

# EENG Electrical Engineering

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## **EENG 3230 Electromagnetic Fields**

**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A study of electromagnetic fields theory and applications including Coulomb's law, Gauss' law, Divergence Theorem, potentials, polarizations, conductance, capacitances, boundary conditions, Ampere's law, Biot savart law, Faraday's law, Maxwell's equations, uniform plane and wave propagation.

**Prerequisite(s):** A minimum grade of "C" in MATH 2243 and prior or concurrent enrollment in ENGR 2334.

## **EENG 3241 Electric Machines w/Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

The concepts of electric machines and their operational characteristics are covered with emphasis on different types of DC/AC motors and generators including single-phase and three-phase transformers. The course also includes laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in all of the following: EENG 3230 and prior or concurrent enrollment in EENG 3345 or EENG 3335.

## **EENG 3337 Power Systems Fundamentals**

**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is designed to introduce students to the basic concepts of electric power systems. Single-phase and 3-phase networks, electric power generation, transformers, transmission lines, and power flow analysis including stability and fault analysis are thoroughly covered. Additional topics dealing with conventional energy sources, electricity market, and regulations affecting the power sector are introduced and discussed. Students are expected to perform power flow simulations using Power World Software and/or other professional programming tools for power system studies.

**Prerequisite(s):** Prior with a minimum grade of "C" or concurrent enrollment in EENG 3241.

## **EENG 3340 Microcontrollers with Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

Fundamental concepts of microcontroller architecture, including the Central Processing Unit (CPU), memory devices (ROM & RAM), Input/output peripheral devices and sensor interfacing. Students learn to write programs in C and Assembly languages used to implement real practical applications using microprocessors. The course includes laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in ENGR 1732, ENGR 2323 and ENGR 2332.

## **EENG 3341 Microelectronics with Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

A study of the characteristics and design of bipolar junction and metal oxide semi-conductor integrated circuit devices with emphasis on commercial and industrial applications including operational amplifiers, digital logic, and solid state memory.

**Prerequisite(s):** A minimum grade of "C" in (EENG 3345 or EENG 3335) and CHEM 1310 or equivalent.

## **EENG 3345 Circuit Analysis II with Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

The course focuses on advanced topics in circuit analysis and design. Topics include Phasor analysis, three-phase systems, AC steady-state power, transformers, transfer functions, Bode plots, passive and active filters, Laplace and Fourier transforms, and two-port networks.

**Prerequisite(s):** A minimum grade of "C" in ENGR 2334.

## **EENG 3420 Linear Systems**

**2 Credit Hours. 2 Lecture Hours. 0 Lab Hours.**

The mathematical foundations and modeling techniques to solve linear systems are covered in this course. Topics include vectors and matrices, eigenvalues and eigenvectors, Fourier series, Fourier transform, Laplace transform, and Z-transform. Several engineering applications in control and communication systems are provided.

**Prerequisite(s):** A minimum grade of "C" in MATH 3230 and prior or concurrent enrollment in EENG 3345.

## **EENG 3421 Advanced Engineering Analysis**

**2 Credit Hours. 2 Lecture Hours. 0 Lab Hours.**

This course offers introduction to the basic concepts of probability within engineering systems such as discrete and continuous random variables and their properties. This course also introduces the basic concepts of statistics and design of experiments such as randomization, replication, blocking, hypothesis Testing, Z-test, t-test, ANOVA, pair-wise comparisons, and randomized complete block designs. Matlab and Minitab software are used to support instruction.

**Prerequisite(s):** A minimum grade of "C" in MATH 2242.

## **EENG 4620 Senior Project I**

**2 Credit Hours. 0,2 Lecture Hours. 0,2 Lab Hours.**

This course is the first sequence of a two-semester long capstone project with emphasis on project research, design, simulation, development and team work, under real engineering constraints. Topics include background and state-of-the-art research on the particular topics of the projects, tasks scheduling, project management, and the research of ethical, environmental and sustainability issues related to the project. Students are required to work in teams, conduct research and start basic project design under the direction of a faculty advisor.

**Prerequisite(s):** A minimum grade of "C" in EENG 3340 and prior or concurrent enrollment in EENG 3341 and (EENG 5431 or 5540).

## **EENG 4621 Senior Project II**

**2 Credit Hours. 0,1 Lecture Hours. 0,2 Lab Hours.**

This course is the second sequence of a two-semester long capstone project with emphasis on project implementation. Students continue the implementation process of their projects including CAE/CAD software development, program writing, printed circuit board fabrication, systems testing, and performance evaluation. Course requirements include weekly progress meetings, oral presentations, a comprehensive final report, and a final project demonstration.

**Prerequisite(s):** A minimum grade of "C" in EENG 4620.

## **EENG 4890 Directed Study in Electrical and Computer Engineering**

**1-3 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

An individualized study involving research and applications pertaining to Electrical Engineering or Computer Engineering.

**Prerequisite(s):** Prior study form as approved by instructor.

## **EENG 5090 Selected Topics in Electrical and Computer Engineering**

**1-4 Credit Hours. 0-3 Lecture Hours. 0-6 Lab Hours.**

Students in this course will have the opportunity to study selected topics in Electrical Engineering or Computer Engineering not currently offered by these programs.

**Prerequisite(s):** Permission of Instructor.

**Cross Listing(s):** EENG 5090G.

## **EENG 5090G Selected Topics in Electrical and Computer Engineering**

**4 Credit Hours. 0-3 Lecture Hours. 0-6 Lab Hours.**

Students in this course will have the opportunity to study selected topics in Electrical or Computer Engineering not currently offered by these programs. Graduate students will complete advanced research beyond the scope of the undergraduate requirements that demonstrates a higher level of mastery of the subject with additional required deliverables representative of graduate work, as determined by the instructor.

**Prerequisite(s):** Permission of instructor. Cross Listing(s): EENG 5090.

**EENG 5234 Nuclear Power System Fundamentals****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course introduces the basic principles, technologies and components of nuclear power systems. It provides a broad scientific and technological understanding of nuclear energy and the nuclear fuel cycle, understanding of economic, environmental, and political issues that influence the nuclear fuel cycle. This course focuses on nuclear power systems from an electrical power utility perspective with many of the topics applicable to other large commercial and industrial power systems.

**Prerequisite(s):** A minimum grade of "C" and prior enrollment in EENG 3337. Cross Listing(s): EENG 5234G.

**EENG 5234G Nuclear Power System Fundamentals****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course introduces the basic principles, technologies and components of nuclear power systems. It provides a broad scientific and technological understanding of nuclear energy and the nuclear fuel cycle, understanding of economic, environmental, and political issues that influence the nuclear fuel cycle. This course focuses on nuclear power systems from an electrical power utility perspective with many of the topics applicable to other large commercial and industrial power systems.

**Prerequisite(s):** A minimum grade of "C" and prior or concurrent enrollment in EENG 3337 or permission of instructor.

**Cross Listing(s):** EENG 5234.

**EENG 5235 Converters Control Techniques****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course presents the needed techniques for analyzing power electronic converters, modeling their dynamics, and designing and synthesizing various types of controllers for them, specifically employed in multi-terminal, hybrid ac/dc, smart grids, and their real-time implementation in digital real-time simulation platforms.

**Prerequisite(s):** A minimum grade of "C" in EENG 3337 and EENG 3420 and prior or concurrent enrollment in EENG 5431. Cross Listing(s): 5235G.

**EENG 5235G Converters Control Techniques****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course presents the needed techniques for analyzing power electronic converters, modeling their dynamics, and designing and synthesizing various types of controllers for them, specifically employed in multi-terminal, hybrid ac/dc, smart grids, and their real-time implementation in digital real-time simulation platforms. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3337 and EENG 3420 and prior or concurrent enrollment in EENG 5431 or permission of instructor.

**EENG 5242 Power Systems Protection with Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

This course offers a comprehensive study of methods and devices used in power system protection including relay types, responses, pilot wire, carrier systems, transmission lines, transformers, machines protection, and modern trends in protection technology. This course will review the need for protection of power system elements and explore the development and regulations of smarter, more flexible protective systems applied to modern power grids. Students will learn the trade-offs between reliability, selectivity, speed, simplicity, and economy using real world case studies. A hands-on lab project, using state of the art equipment, will also be completed during the course.

**Prerequisite(s):** A minimum grade of "C" in EENG 3337 or Permission of Instructor.

**Cross Listing(s):** EENG 5242G.

**EENG 5242G Power System Protection w/Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

This course offers a comprehensive study of methods and devices used in power system protection including relay types, responses, pilot wire, carrier systems, transmission lines, transformers, machines protection, and modern trends in protection technology. This course will review the need for protection of power system elements and explore the development and regulations of smarter, more flexible protective systems applied to modern power grids. Students will learn the trade-offs between reliability, selectivity, speed, simplicity, and economy using real world case studies. A hands-on lab project, using state of the art equipment, will also be completed during the course. Graduate students will be required to complete individual advanced level research in an area beyond the scope of the undergraduate requirements that demonstrates a higher level of mastery in the subject matter with additional required deliverables representative of graduate level work, as determined by the instructor.

**Prerequisite(s):** A minimum grade of "C" in EENG 3337 or Permission of Instructor.

**Cross Listing(s):** EENG 5242.

**EENG 5243 Power Electronics with Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

A coverage of the concepts of power electronics and converters including the use of thyristors, triacs, timers, logic control circuits, optical devices, and sensors. The course also includes laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in EENG 3241 and EENG 3341.

**Cross Listing(s):** EENG 5243G.

**EENG 5243G Power Electronics w/Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

A coverage of the concepts of power electronics and converters including the use of thyristors, triacs, timers, logic control circuits, optical devices, and sensors. The course also includes laboratory activities in support of instruction. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3241 and EENG 3341.

**Cross Listing(s):** EENG 5243.

**EENG 5244 Smart Grids Technology Fundamentals with Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

This course introduces new topics related to distributed generation, micro-grids, renewable energy sources, and smart homes applications. Topics covered include design, modeling, control, and analysis to provide a working knowledge of smart-grid systems. Concepts dealing with computational intelligence, decision support systems, smart metering, optimization, and renewable energy sources are presented and discussed. The laboratory component will provide students with hands-on experience in the utilization of smart-grid technologies and equipment.

**Prerequisite(s):** A minimum if "C" and prior or concurrent enrollment in EENG 3337 or permission of instructor.

**Cross Listing(s):** EENG 5244G.

**EENG 5244G Smart Grids Technology Fundamentals w/Lab  
4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

This course introduces new topics related to distributed generation, micro-grids, renewable energy sources, and smart homes applications. Topics covered include design, modeling, control, and analysis to provide a working knowledge of smart-grid systems. Concepts dealing with computational intelligence, decision support systems, smart metering, optimization, and renewable energy sources are presented and discussed. The laboratory component will provide students with hands-on experience in the utilization of smart-grid technologies and equipment. Graduate students will be required to complete individual advanced level research in an area beyond the scope of the undergraduate requirements that demonstrates a higher level of mastery in the subject matter with additional required deliverables representative of graduate level work, as determined by the instructor.

**Prerequisite(s):** A minimum grade of "C" and prior or concurrent enrollment in EENG 3337 or permission of instructor. Cross Listing(s): EENG 5244.

**EENG 5330 Network Science**

**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course introduces students to emerging technologies (such as smartphones, wiki, Facebook, YouTube, Twitter) that define our networked life while detailing the underlying engineering concepts governing their operation. This course includes an introduction to the basics of analytical and engineering techniques such as optimization, game/auction theory, graph analysis, and learning as applied to networked technologies. In addition, the course explains the use of these concepts to answer key practical questions pertaining to networks and their impacts on real-world engineering systems. **Prerequisite(s):** This course introduces students to emerging technologies (such as smartphones, wiki, Facebook, YouTube, Twitter) that define our networked life while detailing the underlying engineering concepts governing their operation. This course includes an introduction to the basics of analytical and engineering techniques such as optimization, game/auction theory, graph analysis, and learning as applied to networked technologies. In addition, the course explains the use of these concepts to answer key practical questions pertaining to networks and their impacts on real-world engineering systems. **Prerequisite(s):** A minimum grade of "C" and prior enrollment in EENG 3421 or permission of instructor. Cross Listing(s): 5330G.

**EENG 5330G Network Science**

**3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course introduces students to emerging technologies (such as smartphones, wiki, Facebook, YouTube, Twitter) that define our networked life while detailing the underlying engineering concepts governing their operation. This course includes an introduction to the basics of analytical and engineering techniques such as optimization, game/auction theory, graph analysis, and learning as applied to networked technologies. In addition, the course explains the use of these concepts to answer key practical questions pertaining to networks and their impacts on real-world engineering systems. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" and prior or concurrent enrollment in EENG 3421 or permission of instructor.

**Cross Listing(s):** EENG 5330.

**EENG 5341 Robotic Systems Design with Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

The principles of robotics are introduced with emphasis on mobile robots and applications. Topics include robot mechanical base design, motor control, sensor interfacing, robot navigation techniques and path planning. Students will work in teams to design and build mobile robotic systems for different applications. The course also includes laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in EENG 3340 or MENG 3521 or Permission of Instructor.

**Cross Listing(s):** EENG 5341G.

**EENG 5341G Robotic Systems Design w/Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

The basic elements of robotics are introduced with emphasis on mobile robots and applications. Topics include coordinate transformations, sensors, path planning, kinematics, effectors, and control. Students will work in teams to design and build increasingly complex robotic systems. The course also includes laboratory activities in support of instruction. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3340 or MENG 3521 or Permission of Instructor. Cross Listing(s): EENG 5341.

**EENG 5342 Computer Systems Design with Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

Digital computers with emphasis on design and simulation are covered including instruction set design, processor implementation, pipelining, cache design, memory hierarchy, and input/output. The course also includes laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in EENG 3340 or Permission of Instructor.

**Cross Listing(s):** EENG 5342G.

**EENG 5342G Computer Systems Design w/Lab**

**4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

Digital computers with emphasis on design and simulation are covered including instruction set design, processor implementation, pipelining, cache design, memory hierarchy, and input/output. The course also includes laboratory activities in support of instruction. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3340 or Permission of Instructor.

**Cross Listing(s):** EENG 5342.

**EENG 5341 Control Systems with Lab**

**3 Credit Hours. 0,2 Lecture Hours. 0,2 Lab Hours.**

Introduction to classical control theory and applications is presented with emphasis on feedback and its properties including the concept of stability, stability margins, and the different tools that can be used to analyze the system properties. Students will develop a working knowledge of the basic elements of linear control techniques. The course also includes laboratory activities in support of instruction. **Prerequisite(s):** A minimum grade of "C" in EENG 3420 or Permission of Instructor.

**Cross Listing(s):** EENG 5431G.

**EENG 5431G Control Systems with Lab**

**3 Credit Hours. 0,2 Lecture Hours. 0,2 Lab Hours.**

Introduction to classical control theory and applications is presented with emphasis on feedback and its properties including the concept of stability, stability margins, and the different tools that can be used to analyze the system properties. Students will develop a working knowledge of the basic elements of linear control techniques. The course also includes laboratory activities in support of instruction. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3420 or Permission of Instructor.

**Cross Listing(s):** EENG 5431.

**EENG 5432 Programmable Logic Controllers with Lab**

**3 Credit Hours. 0,2 Lecture Hours. 0,2 Lab Hours.**

Topics covered include sequential programmable logic controllers (PLC's) with emphasis on ladder diagrams, input/output devices, networking, and programming design through advanced functions. The course also includes laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in ENGR 2323 and EENG 3341.

**Cross Listing(s):** EENG 5432G.



**EENG 5432G Programmable Logic Controllers w/Lab  
3 Credit Hours. 0,2 Lecture Hours. 0,2 Lab Hours.**

Topics covered include sequential programmable logic controllers (PLC's) with emphasis on ladder diagrams, input/output devices, networking, and programming design through advanced functions. The course also includes laboratory activities in support of instruction. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3241 or MENG 3521 or Permission of Instructor.

**Cross Listing(s):** EENG 5432.

**EENG 5433 Machine Learning and Adaptive Control  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Machine Learning is one of the most widely applied technical fields in the academia and industry. The class covers fundamental algorithms in machine learning including linear regression, classification, neural networks, support vector machines, clustering, and introduction to reinforcement learning. This course also covers adaptive control algorithms: including direct and indirect adaptive control. Electrical Engineering applications are demonstrated in image processing, autonomous driving, and robotics. **Prerequisite(s):** A minimum grade of "C" in EENG 3421 and prior or concurrent enrollment in EENG 5431.

**Cross Listing(s):** EENG 5433G.

**EENG 5433G Machine Learning and Adaptive Control  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

Machine Learning is one of the most widely applied technical fields in the academia and industry. The class covers fundamental algorithms in machine learning including linear regression, classification, neural networks, support vector machines, clustering, and introduction to reinforcement learning. This course also covers adaptive control algorithms: including direct and indirect adaptive control. Electrical Engineering applications are demonstrated in image processing, autonomous driving, and robotics. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3421 and prior or concurrent in EENG 5431, or permission of instructor.

**Cross Listing(s):** EENG 5433.

**EENG 5434 Engineering Optimization Methods  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The course introduces the students to practical optimization methods for solving real-world applications and preparing them for a career in academia and industry. Topics to be covered include linear programming, unconstrained optimization, convex optimization, dynamic programming, and their applications to multiple electrical engineering systems.

**Prerequisite(s):** A minimum grade of "C" in EENG 3420 and prior or concurrent enrollment in EENG 5540.

**Cross Listing(s):** EENG 5434G.

**EENG 5434G Engineering Optimization Methods  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The course introduces the students to practical optimization methods for solving real-world applications and preparing them for a career in academia and industry. Topics to be covered include linear programming, unconstrained optimization, convex optimization, dynamic programming, and their applications to multiple electrical engineering systems. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3420 and prior or concurrent enrollment in EENG 5540.

**EENG 5532 Wireless Communications  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The concepts and techniques of wireless communication systems are covered in this course including propagation channels, communication link analysis, transceivers, signal processing, and multiple access schemes.

**Prerequisite(s):** A minimum grade of "C" in EENG 5540 and EENG 3230 or Permission of Instructor.

**Cross Listing(s):** EENG 5532G.

**EENG 5532G Wireless Communications  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

The concepts and techniques of wireless communication systems are covered in this course including propagation channels, communication link analysis, transceivers, signal processing, and multiple access schemes. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 3230 and EENG 5540 or Permission of Instructor.

**Cross Listing(s):** EENG 5532.

**EENG 5533 Optical Fiber Communications  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course offers introduction to the physics of optical fiber communication components and the applications to communication systems. Topics include light and its behavior in the fiber, fiber attenuation, dispersion and nonlinear effects, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications.

**Prerequisite(s):** A minimum grade of "C" in EENG 5540 or Permission of Instructor.

**Cross Listing(s):** EENG 5533G.

**EENG 5533G Optical Fiber Communications  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course offers an introduction to the physics of optical fiber communication components and the applications to communication systems. Topics include light and its behavior in the fiber, fiber attenuation, dispersion and nonlinear effects, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications. Graduate students will be required to complete an individual research project not required of undergraduate students.

**Prerequisite(s):** A minimum grade of "C" in EENG 5540 or Permission of Instructor.

**Cross Listing(s):** EENG 5533.

**EENG 5535 Electronic Warfare  
3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course covers the fundamental materials of electronic warfare (EW) including basic mathematical /physical concepts of EW, antenna parameters, various types of antennas, aperture, phased arrays, radar system, radar range resolution, radars range equations, radar wave equation, radar cross section (RCS), propagation, LPI signals, jamming, decoys, and simulation with CST and FEKO software.

**Prerequisite(s):** A minimum grade of "C" in EENG 3230 and ENGR 2341.

**Cross Listing(s):** EENG 5535G.

**EENG 5535G Electronic Warfare****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course covers the fundamental materials of electronic warfare (EW) including basic mathematical /physical concepts of EW, antenna parameters, various types of antennas, aperture, phased arrays, radar system, radar range resolution, radars range equations, radar wave equation, radar cross section (RCS), propagation, LPI signals, jamming, decoys, and simulation with CST and FEKO software. Graduate students will be required to complete individual advanced level research in an area beyond the scope of the undergraduate requirements that demonstrates a higher level of mastery in the subject matter with additional required deliverables representative of graduate level work, as determined by the instructor.

**Prerequisite(s):** A minimum grade of "C" in EENG 3230 and ENGR 2341.**Cross Listing(s):** EENG 5535.**EENG 5538 Cybersecurity for Networked Electrical and Electronics Systems****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is designed to introduce emerging topics related to cybersecurity for networked electrical & electronics systems and cyber-physical systems. The course will provide theoretical understanding and practical basis of cybersecurity for networked systems including Shannon's secrecy system, information-theoretic security, wiretrap channels, cyber-attacks on electrical and electronics systems (smart power grid, embedded systems, connected electric vehicles, space communications, etc.), general cybersecurity models, jamming and antijamming, broadcast/interference channels cooperative secrecy, interference and broadcast channel with confidential messages, cooperative secrecy, and security limits of Gaussian and wireless channels.

**Prerequisite(s):** A minimum grade of "C" in all of the following: ENGR 2332 and EENG 3421 or CSCI 5332 or IT 5434 or permission of instructor.**Cross Listing(s):** EENG 5538G.**EENG 5538G Cybersecurity for Networked Electrical and Electronics Systems****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course is designed to introduce emerging topics related to cybersecurity for networked electrical & electronics systems and cyber-physical systems. The course will provide theoretical understanding and practical basis of cybersecurity for networked systems including Shannon's secrecy system, information-theoretic security, wiretrap channels, cyber-attacks on electrical and electronics systems (smart power grid, embedded systems, connected electric vehicles, space communications, etc.), general cybersecurity models, jamming and antijamming, broadcast/interference channels cooperative secrecy, interference and broadcast channel with confidential messages, cooperative secrecy, and security limits of Gaussian and wireless channels. Graduate students will be required to complete individual advanced level research in an area beyond the scope of the undergraduate requirements that demonstrates a higher level of mastery in the subject matter with additional required deliverables representative of graduate level work, as determined by the instructor.

**Prerequisite(s):** A minimum grade of "C" in ENGR 2332 and EENG 3421 or CSCI 5332 or IT 5434.**Cross Listing(s):** EENG 5538.**EENG 5540 Communication Systems with Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

The theory and principles of communication systems are presented in this course. Topics covered include AM, FM, and PM modulation/demodulation, transmission and reception, noise and random processes, pulse modulation, and digital transmission techniques. Laboratory emphasizes hands-on modeling of modulation and demodulation techniques.

**Prerequisite(s):** Prior (with a minimum grade of "C") or concurrent enrollment in EENG 3421 or permission of instructor.**Cross Listing(s):** EENG 5540G.**EENG 5540G Communication Systems Communication Systems w/ Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

The theory and principles of communication systems are presented in this course. Topics covered include AM, FM, and PM modulation/demodulation, transmission and reception, noise and random processes, pulse modulation, and digital transmission techniques. Laboratory emphasizes hands-on modeling of modulation and demodulation techniques. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in all of the following: EENG 3421 and prior or concurrent enrollment in EENG 3420 or Permission of Instructor.**Cross Listing(s):** EENG 5540.**EENG 5541 Digital Communications with Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

Theory and applications of digital communications systems are covered. Topics include ASK, FSK, DPSK, QAM, signaling over AWGN, bandlimited and fading channels, inter-symbol interference, and error-correction codes. The course also includes hands-on laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in EENG 5540 or Permission of Instructor.**Cross Listing(s):** EENG 5541G.**EENG 5541G Digital Communications w/Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

Theory and applications of digital communications systems are covered. Topics include ASK, FSK, DPSK, QAM, signaling over AWGN, bandlimited and fading channels, inter-symbol interference, and error-correction codes. The course also includes hands-on laboratory activities in support of instruction. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** A minimum grade of "C" in EENG 5540 or Permission of Instructor.**Cross Listing(s):** EENG 5541.**EENG 5543 Antennas with Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

This course introduces basic concepts of dipoles and monopoles, solution to radiation problems, antenna parameters, different types of antennas, antenna aperture/array theory, radio wave propagation, impact of antenna performance in communication links. The course also includes laboratory activities in support of instruction.

**Prerequisite(s):** A minimum grade of "C" in EENG 3230.**Cross Listing(s):** EENG 5543G.**EENG 5543G Antennas w/Lab****4 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

This course introduces basic concepts of dipoles and monopoles, solution to radiation problems, antenna parameters, different types of antennas, antenna aperture/array theory, radio wave propagation, and impact of antenna performance in communication links. The course also includes laboratory activities in support of instruction. Graduate students will be required to complete additional assignments and a culminating research project commensurate with graduate level work that is not required of undergraduate students.

**Prerequisite(s):** A minimum grade of "C" in EENG 3230 or Permission of Instructor.**Cross Listing(s):** EENG 5543.**EENG 5891 Special Problems in Electrical and Computer Engineering****3 Credit Hours. 0-3 Lecture Hours. 0-2 Lab Hours.**

This course provides for specialized study in the area of Electrical and Computer Engineering not currently offered by these programs.

**Prerequisite(s):** As determined by Instructor.**Cross Listing(s):** EENG 5891G.

**EENG 5891G Special Problems in Electrical and Computer Engineering****3 Credit Hours. 0,3 Lecture Hours. 0,2 Lab Hours.**

This course provides for specialized study in the area of Electrical and Computer Engineering not currently offered by these programs. Graduate students will complete an independent research project which involves a written and oral presentation not required at the undergraduate level.

**Prerequisite(s):** As determined by Instructor.**Cross Listing(s):** EENG 5891.**EENG 7330 Advanced Electromagnetics****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course introduces fundamental concepts of wave propagation, polarization, radiation from sources, guided waves, transmission lines, smith charts, and numerical calculation techniques such as Finite-Difference Time-Domain (FDTD) method. The course includes research project activities.

**Prerequisite(s):** A minimum grade of "C" in EENG 3230 or Permission of Instructor.**EENG 7331 Advanced Digital Signal Processing****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

This course discusses advanced topics in digital signal processing such as implementation of discrete-time systems, design of FIR/IIR digital filters, sampling and reconstruction of signals, multi-rate digital signal processing, linear prediction and optimum linear filters, and power spectrum estimation.

**Prerequisite(s):** A minimum grade of "C" in ENGR 2341 or Permission of Instructor.**EENG 7332 Digital Control Systems****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

An understanding of the elements of digital control theory will be developed. Students will be introduced to discrete system modeling, sampled data systems, z-transforms, state-space system representation and discrete control designs. Advance topics include Neural Networks and Fuzzy Logic application to control and the use of software tools that can be used to design and analyze this kind of systems. Students will also develop practical applications of digital control systems. **Prerequisite(s):** A minimum grade of "C" in EENG 5431 or MENG 5536 or Permission of Instructor.

**EENG 7530 Research in Electrical Engineering****3 Credit Hours. 3 Lecture Hours. 0 Lab Hours.**

A study of modern research methods and their application to the preparation of the thesis and technical reports.

**Prerequisite(s):** Graduate Student Standing.**EENG 7890 Selected Topics in Electrical Engineering****1-6 Credit Hours. 1-4 Lecture Hours. 0-2 Lab Hours.**

This course is scheduled on an infrequent basis to explore special areas of electrical engineering.

**Prerequisite(s):** Graduate standing.**EENG 7891 Independent Study****1-3 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

Independent study is available for students to undertake individualized experimentation, research, study related to electrical engineering, or a capstone project. The specific topic will be approved by a faculty member in the program, and credit will be assigned commensurate with the magnitude of the study.

**Prerequisite(s):** Graduate student standing.**EENG 7895 Special Problems in Electrical Engineering****1-3 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

Individual and specialized study in the areas of electrical engineering not otherwise covered in the program. Students must submit a proposal of the special problem for approval by the faculty member of record. Credit will be assigned commensurate with the magnitude of the study.

**Prerequisite(s):** Graduate Student Standing.**EENG 7999 Thesis****1-6 Credit Hours. 0 Lecture Hours. 0 Lab Hours.**

This course focuses on the preparation and completion of the thesis.

**Prerequisite(s):** Graduate student standing.