ELECTRICAL ENGINEERING

Electrical engineers are at the forefront of developing technologies to improve and enhance our society. They are involved with understanding the fundamentals of nature to improve design methods and techniques, as well as applying their creativity to solving challenging problems. Electrical engineers design and analyze systems for supplying electric power; navigation systems for automobiles, aircraft, and spacecraft; audio and visual communication systems; and systems for information processing and computing.

The major in electrical engineering provides the undergraduate student with a broad understanding of the many areas within the field of electrical engineering. At the same time, the curriculum provides a choice of technical electives designed to strengthen the student in a chosen area of specialization.

Mission Statement

The Department of Electrical Engineering is committed to outstanding undergraduate and graduate education, distinguished research programs, and strong service to our students, professional and technical societies, and the community.

Programs

- Electrical Engineering, BSE (http://catalog.uwm.edu/engineering-applied-science/electrical-engineering/electrical-engineering-bse)
- Electrical Engineering, Minor (http://catalog.uwm.edu/engineering-applied-science/electrical-engineering/electrical-engineering-minor)

Electrical Engineering Courses

ELECENG 101 Fundamentals of Electrical Engineering
3 cr. Undergraduate.
Principles of electrical engineering including intro to fundamental electrical quantities and circuit analysis. Lab with reinforcing experiments, introduction to electrical test equipment, computer simulation techniques, and team project.
Prerequisites: Math 116(C).
Course Rules: Counts as repeat of ElecEng 299 with same topic.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

ELECENG 150 Electronic Technology in the World Around Us
3 cr. Undergraduate.
An introductory course that explains the modern technology affecting our everyday life. Topics include: digital communication, satellites, television, stereo system, computer, radar, microwaves, lasers.
Prerequisites: none.
General Education Requirements: NS
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

ELECENG 234 Analytical Methods in Engineering
4 cr. Undergraduate.
Prerequisites: Grade of C or better in Math 232(P).
Current Offerings: http://uwm.edu/schedule

ELECENG 299 Topics in Electrical Engineering:
1-3 cr. Undergraduate.
Work on new material in electrical engineering. Section title and credits announced whenever course is offered.
Prerequisites: specific courses dependent on topic.
Course Rules: May be retaken w/chg in topic to max of 6 cr max.
Last Taught: Fall 2011, Fall 2010, Fall 2005, Fall 1998.
Current Offerings: http://uwm.edu/schedule

ELECENG 301 Electrical Circuits I
3 cr. Undergraduate.
Circuit laws and analysis, resistive circuits, energy storage, AC circuits and power, three-phase circuits, computer-aided analysis.
Prerequisites: Physics 210(C) or 220(C).
Current Offerings: http://uwm.edu/schedule

ELECENG 305 Electrical Circuits II
4 cr. Undergraduate.
Transformers, transient response, network functions, s-domain, response, filters, fourier analysis, two-ports. 3 hr Lec/2 hr Lab.
Prerequisites: ElecEng 330(P), ElecEng 301(C).
Current Offerings: http://uwm.edu/schedule

ELECENG 306 Introduction to Electrical Engineering
4 cr. Undergraduate.
An introduction to electrical circuits with laboratory. Topics include dc and ac circuits, signal transients, motors, transformers and operational amplifiers.
Prerequisites: Physics 210(P); ElecEng 234(P).
Last Taught: Spring 2016, Fall 2015, Spring 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

ELECENG 310 Signals and Systems
3 cr. Undergraduate.
Analysis techniques for signals and systems in both continuous and discrete time. Signal representation, including fourier and laplace transforms; system definitions and properties.
Prerequisites: ElecEng 305(C).
Current Offerings: http://uwm.edu/schedule

ELECENG 330 Electronics I
4 cr. Undergraduate.
Op-amps, diodes, bipolar junction transistors, mos field effect circuit applications.
Prerequisites: ElecEng 305(C).
Course Rules: Counts as repeat of ElecEng 331.
Current Offerings: http://uwm.edu/schedule

ELECENG 335 Electronics II
4 cr. Undergraduate.
CMOS Logic Gates, Differential and multistage amplifiers, IC techniques, frequency response.
Prerequisites: ElecEng 330(P), 310(C).
Course Rules: Counts as repeat of ElecEng 332.
Current Offerings: http://uwm.edu/schedule
ELECENG 354 Digital Logic  
3 cr. Undergraduate.  
Number systems and binary codes; Boolean Algebra and basic results;  
switching functions; minimization techniques; analysis and design of  
combinational and sequential logic circuits.  
**Prerequisites:** CompSci 240(P) or 250(201)(P).  
**Last Taught:** Spring 2018, Fall 2017, Summer 2017, Spring 2017.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 361 Electromagnetic Fields  
3 cr. Undergraduate.  
Principles of electrostatics and electromagnetics; laws of fields;  
resistance, inductance, and capacitance; dielectrics; energy storage;  
Maxwell’s field equation.  
**Prerequisites:** grade C or better in Physics 210(P) & 215(P) or Physics 220(P); ElecEng 234(P); grade C or better in Math 233(P).  
**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 362 Electromechanical Energy Conversion  
4 cr. Undergraduate.  
Principles of electrical and electromechanical energy conversion;  
transformers, polyphase induction and synchronous machines, d.c.  
machines, single phase motors, including design parameters and testing;  
with lab (3 hr lec recitation & 2 hr lab per week).  
**Prerequisites:** ElecEng 305(P) & ElecEng 361(P).  
**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 367 Introduction to Microprocessors  
4 cr. Undergraduate.  
Fundamentals of microprocessors, including assembly language  
programming, hardware design, interfacing peripherals and  
programmable I/O devices, and social/ethical issues in engineering  
design and practice. Lab.  
**Prerequisites:** CompSci 240(P) or 250(201)(P); & C or better in ElecEng 354(P).  
**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 410 Digital Signal Processing  
3 cr. Undergraduate/Graduate.  
Spectral computation including DFT and FFT, sampling of continuous  
signals, digital filter design including FIR and IIR filters.  
**Prerequisites:** jr st, ElecEng 310(P).  
**Last Taught:** Fall 2017, Fall 2016, Fall 2015, Fall 2014.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 420 Random Signals and Systems  
3 cr. Undergraduate/Graduate.  
Fundamental probability and random process theory, power spectral  
density. Linear systems and random signals, auto- and cross-correlation,  
optimum MSE filter design.  
**Prerequisites:** jr st, ElecEng 310(P); or grad st.  
**General Education Requirements:** QLB  
**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 421 Communication Systems  
3 cr. Undergraduate/Graduate.  
Basic concepts of information; modulation, transmission and  
demodulation; presentation of information; practical communication  
systems.  
**Prerequisites:** jr st, ElecEng 335(C).  
**Last Taught:** Spring 2016, Spring 2015, Spring 2014, Spring 2010.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 430 Energy Modeling  
3 cr. Undergraduate/Graduate.  
Electrical/thermal energy modeling through lectures and hands-on  
classroom work along with use of energy modeling software.  
**Prerequisites:** jr st; or cons instr.  
**Course Rules:** Jointly offered with and counts are repeat of MechEng 430.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 436 Introduction to Medical Instrumentation  
3 cr. Undergraduate/Graduate.  
Biopotential signals and electrodes; Biopotential Amplifiers and  
Signal Processing; Sensors, Detectors, and Sources; Electrical Safety;  
Specifications; Error Analysis; Device Approval Process.  
**Prerequisites:** jr st; ElecEng 305(P) or equiv.  
**Last Taught:** Spring 2016, Spring 2012, Fall 2010, Fall 2008.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 437 Introduction to Biomedical Imaging  
3 cr. Undergraduate/Graduate.  
Biomedical imaging modalities and underlying principles: X-radiography,  
computed tomography, Radon transforms; image reconstruction  
techniques; ultrasonic imaging; nuclear medicine; magnetic resonance  
imaging; experimental techniques.  
**Prerequisites:** sr st; ElecEng 310(P) or equiv.  
**Last Taught:** Fall 2017, Fall 2014, Fall 2013, Fall 2011.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 439 Introduction to Biomedical Optics  
3 cr. Undergraduate/Graduate.  
Tissue Optical Properties, Light Transport, Fourier Transforms in Spatial  
Domain, Wave theory, Spectroscopy, Optical imaging, Laser-Tissue  
interaction, Photoconversion, Photodynamic Therapy, Microscopy,  
Fluorescence imaging, and OCT.  
**Prerequisites:** jr st; ElecEng 310(P) & 361(P).  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 451 Introduction to VLSI Design  
3 cr. Undergraduate/Graduate.  
Introduction to design of VLSI circuits. Ic fundamentals including: energy  
band diagrams, transistor optimization, design approaches including both  
customs and semi-custom.  
**Prerequisites:** jr st; ElecEng 330(P), 354(P).  
**Last Taught:** Fall 2017, Fall 2015, Fall 2014, Fall 2013.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

ELECENG 457 Digital Logic Laboratory  
3 cr. Undergraduate/Graduate.  
Digital design using a hardware description language and FPGAs. Topics  
include VHDL, Design Methodologies, Finite State Machines, Multiple  
clock domains, Timing Analysis, Simulation and Verification.  
**Prerequisites:** jr st, ElecEng 354(P).  
**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)
ELECENG 458 Computer Architecture
3 cr. Undergraduate/Graduate.
Processor organization and design; memory organization; microprogramming and control unit design; I-O organization; case studies of selected machine architectures.
Prerequisites: jr st; ElecEng 354(P), C or better in CompSci 315(P) or ElecEng 367(P).
Course Rules: Jointly offered with & counts as repeat of CompSci 458.
Current Offerings: http://uwm.edu/schedule

ELECENG 461 Microwave Engineering
3 cr. Undergraduate/Graduate.
Review from electromagnetics, transmission lines and waveguides; impedance matching, passive components, stripline and microstrip line circuits, dielectric waveguide, laboratory experiments, industrial and biomedical applications.
Prerequisites: jr st; ElecEng 361(P) or equiv.
Last Taught: Fall 2016, Fall 2015, Fall 2014, Fall 2013.
Current Offerings: http://uwm.edu/schedule

ELECENG 462 Antenna Theory
3 cr. Undergraduate/Graduate.
Analysis and design of antennas: antenna fundamentals; wire antennas; dipole, monopole, and loop antennas; antenna arrays; aperture antennas; horn, slot, and parabolic dish antennas.
Prerequisites: jr st; ElecEng 361(P).
Last Taught: Spring 2015, Fall 2013, Spring 2012, Spring 2011.
Current Offerings: http://uwm.edu/schedule

ELECENG 464 Fundamentals of Photonics
3 cr. Undergraduate/Graduate.
Fundamentals of ray, electromagnetic, and beam optics; polarization and polarization-based devices; optics of layered media; and guided-wave optics, including optical fibers.
Prerequisites: jr st & ElecEng 361(P); or grad st.
Last Taught: Fall 2015, Fall 2014, Fall 2012.
Current Offerings: http://uwm.edu/schedule

ELECENG 465 Broadband Optical Networks
3 cr. Undergraduate/Graduate.
Multichannel lightwave systems based on wavelength-division, time-division, and subcarrier multiplexing; optical devices and coding techniques for implementing optical networks.
Prerequisites: jr st; ElecEng 305(P) & 361(P); or grad st.
Course Rules: Counts as repeat of ElecEng 490(690) w/same topic.
Current Offerings: http://uwm.edu/schedule

ELECENG 471 Electric Power Systems
3 cr. Undergraduate/Graduate.
Elements of a typical power system. Per-unit quantities; load flow study; economic dispatch; symmetrical components; fault study; system protection; stability.
Prerequisites: jr st; ElecEng 362(C).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

ELECENG 472 Introduction to Wind Energy
3 cr. Undergraduate/Graduate.
Principles of wind turbines; wind characteristics; rotor dynamics of wind turbines; turbine design and integration; controls and electrical systems; grid connection.
Prerequisites: jr st; or cons instr.
Course Rules: MechEng 472 & ElecEng 472 are jointly offered; they count as repeats of one another.
Last Taught: Fall 2016, Fall 2015.
Current Offerings: http://uwm.edu/schedule

ELECENG 474 Introduction to Control Systems
4 cr. Undergraduate/Graduate.
Modeling of continuous systems; stability considerations, analysis and design of feedback control systems in time and frequency domains.
Prerequisites: jr st; ElecEng 310(P), CompSci 240 (P); or grad st.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

ELECENG 481 Electronic Materials
3 cr. Undergraduate/Graduate.
Prerequisites: jr st; MatlEng 201(P) or cons instr.
Course Rules: MatlEng 481 and ElecEng 481 are jointly offered; they count as repeats of one another.
Current Offerings: http://uwm.edu/schedule

ELECENG 482 Introduction to Nanoelectronics
3 cr. Undergraduate/Graduate.
Wave properties of electrons, diffraction, Schrödinger's equation, quantum confinement, band theory, tunnel junctions, Coulomb blockade, quantum dots and wires, quantum conductance and ballistic transport.
Prerequisites: jr st; ElecEng 330(C), ElecEng 361(C).
Last Taught: Fall 2016, Fall 2011.
Current Offerings: http://uwm.edu/schedule

ELECENG 490 Topics in Electrical Engineering:
1-3 cr. Undergraduate/Graduate.
Specific topics, credits, and any additional prerequisites will be announced in the Schedule of Classes each time the course is offered.
Prerequisites: jr st.
Course Rules: May be retaken w/chg in topic to max of 9 cr.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

ELECENG 541 Integrated Circuits and Systems
3 cr. Undergraduate/Graduate.
Prerequisites: jr st; ElecEng 330(P).
Current Offerings: http://uwm.edu/schedule
ELECENG 545 FPGA Embedded CPUs & Firmware Development  
3 cr. Undergraduate/Graduate.  
Use of modern embedded system central processor units (CPUs) with integrated field-programmable gate arrays (FPGAs). Design and implementation of firmware for these devices.  
**Prerequisites:** jr st; ElecEng 367(P) & 457(P).  
**Course Rules:** Jointly offered with & counts as repeat of ElecEng 545.  
**Last Taught:** Spring 2018, Spring 2017, Fall 2016, Fall 2015.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 562 Telecommunication Circuits  
3 cr. Undergraduate/Graduate.  
Radio frequency communication systems, terrestrial and satellite communication systems, mixers, oscillators, filters, design considerations for receivers and transmitters.  
**Prerequisites:** sr st; ElecEng 336(P).  
**Last Taught:** Fall 2011, Spring 2010, Spring 2008, Spring 2006.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 565 Optical Communication  
3 cr. Undergraduate/Graduate.  
Overview of communication systems, light and electromagnetic waves, optical fibers, lasers, led, photodetectors, receivers, optical fiber communication systems.  
**Prerequisites:** sr st; ElecEng 361(P), & 330(P) or 465(P).  
**Last Taught:** Spring 2016, Spring 2015, Spring 2013, Fall 2011.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 568 Applications of Digital Signal Processing  
3 cr. Undergraduate/Graduate.  
Introduction to the use of modern digital signal processor (DSP) units in DSP applications such as digital filtering and speech signal processing.  
**Prerequisites:** ElecEng 310(P), 367(P).  
**Course Rules:** Counts as repeat of ElecEng 490 and 890 w/similar topic;  
**Last Taught:** Spring 2018.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 572 Power Electronics  
3 cr. Undergraduate/Graduate.  
Power diodes and transistors; static converters; D.C. power supplies; power transistor circuits; SCR's; classical and modern forced-commutation inverters; choppers; cycloconverters, applications in power.  
**Prerequisites:** sr st; ElecEng 335(C).  
**Last Taught:** Spring 2018, Fall 2017, Fall 2016, Fall 2015.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 574 Intermediate Control Systems  
3 cr. Undergraduate/Graduate.  
State space; frequency domain methods of modelling, analysis and design of control systems; digital control; and multivariate systems.  
**Prerequisites:** sr st; MechEng 474(P) or ElecEng 474(402P); or grad st.  
**Course Rules:** ElecEng 574(503) & MechEng 574(478) are jointly offered & count as repeats of each other. Not open for cr to students who have cr in ElecEng 503(ER) or MechEng 478(ER).  
**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 575 Analysis of Electric Machines and Motor Drives  
3 cr. Undergraduate/Graduate.  
Reference frame analysis, computer simulation, permanent magnet synchronous machines, induction machines, power electronic inverters, pulswidth modulation, vector control.  
**Prerequisites:** jr st, ElecEng 330(P) & 362(P).  
**Last Taught:** Spring 2017, Spring 2016, Spring 2015, Spring 2014.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 588 Fundamentals of Nanotechnology  
3 cr. Undergraduate/Graduate.  
Nanofabrication, self-assembly, principles of scanning tunneling/atomic force microscopy, operators, energy quantization; density of states, quantum dots, nanowires, carbon nanotubes: electronic properties and applications.  
**Prerequisites:** jr st; non-ElecEng majors; ElecEng 361(P) or equiv.  
**Last Taught:** Fall 2014, Fall 2012, Fall 2009, Fall 2008.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 595 Capstone Design Project  
4 cr. Undergraduate.  
Team project in simulated industrial environment. Each team develops solutions to complex real world design problems and reports results in professional writing and oral presentation.  
**Prerequisites:** sr st; ElecEng 335(P), ElecEng 367(P).  
**Course Rules:** Counts as repeat of ElecEng 355.  
**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 599 Senior Thesis  
1-3 cr. Undergraduate.  
Independent research under the direction of a faculty member; submission of a written thesis is required. 3 cr total required.  
**Prerequisites:** sr st & cons instr.  
**Course Rules:** May be retaken to max of 3 cr.  
**Last Taught:** Fall 2014, Spring 2014, Spring 1997, Fall 1990.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 699 Independent Study  
1-3 cr. Undergraduate/Graduate.  
**Prerequisites:** jr st; cons instr.  
**Course Rules:** May be retaken to max of 6 cr toward the undergraduate degree.  
**Last Taught:** Spring 2018, Fall 2017, Summer 2017, Spring 2017.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)

ELECENG 700 CEAS Graduate Seminar  
1-3 cr. Graduate.  
Seminar in professional ethics, oral and written communication, contemporary social issues, career development, time management, and laboratory safety.  
**Prerequisites:** grad st  
**Course Rules:** Civ Eng 700, CompSci 700, ElecEng 700, Ind Eng 700, MatEng 700 & MechEng 700 are jointly offered and count as repeats of one another  
**Last Taught:** Spring 2018, Fall 2017, Spring 2017, Fall 2016.  
**Current Offerings:** [http://uw.edu/schedule](http://uw.edu/schedule)
ELECENG 701 Advanced Linear System Analysis
3 cr. Graduate.
Theory and analysis of linear dynamic systems; discrete and continuous state models; linear algebra for dynamic systems; state transition matrix, numerical methods; and applications.
Prerequisites: grad st.
Course Rules: ElecEng 701 & MechEng 701 are jointly offered and count as repeats of one another.
Last Taught: Fall 2016, Fall 2015, Fall 2014, Fall 2013.
Current Offerings: http://uwm.edu/schedule

ELECENG 710 Artificial Intelligence
3 cr. Graduate.
Programming, search techniques game playing, knowledge representation, knowledge acquisition, expert systems. Selected topics from learning, Natural language understanding, vision and robotics.
Prerequisites: grad st; CompSci 252 & 535.
Course Rules: Not open to students who have cr in CompSci 710.
Last Taught: Spring 2016, Fall 2014, Fall 2012, Fall 2011.
Current Offerings: http://uwm.edu/schedule

ELECENG 711 Introduction to Machine Learning
3 cr. Graduate.
Introduction to machine learning techniques and applications, including optimal classification, regression, support vector machines, boosting, deep learning, and clustering.
Prerequisites: grad st
Course Rules: Not open to students who have cr in CompSci 711 which is identical to Eleceng 711.
Last Taught: Fall 2017, Spring 2016, Fall 2013, Spring 2011.
Current Offerings: http://uwm.edu/schedule

ELECENG 712 Image Processing
3 cr. Graduate.
This course covers the materials required to process and enhance photographic images, remote sensor multispatial scanner data and others. Topics include transform techniques, recorders, discriminate function, and associated hardware.
Prerequisites: grad st
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2013.
Current Offerings: http://uwm.edu/schedule

ELECENG 713 Computer Vision
3 cr. Graduate.
Fundamental issues and current research in computer vision. Topics in early or low-level vision, intermediate vision or perceptual organization, and high-level vision or object recognition.
Prerequisites: grad st; ElecEng 410(P) or cons instr.
Course Rules: Jointly offered w/ and counts as a repeat of CompSci 713.
Last Taught: Fall 2005.
Current Offerings: http://uwm.edu/schedule

ELECENG 716 Tomography: Imaging and Image Reconstruction
3 cr. Graduate.
In-depth examination of the fundamentals of tomographic imaging and tomographic image reconstruction algorithms.
Prerequisites: grad st; ElecEng 410 (P) & ElecEng 420 (P)
Current Offerings: http://uwm.edu/schedule

ELECENG 717 Tomography: Image Quality and Artifact Correction
3 cr. Graduate.
In depth study of the factors affecting tomographic image quality. State-of-the-art techniques and practices for artifact correction.
Prerequisites: grad st; ElecEng 716 (P)
Last Taught: Spring 2014.
Current Offerings: http://uwm.edu/schedule

ELECENG 718 Nonlinear Control Systems
3 cr. Graduate.
Advanced concepts and methodologies in modeling and design of nonlinear control systems. Lyapunov theory; describing functions; variable structure control.
Prerequisites: grad st; ElecEng or MechEng474(P) or equiv; ElecEng or MechEng 701(P); or cons instr.
Course Rules: ElecEng 718 & MechEng718 are jointly offered and count as repeats of one another. Not open for credit to students w/ cr in MechEng 778.
Current Offerings: http://uwm.edu/schedule

ELECENG 721 Digital Communications
3 cr. Graduate.
Fundamentals of design and analysis of digital communication systems in the presence of noise; application of satellite, phone, and computer communication systems.
Prerequisites: grad st, ElecEng 421 or cons instr.
Last Taught: Spring 2011, Fall 2009, Fall 2007, Fall 2004.
Current Offerings: http://uwm.edu/schedule

ELECENG 733 Sensors and Systems
3 cr. Graduate.
Physical principles and working of sensors, interfacing, and sensor networks.
Prerequisites: grad st; ElecEng 305 or cons. instr.; Jointly offered with & counts as repeat of BME 733 & MechEng 733.
Last Taught: Fall 2017.
Current Offerings: http://uwm.edu/schedule

ELECENG 737 Medical Imaging Signals and Systems
3 cr. Graduate.
Medical imaging physics; physical parameters of imaging systems; imaging system models; physical measurements; image reconstruction; image characteristics; biomedical applications.
Prerequisites: grad st; ElecEng 310(P) and Physics 210(P), or cons instr.
Last Taught: Fall 2009.
Current Offerings: http://uwm.edu/schedule

ELECENG 741 Electromagnetic Fields and Waves
3 cr. Graduate.
Propagation, radiation and scattering of electromagnetic waves and their applications in electrical engineering.
Prerequisites: grad st; Eleceng 361 or equiv.
Last Taught: Fall 2013, Fall 2010, Fall 2009, Fall 2005.
Current Offerings: http://uwm.edu/schedule
ELECENG 742 Electromagnetic Wave Theory
3 cr. Graduate.
Electromagnetics of layered media and open waveguides; surface waves, radiation modes, and plasmons; asymptotic methods; Dyadic green's functions; integral equation methods
Prerequisites: Grad st; ElecEng 361(P).
Current Offerings: http://uwm.edu/schedule

ELECENG 755 Information and Coding Theory
3 cr. Graduate.
Information measures, entropy, source coding, shannon's theorems, channel capacity, error correcting codes, linear codes, convolutional codes, arithmetic codes, encoding and decoding algorithms.
Prerequisites: grad st.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

ELECENG 758 Advanced Computer Architecture
3 cr. Graduate.
Advanced topics in computer architecture including pipeline processing, multiple and parallel processing systems, performance enhancement issues and vlsi computing structures.
Prerequisites: grad st; CompSci 458 or ElecEng 458.
Course Rules: Not open for cr to students with cr in CompSci 758, which is identical to ElecEng 758.
Last Taught: Fall 2013.
Current Offerings: http://uwm.edu/schedule

ELECENG 760 Computer Systems Performance Evaluation
3 cr. Graduate.
Performance measurement and tools, workload characterization, markov models, queueing theory, simulation, benchmarks, data analysis, parallel systems performance analysis.
Prerequisites: grad st; & CompSci 458(P) or ElecEng 458(P).
Course Rules: Not open to students who have cr in CompSci 760, which is the same as ElecEng 760.
Last Taught: Fall 2017, Fall 2016, Fall 2014, Spring 2013.
Current Offerings: http://uwm.edu/schedule

ELECENG 762 Fault-Tolerant Computing
3 cr. Graduate.
Faults in digital circuits, fault detection, fault location, system reconfiguration or repair, system recovery, design for testability, self-checking circuits, fault-tolerant interconnection networks, systems level fault-diagnosis, fault-tolerant software.
Prerequisites: grad st; ElecEng 354.
Course Rules: Not open to students with cr in CompSci 762, which is identical to ElecEng 762.
Current Offerings: http://uwm.edu/schedule

ELECENG 765 Introduction to Fourier Optics and Optical Signal Processing
3 cr. Graduate.
Two dimensional linear systems, scalar diffraction theory, imaging properties of lenses, optical imaging systems, spatial filtering, wavefront reconstruction.
Prerequisites: grad st; ElecEng 310(P) & 361(P)
Current Offerings: http://uwm.edu/schedule

ELECENG 766 Introduction to Nonlinear Optics
3 cr. Graduate.
Characteristics and efficiency of various nonlinear optical processes that find applications in communications, signal processing and computing. Topics include optical switching devices, mixers and solitons.
Prerequisites: grad st; ElecEng 361(P).
Current Offerings: http://uwm.edu/schedule

ELECENG 781 Advanced Synchronous Machinery
3 cr. Graduate.
Machine construction, direct and quadrature axis reactances, steady state performance, unbalanced operating conditions, transient performance, motor starting, standards.
Prerequisites: ElecEng 362.
Current Offerings: http://uwm.edu/schedule

ELECENG 810 Advanced Digital Signal Processing
3 cr. Graduate.
Prediction and optimum filters; lattice structures; adaptive filters; deconvolution techniques, spectrum estimation, applications.
Prerequisites: grad st; ElecEng 410(P).
Last Taught: Spring 2015, Fall 2011, Spring 2010, Fall 2008.
Current Offerings: http://uwm.edu/schedule

ELECENG 816 Optimal Control Theory
3 cr. Graduate.
Analysis and synthesis of discrete and continuous optimal control systems; linear quadratic regulators; dynamic programming and variational methods; applications.
Prerequisites: grad st; ElecEng or MechEng474(P) or equiv; ElecEng or MechEng 701(P); or cons instr.
Course Rules: ElecEng 816 & MechEng 816 are jointly offered and count as repeats of one another.
Current Offerings: http://uwm.edu/schedule

ELECENG 819 Adaptive Control Theory
3 cr. Graduate.
Adaptive control systems including mathematical foundations, estimation, model reference adaptive control, self tuning regulators, numerical methods, applications.
Prerequisites: grad st; ElecEng or MechEng474(P) or equiv; ElecEng or MechEng 701(P); or cons instr.
Course Rules: ElecEng 819 & MechEng 819 are jointly offered and count as repeats of one another.
Current Offerings: http://uwm.edu/schedule

ELECENG 872 Computer Analysis of Electric Power Systems
3 cr. Graduate.
Graph theory, matrix algebra and numerical analysis applied to computer solution of power system problems; mathematical models; algorithms and solution techniques for load flow and fault studies.
Prerequisites: grad st & ElecEng 471.
Current Offerings: http://uwm.edu/schedule
ELECENG 880 Bioengineering Seminar
1 cr. Graduate.
Presentations by bioengineering affiliated faculty, invited speakers, and graduate students.
Prerequisites: grad st
Course Rules: MechEng 880, ElecEng 880, CompSci 880, MatEng 880, IndEng 880 & Civ Eng 880 are jointly offered and count as repeats of one another. May be repeated to 3 cr. max.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

ELECENG 888 Candidate for Degree
0 cr. Graduate.
Available for graduate students who must meet minimum credit load requirement.
Prerequisites: grad st.
Course Rules: Fee for 1 cr assessed.
Last Taught: Summer 2017, Spring 2017, Summer 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

ELECENG 890 Special Topics:
3 cr. Graduate.
Lectures on special topics in electrical engineering. Variable content course. Specific topics and any additional prerequisites will be announced in the schedule of classes each time the course is offered.
Prerequisites: grad st.
Course Rules: May be repeated w/ chg in topic to 9 cr max.
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: http://uwm.edu/schedule

ELECENG 990 Masters Thesis
1-9 cr. Graduate.
Prerequisites: grad st; cons instr.
Current Offerings: http://uwm.edu/schedule

ELECENG 998 Doctoral Thesis
1-12 cr. Graduate.
Prerequisites: grad st; cons instr & grad prog comm.
Current Offerings: http://uwm.edu/schedule

ELECENG 999 Advanced Independent Study
1-3 cr. Graduate.
Prerequisites: grad st & cons instr.
Current Offerings: http://uwm.edu/schedule

Faculty

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
<th>Degree</th>
<th>School</th>
<th>Graduate Faculty</th>
<th>Emeritus Faculty</th>
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<tr>
<td>Brian Armstrong</td>
<td>Professor</td>
<td>PhD</td>
<td>Stanford University</td>
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<tr>
<td>John T. Boyland</td>
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<td>Christine T. Cheng</td>
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<td>Robert Cuzner</td>
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<td>Adrian Dumitrescu</td>
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<td>George Hanson</td>
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<td>Charles E. Kahn Jr.</td>
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<tr>
<td>Jayson Rock</td>
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<tr>
<td>Lingfeng Wang</td>
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