal systems elective requirements in Mechanical Engineering. Cannot be repeated for more than a total of three credit hours. *Semester course, one, two or three hours.*