Electrical Engineering (ELEN)

ELEN 2020 Electric Circuits 2 (3 credits)
Sinusoidal steady-state analysis. Power in AC circuits. Linear and ideal transformers. Laplace transform methods and circuit analysis applications. Passive and active frequency-selective circuits. Balanced three-phase circuits. Two-port circuits.
Prerequisite: EECE 2010.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%202020)

ELEN 2040 Engineering Systems (3 credits)
Focuses on the modeling and solution of physical systems including translational and rotational mechanical systems, mass balance systems (fluids, chemical), thermal systems and electrical systems. Analytic solution techniques stress the universality of the mathematics for all systems. Computer solutions using MatLab and Simulink are used to further investigate the linear system behavior and to introduce non-linear system behavior.
Prerequisite: EECE 2010 and either MATH 2450 or MATH 1455.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%202040)

ELEN 3001 Electric Circuits (3 credits)
Circuit modeling; basic solution methods for DC and AC circuits; DC transient analysis of first order and second order circuits. More advanced circuit solution methods including node voltage equations and Thevenin's Theorem. Op Amp circuits and an introduction to transfer functions. May not be taken for credit by EECE students.
Prerequisite: MATH 1451 or MATH 1455.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203001)

ELEN 3020 Linear Systems Analysis (3 credits)
Mathematical models of continuous-time and discrete-time signals and systems are studied. The time domain viewpoint is developed for linear time invariant systems using the impulse response and convolution integral. The frequency domain viewpoint is also explored through the Fourier Series and Fourier Transform. Basic filtering concepts including simple design problems are covered. Application of the Laplace transform to block diagrams, linear feedback, and stability including Bode plots are discussed. The sampling theorem, the z-transform, and the Discrete Fourier Transform are introduced. Examples of electrical, mechanical and biomedical signals and systems are used extensively throughout the course.
Prerequisite: ELEN 2020 and MATH 2451; or EECE 2001 and MATH 2451; or BIEN 2300 and MATH 2451; or ELEN 3001 and MATH 2451.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203020)

ELEN 3025 Electrical Instrumentation Laboratory (2 credits)
Develops familiarity with typical electronic instruments and terminology. Combines theory with experience to analyze and design electrical networks. Learn experimental technique and documentation. 1 hr. lec., 3 hrs. lab.
Prerequisite: EECE 3010, ELEN 2020 and EECE 2015.
Level of Study: Undergraduate
Marquette Core Curriculum: Writing Intensive
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203025)

ELEN 3030 Analog Electronics (3 credits)
Analysis and design of analog electronic circuits. Low and high frequency models for both bipolar and field effect transistors. Design features and operating characteristics of integrated linear circuits with emphasis on operational amplifiers and op-amp circuits.
Prerequisite: EECE 3010 and ELEN 2020.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203030)

ELEN 3035 Electronics Projects Laboratory (2 credits)
Gain experience in the design, assembly, testing and trouble-shooting of analog electronic circuits. Experiments encompass a wide range of topics, such as: amplifiers, filters, power supplies, power control, oscillators and communication circuits. Transistors, op-amps, general purpose and specific purpose devices are used. 1 hr. lec., 3 hrs. lab.
Prerequisite: ELEN 3030, ELEN 3025 and MATH 4720.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203035)

ELEN 3110 Electromagnetic Fields 1 (3 credits)
Development and use of the point and integral forms of Maxwell's equations for static and quasi-static electric and magnetic fields with emphasis placed on the vector nature of these fields. Includes analytic and computational solutions to field's problems. The wave equation for E.M. fields is derived and discussed.
Prerequisite: ELEN 2020, MATH 1455, and PHYS 1004 or PHYS 1014.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203110)

ELEN 3120 Electromagnetic Fields 2 (3 credits)
Development and use of Wave Equations as derived from Maxwell's equations to explain the propagation of electromagnetic waves. Includes treatment of physical optics, antennas, waveguides and transmission lines.
Prerequisite: ELEN 3110.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203120)

ELEN 3210 Electric Drives (3 credits)
Application of electromagnetic field and circuit theory to electromechanical energy conversion systems. Solutions for the magnetic fields, electromagnetic and electrostatic induced forces, and equivalent circuits using conservation of energy principles. Operation of electric machinery from solid-state power switch converters.
Prerequisite: ELEN 3110.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%203210)

ELEN 4090 Developments in Electronics (1-3 credits)
Course content is announced prior to each term. Students may enroll in the course more than once because subject matter changes. Depending upon the subject matter and the instructor, the class may be taught in traditional lecture format or as a seminar which focuses on readings from the current literature. Possible topics include laser electronics, optoelectronics and photonics, RF circuit design, SOC design.
Prerequisite: Cons. of instr. or Sr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204090)

ELEN 4100 Transmission Lines and Electromagnetic Waves (3 credits)
Development and use of wave equations as derived from Maxwell’s equations to explain the propagation of electromagnetic waves. Includes wave propagation, reflection/diffraction, antennas, and transmission lines including use of the Smith chart. Discusses S parameters and the vector network analyzer. An introduction to the physical principles of radio communication.
Prerequisite: ELEN 3110 or equiv.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204100)

ELEN 4110 Microwave Engineering (3 credits)
Studies the fundamentals of microwave engineering. After a review of transmission line theory and the Smith chart, the scattering parameters are developed and used to characterize and design a variety of devices including power dividers/directional couplers, filters, amplifiers, oscillators and mixers. Also introduces and develops receiver architectures and system noise.
Prerequisite: ELEN 3120.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204110)

ELEN 4130 Antenna Theory and Design (3 credits)
Design and use of antennas of varying types, including wire, broadbands, horn, and reflector antennas in transmitting and receiving applications. The application and design of antenna arrays, and an introduction to diffraction theory.
Prerequisite: ELEN 3120 or ELEN 4100.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204130)

ELEN 4150 Applied Finite Elements in Electromagnetics (3 credits)
Introduction to finite element (FE) analysis as applied to linear and static electromagnetic field problems. Review of basic field formulations using Maxwell's electromagnetic field equations, solution of boundary value problems using the finite difference methods, FE formulations, assembly of elemental and global matrices, pre-processing, post-processing. Application of the FE method using one-dimensional and two-dimensional elements, magnetostatic and electrostatic analysis, and the use of commercially available software packages.
Prerequisite: ELEN 3110 or equiv.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204150)

ELEN 4190 Developments in Electromagnetics (1-3 credits)
Course content is announced prior to each term. Students may enroll in the course more than once because subject matter changes. Depending upon the subject matter and the instructor, the class may be taught in traditional lecture format or as a seminar which focuses on readings from the current literature. Possible topics include wireless and microwave components and systems, electromagnetic compatibility, radio wave propagation.
Prerequisite: Cons. of instr. or Sr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204190)

ELEN 4210 Design and Analysis of Electric Motor-Drive Systems (3 credits)
Principles of design of AC and DC electric machines, in particular design of electric motors in power electronically controlled adjustable speed drives, torque and power to volume analysis under constant volts per hertz torque-speed control. Covers design of AC induction, synchronous, universal and DC conventional as well as brushless DC motors, and low horsepower motors in adjustable speed drives. Covers effects of space and time harmonics on motor design and performance, including harmonic abatement for control of torque pulsation. Use of modern modeling techniques throughout.
Prerequisite: ELEN 2020, ELEN 3110 and ELEN 3210.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204210)

ELEN 4220 Power Electronics for Renewable Energy Systems (3 credits)
Fundamental concepts, techniques, and methods for design and analysis of power electronic systems. Modeling of semiconductor switching devices for use in power electronic systems. Practical aspects and power electronic conversion techniques for rectifiers, DC-to-DC converters, DC-to-AC inverters and their applications in power electronic systems.
Prerequisite: EECE 3010 and ELEN 3020.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204220)

ELEN 4230 Renewable and Legacy Electric Energy Systems Analysis (3 credits)
Elements of electric power systems; fundamental concepts and techniques for design and analysis; per unit system; load flow; economic dispatch; symmetrical components; balanced and unbalanced fault calculations, systems instrumentation and power system protection.
Prerequisite: ELEN 2020 and ELEN 3020.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204230)

ELEN 4240 Protection and Monitoring of Electric Energy Systems (3 credits)
Principles of design of relay and sensor systems for detection of faulty operating conditions in electric generators, transformers, power transmission lines, motors and other loads in power systems. Symmetrical components, balanced and unbalanced faults including single and multiple unbalances. Design and hierarchical coordination of protection systems for interconnected generation, transmission and distribution facilities in power systems, which includes integrated generator-transformer-busbar-transmission line-load protection and analysis of operation under fault conditions.
Prerequisite: ELEN 2020, ELEN 3110 and ELEN 3210.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204240)

ELEN 4250 Transients in Electric Energy Systems and Devices (3 credits)
Covers microsecond fast transients in power systems and devices resulting from lightning strokes, switching surges in power systems and devices, as well as impulse surges resulting from pulse width modulation in modern adjustable speed drives, using distributed parameter models and analysis of transmission lines and windings of transformers, generators and motors. Also covers successive reflections, transition points, wavefront flattening techniques and studies surge arrestor design applications for voltage buildup reduction and control. Includes polyphase multi-velocity multi-conductor system transients.
Prerequisite: ELEN 2020 and ELEN 3110.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204250)

ELEN 4290 Developments in Energy and Power (1-3 credits)
Course content is announced prior to each term. Students may enroll in the course more than once as subject matter changes. May be taught in traditional lecture format or as a seminar which focuses on readings from current literature. Topics may include: electronics for machine and drive systems, electrical transients, faults and diagnostics and protection in power devices and systems, renewable energy systems, smart grids and advanced topics in the electric energy engineering area.
Prerequisite: Cons. of instr. or Sr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204290)

ELEN 4310 Control Systems (3 credits)
Review of continuous-time linear systems. Time-domain system analysis. Time-domain design of lead/lag and PID controllers. Root-Locus technique. Frequency-domain system analysis including Nyquist, Bode, and Nichols analysis and relative stability. Frequency-domain design/lag and PID controllers.
Prerequisite: ELEN 3020 or BIEN 3300.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204310)

ELEN 4320 Digital Control Systems (3 credits)
Review of sampling processes, discrete time linear systems analysis and Z-transforms. Discrete time and sampled data state-variable analysis. Stability analysis, time domain and frequency-domain analysis and design. Digital control design and implementation issues.
Prerequisite: ELEN 3020 or BIEN 3300.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204320)

ELEN 4390 Developments in Control (1-3 credits)
Course content is announced prior to each term. Students may enroll in the course more than once because subject matter changes. Depending upon the subject matter and the instructor, the class may be taught in traditional lecture format or as a seminar which focuses on readings from the current literature. Possible topics include optimal, adaptive and robust control methods, digital control and nonlinear systems.
Prerequisite: Cons. of instr. or Sr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204390)

ELEN 4430 Physical Principles of Solid State Devices (3 credits)
Presents fundamental physical principles of solid state devices. Includes a brief review of Quantum Mechanics and applications of modern semiconductor devices that use the Quantum Mechanics principles. Explains the operation principle of modern semiconductor devices from Quantum Mechanics, and these principles are used to extend the students' knowledge of devices used in electronic circuits.
Prerequisite: EECE 3010 and ELEN 3110.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204430)

ELEN 4440 MEMS and Nanotechnology (3 credits)
Lecture and laboratory work are combined to provide students with a practical, hands-on introduction to micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS).
Prerequisite: EECE 3010, ELEN 3110.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204440)

ELEN 4460 Sensor Devices: Theory, Design and Applications (3 credits)
Sensor classification and transduction principles. Fundamental principles and theory of operation of various types of sensors, based on various technologies which include optical, electrical, acoustical, thermal, magnetic, mechanical and chemical. Analysis of sensor signals. Study of sensor characteristics which include hysteresis, non-linearity, saturation, repeatability, sensitivity, selectivity and resolution. Design and practical implementations of various sensors for scientific, industrial and consumer applications.
Prerequisite: Sr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204460)

ELEN 4490 Developments in Devices (1-3 credits)
Course content is announced prior to each term. Students may enroll in the course more than once because subject matter changes. Depending upon the subject matter and the instructor, the class may be taught in traditional lecture format or as a seminar which focuses on readings from the current literature. Possible topics include optoelectronic devices, nano-scale devices, solid-state devices, integrated electronic devices, power devices, electro-mechanical devices, quantum devices.
Prerequisite: Cons. of instr. or Sr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204490)

ELEN 4550 Developments in Signal Processing (1-3 credits)
Course content is announced prior to each term. Students may enroll in the course more than once because subject matter changes. Depending upon the subject matter and the instructor, the class may be taught in traditional lecture format or as a seminar which focuses on readings from the current literature. Possible topics include filter design, DSP hardware, Nonlinear signal processing and multi-dimensional signal processing.
Prerequisite: Sr. stndg. or cons. of instr.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204550)

ELEN 4560 Introduction to Communication Systems (3 credits)
Survey of digital and analog communication systems including signal representation, modulation techniques, transmit and receive network design considerations.
Prerequisite: BIEN 3300 or ELEN 3020.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204560)

ELEN 4565 Optical Fiber Communications (3 credits)
Introduces and develops fundamental principles and theories of optical fiber systems. Review of electromagnetic principles of wave-guides. Step-Index and Graded-Index, single and multimode fibers. Signal analysis in optical fibers: mode interaction, attenuation, dispersion and pulse spreading. Operating characteristics of optical sources and photo-receivers with impact on system performance. Coupling to a fiber and distribution system. Optical fiber communication system design.
Prerequisite: MATH 4720, Sr. stndg. and ELEN 3110.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204565)

ELEN 4570 Wireless Communications (3 credits)
Fundamentals, analysis and design of cell systems, including trunking theory and grade of service. Large scale and small scale path loss analysis and modeling. Overview of modulation techniques, including amplitude and frequency modulating, and digital modulation techniques.
Prerequisite: ELEN 3020 or BIEN 3300; and ELEN 3110.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204570)

ELEN 4590 Developments in Communications (1-3 credits)
Course content is announced prior to each term. Students may enroll in the course more than once because subject matter changes. Depending upon the subject matter and the instructor, the class may be taught in traditional lecture format or as a seminar which focuses on readings from the current literature. Possible topics include digital modulation and detection, coding theory, information theory.
Prerequisite: Cons. of instr. or Sr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204590)

ELEN 4920 Principles of Design (3 credits)
Course content focuses on a structured product design and development process that includes project definition, customer needs identification, product specification, concept generation and concept selection. Also focuses on issues related to teamwork, project management and effective communication. Student team design projects culminate in the development of a technically and economically viable concept and a proposal for future development of this concept (done in the second semester of this two-course sequence). 2 hrs. lec., 1 hr. disc.
Prerequisite: Sr. stndg.; Co-op students, jr. stndg. Cross-listed with BIEN 4920, COEN 4920 and MEEN 4920.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204920)

ELEN 4995 Independent Study in Electrical Engineering (1-4 credits)
Undergraduate independent study project of either a theoretical or experimental nature.
Prerequisite: Jr. stndg., 3.000 GPA, cons. of instr., and cons. of dept. ch. Consent required.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204995)

ELEN 4998 Senior Design Project (3 credits)
Focuses on detailed design, prototyping and testing design concepts. Includes topics directly relevant to student design projects and careers in the engineering profession. Student team design projects culminate in a final report that documents the performance and details (engineering drawings and/or documentation) of their final design. 2 hrs. lec., 1 hr. disc.
Prerequisite: ELEN 4920. Cross-listed with BIEN 4998, COEN 4998 and MEEN 4998.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=ELEN%204998)