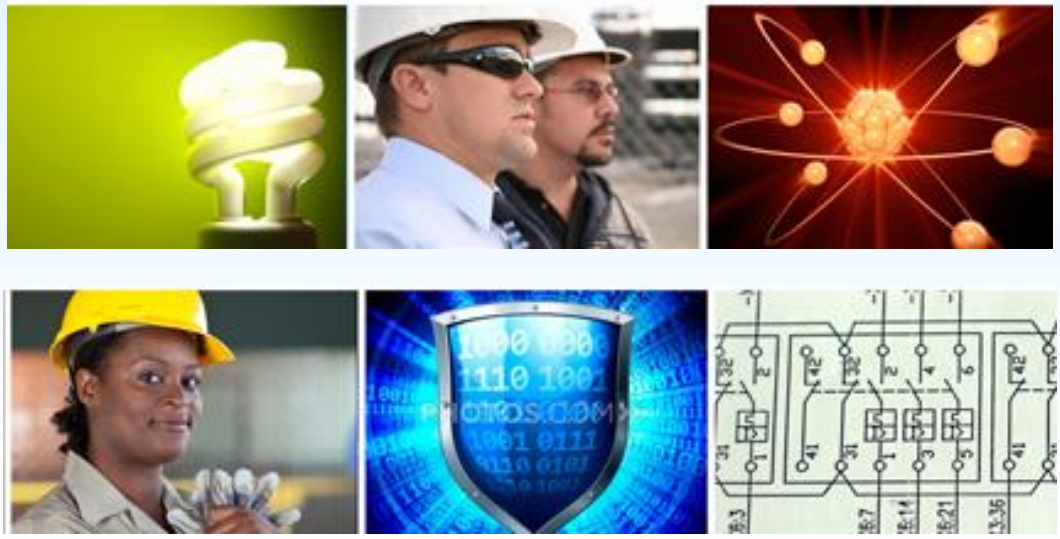
EPCE

ENERGY PROVIDERS COALITION FOR EDUCATION

EPCE Online Education Programs



BISMARCK STATE COLLEGE

WPI

CLEMSON UNIVERSITY

EXCELSIOR COLLEGE. *Start to Finish℠*

The Virtual High School

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Bismarck State College (BSC) Non-Credit Course Descriptions

Smart Grid Courses

Renewable Energy Sources and the Smart Grid
This course examines electricity production from various forms of renewable energy, and provides a survey of the function, operation and vision of the smart grid. Renewable energy sources including solar, wind, tidal, geothermal and others are studied in detail, covering availability, dispersion, methods of recovery, utilization and integration into the Smart Grid.

This is an online, self-study course with approximately 10-12 hours of content and is worth 1 Continuing Education Unit (CEU)

Operation Considerations for the Smart Grid
This course examines the operation considerations for the Smart Grid and will focus on understanding the operational considerations for technicians who will install, control, monitor, and maintain the smart grid. The course is designed to ensure that technicians working on the smart grid have a balanced understanding of why and how the smart grid will be operated, both from the utility perspective as well as the customer perspective. The course will cover technologies and systems utilized. It will also cover the skills needed to maintain the smart grid, along with addressing safety precautions needed. This course is divided into the following six modules:

1. Smart Grid: The Big Picture
2. Communications and Data of the Smart Grid
3. The Customer Side of the Smart Grid
4. The Utility Side of the Smart Grid
5. Controlling, Operating, and Monitoring the Smart Grid
6. Maintenance Needs of the Smart Grid

This is an online, self-study course with approximately 10-12 hours of content and is worth 1 Continuing Education Unit (CEU)

Impact of the Smart Grid
This course examines the business impacts of the Smart Grid. The course is focused on providing a comprehensive understanding of the overall business impacts to those that will be making decisions surrounding implementation of the smart grid and to those that will be governing and operating the smart grid itself. Some of the business impacts discussed will include: financial implications; emissions implications; assessing, weighing, and managing risk; customer knowledge and perspective regarding the smart grid; utility employee knowledge requirement changes; and methods to produce a quality business plan for a smart grid project.

This course is divided into the following five units:

- National and Societal Impacts
- Impacts on the Environment
- Impacts on Employees
- Impacts on Utilities
- Building the Smart Grid Business Case

This is an online, self-study course with approximately 10-12 hours of content and is worth 1 Continuing Education Unit (CEU)

Smart Grid, Smart Customer
The course is designed to provide customer service representatives and other industry employees with a brief, non-technical overview of what the smart grid is and what enhancements it will provide both the consumer and the electric power industry. The course begins with an overview of traditional and renewable generation sources,

the advantages and disadvantages of each, and the integration of renewable power on the grid. Basic difference will be reviewed between the design and operation of the traditional grid compared to today's much improved, evolving smarter grid. Lastly, the importance of consumer education and the changes that companies may experience from the spectrum of stakeholders will be discussed.

This is an online, self-study course with approximately 90 minutes of content.

Industry Preparation Courses

Orientation to the Electric Industry
This course will familiarize students with today's electrical industry. The course will begin looking at the history of the industry and at those who played major roles in its creation, development and structure. The course will familiarize students with the three sectors of the industry and the roles of each. Lastly the course will touch on deregulation, new technology and what the future appears to hold.

This is an online, self-study course with approximately 8-10 hours of content and is worth 1 Continuing Education Unit (CEU)

Industrial Aptitude Test Prep Course
This course will expose students to variety types of lessons and questions focusing on reading comprehension, mechanical aptitude, spatial aptitude and general mathematics that they will face in an Industrial Aptitude test. The course is designed to help the student discover their strengths as well as their weaknesses. Once the students are able to identify the subjects they are weak in, they can concentrate on those areas. This self-paced course will result in maximum test result by building the students self confidence as they proceed and help them avoid "test anxiety" that causes low test scores.

This is an online, self-study course with approximately 10-12 hours of content.

Bismarck State College Electric Power Technology Program Course Descriptions

Students have the following options:

Associate of Applied Science in Electric Power Technology (ELPW)
This degree requires 68 credit hours**:**

- 15 Electric Power Technology courses (41 credit hours)
- 3 – 4 Specialization courses (12 credit hours) in your choice of one of the following areas: Line Construction, Metering, Substation, or System Design
- General Education classes (15 credit hours)

Certificate in Electric Power Technology (ELPW)
This certificate requires 57 credit hours**:**

- 15 Electric Power Technology courses (41 credit hours)
- 3 – 4 Specialization courses (12 credit hours) in your choice of one of the following areas: Line Construction, Metering, Substation, or System Design
- 2 classes from two different areas of study for general education (4 credit hours)

Individual Electric Power Technology Courses for Professional Development

1st Semester Courses

ELPW 101 - Basic Computer Skills - 3 Credits
This course is designed to give students a general understanding of computers, both hardware and software. Students will learn to access the Internet and navigate through their online courses and utilize the system tools. This course will also include a basic study of MS Word, MS Excel and MS PowerPoint. Students must have access to these XP/2003 or 2007 software applications.

ELPW 111 - Introduction to the Electrical Industry & Power Grid - 3 Credits
This course will begin with a basic introduction to the systems and components that make up a basic electrical system, including generation, transmission and distribution. You will then study the history behind electrical utility industry. Students will study how the electrical system in the United States was established and how Thomas Edison and George Westinghouse influenced the development of electrical systems. You will also learn how the electrical industry was first regulated and how regulation of the industry has changed. Students will also gain knowledge of how the electrical industry is currently being "re-regulated" to encourage competition. Students will also gain knowledge of the system operations and marketing of electricity. Finally, you will learn how the electrical industry is segmented into utility sectors, such as investor owned, Federally owned, publicly owned and cooperatively owned utilities.

ENRT 103 - Applied Math - 3 Credits
This course will teach basic math skills and apply those to energy industry situations. Students will learn the metric system, basic volume and area calculations as well as algebra and trigonometry and how they apply to industry specific situations.

ENRT 106 - DC Fundamentals - 2 Credits
Recommended prerequisite: ENRT 103
This course covers basic direct current theories and applies those theories to the electrical system and related

equipment. Students will study methods of producing a voltage, such as batteries, magnetic fields, basic series and parallel circuits. Students will also study basic DC circuit calculations.

ENRT 108 - AC Fundamentals - 3 Credits
Recommended prerequisite: ENRT 103 & ENRT 106
This course covers basic alternating current theories and applies those theories to electrical systems and related equipment. Students will also study basic generator and motor design, construction and operating principles.

2nd Semester Courses

ELPW 105 - Electrical System Fundamentals - 3 Credits
This course will begin with a look at several types of power generation stations, such as large fossil fired power plants, hydroelectric power plants, gas turbine and combined cycle generating stations and finally a brief look at wind generation. After the introduction to power generation, students will study how the power is delivered from the power station to the consumer. This course will cover transmission lines and related components within a typical transmission system, such as step-up and step-down transformers, circuit breakers, disconnects and protective relaying.

ELPW 109 - Electrical Industry Safety - 3 Credits
This course covers the general safety practices and information employees need while working in any segment of the electrical industry, and the Federal Agencies responsible for insuring a safe working environment. Students will also gain an understanding of the Workers Right to Know regulations and awareness of Public Safety issues.

ELPW 110 - Basic Print Reading - 3 Credits
This course gives students an introduction to the different schematics used in power plant operations and electrical transmission and distribution systems. Students will gain an understanding of the standard symbols used in the various systems schematics and how to read them. Students learn how to read basic piping and instrumentation diagrams, and how to interpret single line electrical diagrams. Students finish the course by studying electrical system diagrams beginning at the generator and following through to the distribution system.

ELPW 112 - Electrical System Components - 2 Credits
This course takes an in-depth look into the components used in the transmission of electricity. Students begin with a study of switchyards and substations, and then learn the operation of transformers, circuit breakers, regulators, capacitor banks, tap changers, disconnects, current and potential transformers and lightning arrestors. Students also study the various types of electrical conductors, structures and insulators used in the transmission of electricity. Finally, students learn the components, which make up a typical substation and how it feeds a distribution network that supplies customers with electricity.

ENRT 115 - Industrial Composition - 2 Credits
In this course, students will learn some of the common terminology used in the industry and the proper writing techniques necessary to work within the industry. Students will participate in practical industrial writing scenarios, such as filling out work request orders, electrical switching orders and inter-company memos.

3rd Semester Courses

ELPW 118 - Industrial Communications - 2 Credits
This course defines the interpersonal skills needed to communicate with co-workers and customers to effectively

work within the electrical industry. Students learn the proper methods used to resolve on-the-job conflicts and how to establish positive working relationships with co-workers. Students will evaluate and learn techniques for handling different workplace scenarios. They also will learn what is considered acceptable behavior in the workplace, and how to recognize discrimination and sexual harassment and understand that these behaviors are unacceptable in the industry.

ELPW 200 - Advanced Print Reading - 3 Credits
This course covers advanced electrical prints used to navigate complex electrical systems and feeder maps. Students also study schematics that are used when working with electronic systems and system instrumentation that is used to control and monitor the flow of electricity through the electrical system. Students also learn to use the diagrams to troubleshoot system problems and to safely isolate sections of the electrical system.

ELPW 202 - Advanced Industrial Safety - 3 Credits
This course focuses on specific safety practices of the industry. Students begin by studying general practices, such as confined space entry, lock-out tag out procedures, fall protection, fire safety and working with hazardous materials. Students also learn some specific safety procedures used by linemen, such as proper bucket truck operation, and some techniques used when working with electrical conductors. Finally, students learn some of the specific considerations that must be adhered to as an electrical system dispatcher to ensure the safety of line crews and technicians working on the electrical system.

ELPW 204 - Advanced Electrical Systems - 3 Credits
This course provides students with a complete understanding of the design and operation of an electrical system. Students begin by understanding switchyard construction and the different configurations, and also how different sections of the transmission and distribution system can be safely isolated. Students also learn how storms and conditions can affect the electrical system. In addition, students learn some of the procedures used by system operators and line crews to maintain safe and effective delivery of power during adverse conditions and steps necessary to restore power after outages.

ELPW 206 - Electrical System Protection - 3 Credits
This course covers protection fundamentals, philosophies and principles used to protect the electrical system, beginning with the generator itself. Various types of relays, input sources and system grounding are also covered.

Specialization Areas - 4th Semester Courses - ***Choose one specialization areas below.***

Courses required for specialization in Line Construction

ELPW 250 - Transformers - 4 Credits
This course begins with a review of basic transformer design and operation. Students will study 3-phase transformers, single phase loads for 3-phase transformers, and the different connections used in such transformers. The course introduces students to installation procedures and maintenance procedures.

ELPW 230 - Underground Line Construction - 4 Credits
This course covers the two basic categories of underground line construction, such as direct burial and those found in vaults and ducts. Students learn the design, conductors and the transformers used in residential direct burial and the factors that affect it. The course includes underground line construction design and the factors that affect this type of installation.

ELPW 210 - Overhead Transmission & Distribution Line Construction - 4 Credits
This course covers the design and construction of transmission and distribution overhead lines. This includes structures, conductors, insulators and the factors that influence particular use for both transmission and distribution systems. The course covers guidelines for working safely with poles, conductors, switchgear, transformers, rigging, grounds and more. Students will be introduced to high and low voltage troubleshooting procedures, stringing procedures, and guidelines for live line work. Maintaining good voltage to the customer and street lighting issues also will be discussed.

Courses required for specialization in Substation

ELPW 251 - Substation Construction & Maintenance - 4 Credits
This course begins with a review of hand and power tools used during the construction and maintenance of substations and continues with safety procedures and equipment put in place to protect workers within a substation. Students learn the basic construction of a substation, including electrical equipment rigging and installation, cable tray and conduit installation, cable controls & panel wiring, as well as a wide variety of installation procedures for electrical components and protection equipment.

ELPW 211 - Substation Relays - 4 Credits
This course focuses on testing and calibrating substation equipment, including voltage testing on equipment feeder relays, and circuit breaker relays. Students also learn the various tests that need to be conducted on protective relays, such as overcurrent and voltage relays, directional and line relays, as well as ground and test device testing.

ELPW 231 - Substation Operations - 4 Credits
This course will detail the specifics of power electronics as applied in substations for power transmission. It will describe typical functions provided in utility substation automation systems and some important considerations in the interface between substation equipment and the automation system components. Students will look at the availability of information, the analysis of this information, and the subsequent decision making to optimize system operation in a competitive environment. Oil containment, animal issues and security will also be discussed and the requirements necessary to qualify a substation to withstand seismic events. The operation of substation fire protection and substation communications systems such as the SCADA system and SCADA security will be examined.

Courses required for specialization in System Design*
**Students need the ability to apply geometry, trigonometry, and algebra throughout the courses in this specialization.*

ELPW 208 - Advanced Math - 4 Credits
This course will cover algebra, geometry, and trigonometry needed for energy technicians working in the electrical system design and metering specialization areas. This course will cover the fundamental concepts of algebra, equations, functions and graphs. This course will also cover trigonometric functions, laws of sines and cosines and vectors. Lastly the course will discuss analytic geometry.

ELPW 212 - System Design Basics - 3 Credits
In this course the student will study the basic principles and applications of components that comprise an electric power distribution system. It will focus on quantitative approaches to analyze systems including ideal transformers and line parameters. Customer requirements, design layout considerations, tariffs and new construction

permitting requirements for overhead and underground distribution systems will also be studied.

ELPW 232 - System Design Analysis - 3 Credits
In this course students will study the process calculations involved with distribution system design. Included is a brief review of fundamental principles and relationships, followed by exercises using phasors in complex coordinate planes, power transformer equivalent circuits, per unit notation, transmission line parameters and steady state operation, symmetrical faults and symmetrical components, unsymmetrical faults and system protection. The course winds up with an overview of system protection principles and settings calculations for various types of protective relays.

ELPW 252 - Civil Design - 2 Credits
In this course the student will study the basic principles of civil design in electrical distribution system facilities. It includes site selection and surveying, soils testing and compaction, grounding, grading, drainage and oil catchment requirements, step potential protection, design layouts, line plan and profile development, foundations, trenching and raceway design, and underground distribution cable direct burial, duct bank, manhole and vault design considerations.

Courses required for specialization in Metering*
**Students need the ability to apply geometry, trigonometry, and algebra throughout the courses in this specialization track.*

ELPW 208 - Advanced Math - 4 Credits
This course will cover algebra, geometry, and trigonometry needed for energy technicians working in the electrical system design and metering specialization areas. This course will cover the fundamental concepts of algebra, equations, functions and graphs. This course will also cover trigonometric functions, laws of sines and cosines and vectors. Lastly the course will discuss analytic geometry.

ELPW 213 - Fundamentals of Metering - 3 Credits
This course introduces students to the fundamentals of metering, such as terminology and basic principles of meters. Students learn basic math needed in metering, and review basic electricity and magnetism principles. They are introduced to meter testing equipment, meter diagrams and standards, and learn technical data and how to read watt hour and demand meters.

ELPW 233 - Single-Phase & Polyphase Metering - 3 Credits
In this course students learn about single-phase metering and polyphase metering, including meter design, adjustments and compensations, and applications. They also learn about power factor analyzers, high amperage CT cabinets, meter demand theory, demand registers, and testing and maintenance of thermal demands.

ELPW 253 - Advanced Metering Technology - 2 Credits
This course will introduce students to various metering system designs and application options. The student will study the metering system components, associated wiring configurations and instrument transformer variations. Topics will include ratio, burden, and correction factor calculations; functional testing, and calibration procedures as well as safe installation procedures. Also included are cogeneration metering, and principles of load management and associated equipment.

Bismarck State College Nuclear Power Technology Program Course Descriptions

Students have the following options:

Associate of Applied Science in Nuclear Power Technology (NUPT)
This degree requires 67 credit hours**:**

- 16 Nuclear Power Technology courses (52 credit hours)
- General Education classes (15 credit hours)

Certificate in Nuclear Power Technology (NUPT)
This certificate requires 56 credit hours**:**

- 16 Electric Power Technology courses (52 credit hours)
- 2 classes from two different areas of study for general education (4 credit hours)

Individual Electric Power Technology Courses for Professional Development

1st Semester Courses

NUPT 101 - Overview of Nuclear Energy - 2 Credits
In this course the student will study the history of nuclear power, the basic principles of reactor design and operation at commercial nuclear electrical generating facilities. It includes an examination of nuclear waste issues, a study of the important events which occurred at commercial nuclear plants, and a look towards the future of the electrical generating industry.

NUPT 103 - Nuclear Mathematical Fundamentals - 3 Credits
This course will review basic math, including basic arithmetic functions, fractions, and decimals. The course will continue by covering scientific notation, dimensional analysis, algebra, basic geometry and trigonometry. Control charts and graphs, logarithms and exponential functions, and rate concepts will also be covered.

NUPT 105 - Classical Physics - 4 Credits
Recommended prerequisite: NUPT 103
This course is designed to introduce students to classical physics. Topics covered include: units of measurement, kinetics, force, energy, momentum, work, fluids, and mechanical principles.

NUPT 107 - Engineering Drawings, Diagrams and Schematics - 3 Credits
This course will introduce students to engineering drawings, diagrams and schematics that are used in nuclear operations. Students will learn how to read and decipher the various nuclear symbols, components, systems, and legends found on diagrams, drawings, and schematics.

2nd Semester Courses

NUPT 113 - Mechanical Science - 3 credits
This course will cover the basic function, design, and operation of mechanical components and equipment which are an integral part of nuclear facilities. Pumps, heat exchangers, valves, diesel engines, compressors, and filters will be included as well as some mechanical systems such as cooling towers and refrigeration.

NUPT 215 - Nuclear Plant Chemistry - 3 Credits
Recommended prerequisite: NUPT 103
This course covers basic chemistry fundamentals relating to maintaining water purity in primary and secondary systems. This course also covers chemistry concepts for both pressurized water reactors and boiling water reactors. Principles of water treatment, hazards and safety requirements will also be contained in the course.

NUPT 109 - Electrical Science - 4 Credits
Recommended prerequisite: NUPT 103
This course begins with the study of basic electrical fundamentals, theory, laws, and magnetism. Direct current and alternating current electrical circuits, generators, motors, and other components along with their applications will be covered. Single-phase AC circuits and three-phase AC circuits will be discussed. Inductance, capacitance, impedance, and resonance will be covered along with construction of conductors, insulators, and relays.

NUPT 213 - Nuclear Physics - 3 Credits
Recommended prerequisite: NUPT 105
This course will tour the topics that comprise the fundamentals of nuclear science, giving the students an appreciation of theory and principles that govern nuclear processes involved in an operating reactor. This course covers the fundamental atomic structures, nuclear nomenclature, binding energy and nuclear decay reactions. Other topics such as the famous E=mc2 equation, neutron interaction with matter, the fission process and decay heat will be related to the everyday operation of a nuclear power plant.

3rd Semester Courses

NUPT 217 - Heat Transfer, Fluid Flow & Thermodynamics - 4 Credits
Recommended prerequisite: NUPT 105
This course covers heat transfer, fluid flow fundamentals, and the basics of thermodynamics. It begins with a discussion of temperature and heat, and progresses into heat capacities, sensible and latent heats. The laws of thermodynamics and related terms are introduced. The student will learn to perform energy balances, and understand thermodynamic processes and cycles. Properties of fluids and descriptions of their behavior are discussed. Topics covered include density, static head, hydraulics, buoyancy, and fluid flow. Centrifugal pumps are studied as well as closed system operation.

NUPT 111 - Instrumentation & Control - 4 Credits
Recommended prerequisites: NUPT 109 & NUPT 217
This course will cover the construction, operation, and failure modes of basic sensors and detectors used in nuclear generation. Included in this are gamma and neutron core power detector construction, operation and effects. Various control systems will be covered including failure symptoms and troubleshooting techniques from an operational perspective.

NUPT 221 - Science of Radiological Protection - 3 Credits
This course will provide the student with a broad, in-depth knowledge of radiological protection principles.

NUPT 219 - Material Science - 3 Credits
This course provides the student with a basic understanding of the structure of metals and how those structures are affected by various processes. The properties of metals and their applications are also covered along with thermal stress and shock. Ductile and brittle fractures will also be covered along with selecting materials for specific use in the industry. Lastly, students will discuss how important pressure and temperature curves are and why they are used when heating up and cooling down plant equipment.

4th Semester Courses

NUPT 220 - Reactor Theory - 2 Credits
Recommended prerequisite: NUPT 213
This course will tour the topics that comprise the fundamentals of how reactors are built and operated, giving the

student understanding and appreciation of the theory and principles that govern control room operation and activities outside the control room and how they/could they affect the reactor. This course starts with classification of the types of neutrons, and the neutron lifecycle. Other topics include reactivity which provides an understanding what criticality means in terms of reactor operation. Lastly, a discussion of reactor shutdown operation and decay heat removal and significant reactor events.

NUPT 225 - Nuclear Plant System Component Design and Function - 4 Credits
This course will provide the student with a broad, in-depth knowledge of nuclear plant Reactor, Reactor Auxiliaries, Secondary Plant and Electrical Systems.

NUPT 223 - Reactor Safety Design - 3 Credits
This course will provide the student with a broad, in-depth knowledge of Reactor Safety Design and protection principles.

NUPT 227 - Conduct of Facility Operations - 4 Credits
This course will provide the student with a broad-brush knowledge of the Conduct of Operations as set forth by the Department of Energy (DOE Order 5480.19, Conduct of Operations). This document contains best operating practices found in the commercial nuclear fleet, and as such can be looked at as a summary document for candidate utility workers.

Clemson University Bachelor of Science in Electrical Engineering (BSEE) Program Course Descriptions

This degree requires 126 credit hours**:**

- Prerequisite courses, including math, science, English, and computer programming (36 credit hours)
- ECE Engineering courses (61 credit hours)
- Other Engineering courses (5 credit hours)
- Other Mathematics courses (5 credit hours)
- English and Communications courses (6 credit hours)
- Arts, Humanities, and Social Sciences (15 credit hours)

Prerequisite Courses

Colorado Community College Online (CCCOnline) has been identified by EPCE as a single source online provider of all of these Clemson BSEE prerequisites. The Clemson ECE department has approved CCCOnline's courses as covering the prerequisite courses through transfer credits.

CH 101 - Chemistry I
Introduction to the elementary concepts of chemistry through classroom and laboratory experience. Emphasizes chemical reactions and the use of symbolic representation, the mole concept and its applications and molecular structure.

CH 102 - Chemistry II
Continuation of CH 101, treating solutions, rates of reactions, chemical equilibrium, electrochemistry, chemistry of selected elements, and an introduction to organic chemistry.

CPSC 111 - Elementary Computer Programming in C/C++
Introduction to computer programming in C/C++ and its use in solving problems. Intended primarily for technical majors. Basic instruction in programming techniques is combined with tools use and discussions of ethical issues arising from the impact of computing on society.

ENGL 103 - Accelerated Composition
Training in composing correct and effective expository and argumentative essays, including writing documented essays.

MTHSC 106 - Calculus of One Variable I
Topics include analytic geometry, introduction to derivatives, computation and application of derivatives, integrals, exponential and logarithm functions.

MTHSC 108 - Calculus of One Variable II
Topics include transcendental functions, applications of integration, integration techniques, indeterminate forms, improper integrals, parametric equations, polar coordinates, and infinite series.

MTHSC 206 - Calculus of Several Variables
Topics include real valued functions of several variables, multiple integration, differential calculus of functions of several variables, vector field theory.

MTHSC 208 - Introduction to Ordinary Differential Equations
Introduction to the study of differential equations and their application to physical problems. Topics include exact, series, and numerical solutions; solutions by means of Laplace transforms; and solutions of systems of differential equations.

PHYS 122 - Physics with Calculus I
Topics include vectors, laws of motion, conservation principles, rotational motion, oscillations, and gravitation.

PHYS 221 - Physics with Calculus II
Topics include thermodynamics, kinetic theory of gases, electric and magnetic fields, electric currents and circuits, and motions of charged particles in fields.

ECE Engineering

ECE 201 - Logic and Computing Devices
Study of logic with an introduction to Boolean algebra; number systems and representation of information; use of integrated circuits to implement combinational and sequential logic functions and computing elements; and organization and structure of computing systems.

ECE 202 - Electric Circuits I
Study of DC resistive circuits, Kirchhoff's Laws, Nodal and Mesh emphasis, sources, Thevenin's and Norton's theorems, RC, RL, RCL circuit solutions with initial condition using homogenous or nonhomogenous ordinary differential equations having constant coefficients. Develop sinusoidal steady state solution.

ECE 211 - Electrical Engineering Lab. I
Principles of measurement and instruments used to measure parameters and dynamic variables in electric circuits, steady state and transient measurements in DC and AC circuits, and data analysis methods are included.

ECE 212 - Electrical Engineering Lab. II
Emphasizes measurement techniques in AC steady-state circuits and comparison to theoretical predictions. Two-port network methodology and transfer functions are studied experimentally and related to analysis using transform techniques.

ECE 262 - Electric Circuits II
Continuation of the study of electric circuits, including three-phase circuits, complex frequency and network functions, frequency response, two-port parameters, magnetically-coupled circuits, Laplace transforms, and introduction to Fourier series and transforms.

ECE 272 - Computer Organization
Introductory course in computer organization and architecture. Topics include basic hardware and software structure, addressing methods, programs control, processing units, I-O organization, arithmetic, main-memory organization, peripherals, microprocessor families, RISC architectures, and multiprocessors.

ECE 311 - Electrical Engineering Lab. III
Measurements and characteristics of electronic devices and circuits; use of manual and automated instruments to acquire data; oral and written engineering reports.

ECE 312 - Electrical Engineering Lab. IV
Design and characterization of functional circuits using solid-state devices; use of manual and automated instruments for measurements; statistical analysis of data; preparation of engineering reports.

ECE 317 - Random Signal Analysis
Introduction to engineering problems of a probabilistic nature. Systems transformations, statistical averages, simulation, and estimation of system parameters.

ECE 320 - Electronics I
Introduction to electronic materials and devices; principles of design; design of DC and AC circuits using diodes, bipolar junction transistors, field-effect transistors and use of transistors in digital circuits.

ECE 321 - Electronics II
Analysis and design of discrete amplifier circuits at low and high frequencies; operational amplifiers, distortion in amplifiers, oscillator design, and circuit analysis of active digital devices.

ECE 330 - Signals, Systems, and Transforms
Study of systems models, analysis of signals, Fourier series and transforms, sampling and Z transforms, discrete Fourier transforms.

ECE 360 - Electric Power Engineering
Presents the basic principles of electromagnetic induction and electromagnetic forces developed. Topics include synchronous machines, power transformers, electric power transmission, and distribution systems, DC motors, and induction motors.

ECE 371 - Microcomputer Interfacing
Interfacing of microcomputers to peripherals or other computers for purposes of data acquisition, device monitoring and control, and other communications. The interfacing problem is considered at all levels including computer architecture, logic, timing, loading, protocols, and software laboratory for building and simulating designs.

ECE 380 - Electromagnetics
Introduction to electric fields and potentials, dielectrics, capacitance, resistance, magnetic field, forces, work and energy, inductance, time-varying fields, and Maxwell's equations.

ECE 381 - Fields, Waves, and Circuits
Covers foundation of circuit theory, transmission lines and circuits, plane-wave propagation, fiber optics, radiation and antennas, and coupled circuits.

ECE 409 - Continuous and Discrete System Design
Introduction to classical linear control systems. Topics include continuous and discrete descriptions of systems, time and frequency response, stability, system specification, system design of continuous and discrete systems.

ECE 427 - Communications Systems
Study of communication systems design and analysis. Topics include signals and spectra, baseband signaling and detection in noise, digital and analog modulation and demodulation techniques, communications link budget analysis.

ECE 495 - Integrated Systems Design I
Considers engineering design of systems in a continuous process of project definition, planning, execution, and evaluation. This process includes consideration of both technical and non-technical factors in design. Strong emphasis is placed on the development of effective technical communications skills, particularly oral communications competency.

ECE 496 - Integrated System Design II
Project-oriented course which brings together electrical engineering students of dissimilar training into teams or project groups. Group assignments are made which are designed to develop an appreciation for individual and creative thinking as well as team effort.

Other Engineering Courses

CES 102 - Engineering Disciplines and Skills
Introduction to engineering disciplines. Students study spreadsheets and obtain graphical solutions. They complete team-based design projects.

ENGR 141 – Programming and Problem Solving
Students formulate and solve problems using MATLAB; estimate answers for comparison to computed solutions; read, interpret, and write programs, instructions, and output; iterate, evaluate conditional statements, and debug; and analyze data using laptop-based instrumentation.

Clemson University Electrical Engineering Certificates Course Descriptions

Renewable Energy Certificate (3 undergraduate courses)

ECE 457 Fundamentals of Wind Power
Introduction to wind turbine systems including wind energy potential and application to power generation. Topics include wind energy principles, wind site assessment, wind turbine components, power generation machinery, control systems, connection to the electric grid, and maintenance. Preq: ECE 307 or ECE 320 or consent of instructor.

ECE 461 Fundamentals of Solar Energy
Introduction to solar energy conversion systems. Topics include environmental benefits of solar energy, solar thermal systems, concentration solar power, photovoltaic (PV) cell design and manufacturing, sizing of PV system, hybrid photovoltaic/thermal systems, energy storage, and urban/rural applications. Preq: ECE 320 or consent of instructor.

ECE 420 Renewable Energy Penetration on the Power Grid
Introduction to the basic definitions of electrical power, interfacing primary sources, generator/load characteristics, and renewable energy resources. Topics include solar energy grid interfacing, wind energy grid interfacing, battery charging/management, harmonic distortion, voltage sags, and national standards. Preq: ECE 307 or ECE 320.

Power Systems Certificate (3 undergraduate courses)

ECE 360 Electric Power Engineering
Presents the basic principles of electromagnetic induction and electromagnetic forces developed. Topics include synchronous machines, power transformers, electric power transmission, and distribution systems, DC motors, and induction motors. Preq: ECE 262, PHYS 221.

ECE 418 Power System Analysis
Study of power system planning and operational problems. Topics include load flow, economic dispatch, fault studies, transient stability, and control of problems. System modeling and computer solutions are emphasized through class projects. Preq: ECE 360, 380.

ECE 419 Electric Machines and Drives
Performance, characteristics, and modeling of AC and DC machines during steady-state and transient conditions. Introduction to power electronics devices and their use in adjustable speed motor drives. Preq: ECE 321, 360, 380 Coreq: MthSC 434 or consent of instructor.

Excelsior College Bachelor of Science in Electrical Engineering Technology (BSEET) Program Course Descriptions

This degree requires 124 credit hours**:**

- Electrical Engineering Technology Technical Component, including Concentration requirements (57 credit hours, including 16 upper level)
- Arts and Sciences Component (60 credit hours)
- Free Electives Component (7 credit hours including Information Literacy)

BSEET Technical Component Courses

ELEC 152 – Circuit Theory I
DC circuits. Introduction to the basic principles of electricity. Topics covered include: current, voltage, resistance (both linear and non-linear), Ohms Law, work and power, series and parallel resistance, resistance networks, Kirchhoff's Law, network theorems (Norton's, Thevenin's, superposition, and Millman's), mesh and nodal analysis, inductance, capacitance, and time constants. This course contains a lab component

ELEC 153 – Circuit Theory II
Principles and applications of alternating current circuits, the sine wave, reactance, complex algebra and phasors, impedance, power in AC circuits, series and parallel impedances, impedance networks, and resonance. This course contains a lab component

ELEC 160 – Electronics I
An introduction to the study of semiconductor devices such as PN-junction diodes, bipolar junction transistors (BJT), field-effect transistors (FETs,) Metal-Oxide Semiconductor field-effect transistors (MOSFET), which will enable the students to perform analysis of DC transistors biasing, small-signal single and multi-stage amplifiers using BJTs , FETs and MOSFETs, and frequency response of transistor single and multi-stage amplifiers. This course contains a lab component

ELEC 161 – Electronics II
Analysis and application of advanced electronic circuits. Topics include differential amplifiers, stage gain in decibels, input and output impedances, linear IC operational amplifiers, frequency response, Bode plots, active filters, D/A and A/D circuits, oscillators and high frequency amplifiers. Emphasis is in troubleshooting of test circuits, and analysis based on computer simulation. This course contains a lab component

ELEC 201 – Digital Electronics
Principles and applications of digital circuits. Topics include number systems, binary arithmetic, logic gates and Boolean algebra, logic families, combinational and synchronous logic circuit design, logic minimization techniques (Karnaugh maps, Quine-McCluskey), counters, shift registers, encoders and decoders, multiplexors and demultiplexors, and interfacing. This course contains a lab component

ELEC 202 – Microprocessors I
Principles and applications of microprocessors, including hardware and software, interfacing, assembly language programming, and microprocessor-based systems. Eight, 16, and 32-bit microprocessor technology and features are presented. This course contains a lab component

IT 210 –Object Oriented Programming
Covers problem solving and algorithm development using the object-oriented programming language Java. Introduction to object-oriented features including encapsulation, inheritance, and polymorphism. Examines the development of processes of design, coding, debugging, and documentation. Focuses on techniques of good programming style.

IT 390 – Project Management
Explores system development life cycle (SDLC) and project life cycle to enhance skills in budget and timeline management. Use of project management software to design project schedules, using bar charts, PERT and critical path method.

ELEC 495 – Integrated Technology Assessment (Capstone)
A capstone course for the B.S. Information Technology program. It requires students to reflect on their past academic and professional experiences and use the information gained from this reflective exercise to develop learning statements related to the Information Technology degree outcomes. The learning statements must be supported by documented evidence that demonstrate that the outcomes have been met. Students learn how to develop an online portfolio during the first four weeks of this 15-week course, and then work under the guidance of a faculty mentor during the remainder of the semester to compose learning statements, compile appropriate evidence, and create the Integrated Technology Assessment portfolio.

EET Concentrations require a minimum of 15 credits, including 9 upper-level credits.
At least 3 courses must include labs

Electronics Concentration

ELEC 306 –Advanced Digital Design
Systematic design methods for sequential state machines. Specification and modeling of sequential systems. Design implementation using programmable logic devices. This course contains a lab component.

ELEC 307 –Microcontrollers
Design of microprocessor-based systems. A detailed study of microprocessor/microcontroller applications in data acquisition and process control systems. This course contains a lab component

ELEC 321 – Control Systems
Emphasizes the practical applications of control systems. Covers the terminology, concepts, principles, procedures, and computations used by engineers and technicians to analyze, select, specify, design, and maintain all parts of a control system. Emphasizes the application of established methodology with the aid of examples, calculators, and computer programs. Derivatives and integrals are introduced and explained as they are used. Emphasis is on developing an intuitive grasp of how derivatives and integrals relate to physical systems.

ELEC 331 –Digital and Analog Communications
Principles and applications of communication circuits, RF circuit theory (transmitters, receivers), modulation (AM, FM), transmission lines and media, wave propagation, analog versus digital communication techniques, protocols, and communication networks. This course contains a lab component.

IT 350 – Business Data Communications
This course provides overview and practical application of the current theory and practice of business data communications and networks. There will be emphasis on the role of the telecommunications industry in the growth of information societies and their reliance on technical services to stimulate economic growth. The course will examine the seven-layered Open Systems Interconnection (OSI) reference model, standards, protocols and the notion of network architecture to manage information and communications.

Power Systems Concentration

ELEC 370 – Instrumentation and Data Acquisition
This course provides an introduction to virtual instrumentation and data acquisition. Topics covered include virtual instruments, sub virtual instruments, structures, and data acquisition. This course contains a lab component.
ELEC 345 – Electrical Machines

This course introduces the concept of energy storage and conversion, force and electromotive force (EMF) production, electromagnetic induction, transformers, and generators. It covers performance characteristics of DC, induction and synchronous machines, Stepper motor and ,brushless DC machines.

ELEC 210 - Programmable Logic Controllers
This course introduces students to programmable logic controllers (PLCs). Topics covered include PLC programming, troubleshooting, networking, and industrial applications. Topics include PLC programming, troubleshooting, networking, and /industrial applications. This course contains a lab component,

ELEC 360 – Generation and Transmission of Electric Power
This course will examine electric power generation and transmission systems; power flow; economic scheduling of electric power generation; transmission operations; and power system faults.

ELEC 350 – Power Electronics
This course covers principles of operation of power semiconductor devices such as Thyristors and IGBTs. Also covers fundamentals of power converter circuits including switching power supplies, DC/DC converters, phase controlled AC/DC rectifiers, and DC/AC inverters.

Nanotechnology Concentration

ELEC 305 – Introduction to Nanotechnology
Introduction to the underlying principles of nanotechnology, nanoscience, and nanoengineering. Introduces scientific principles and laws relevant on the nanoscale. Discusses applications in engineering physics, chemistry, and biology.

ELEC 310 – Basic Nanofabrication Process
An introduction to the basic principles and methods of nanofabrication and the associated metrology/characterization methods used in industrial and research applications of nanotechnology. Discusses the grand challenges of nanofabrication with respect to industrial scaling of nanofabrication techniques and showcases examples of specific industrial applications in electronics, photonics, chemistry, biology, medicine, defense, energy, etc.

ELEC 410 – Nanotechnology Process Equipment
Overview of the equipment used in nanofabrication processes at the manufacturing level as well as research and development stages. Covers nanotechnology, 300-mm wafer processing, green processes and devices, new fabrication advances and non-vacuum processing tools. Examples of equipment used in applications for micro/nanoelectronics and photovoltaics will be presented. This course contains a lab component.

ELEC 415 - Introduction to Nanofabrication Manufacturing Technology
This course provides an introduction to the fundamentals of Nanofabrication Manufacturing Technology (NMT). Topics include etching, and micromachining, nanogrinding, laser based nanofabrication, pulse water drop micromachining, diamond nanogrinding, and commercialization issues of nanotechnology.This course contain a lab component.

ELEC 420 - Micro-Electro Mechanical Systems
This course focuses on Micro Electromechanical Systems (MEMS) and Nano Electromechanical Systems (NEMS). Topics include MEMS and NEMS architecture, synthesis, modeling and control. Micro-sensors, Micro-actuators, micro-engines and optical MEMS applications are explored. Electronic applications of MEMS, such as in data storage and bio-medical sensors, are also covered. This course contains a lab component.

Excelsior College Bachelor of Science in Nuclear Engineering Technology (BSNET) Program Course Descriptions

This degree requires 124 credit hours**:**

- Nuclear Engineering Technology Technical Component (48 credit hours, including 16 upper level)
- Arts and Sciences Component (60 credit hours)
- Free Electives Component (16 credit hours, including Information Literacy)

NUC 240 - Atomic and Nuclear Physics
Includes the study of the structure of the atom and of the nucleus, of atomic and nuclear energy states, wave-particle duality, electron and nucleon spin, multi-electron atoms, atomic spectra, atomic bonding, electron motion, nuclear reactions, radioactivity, fission, and fusion. Examines the theories postulated and proven that formed the branch of physics known as atomic physics in the late 19th century and early 20th century and became the foundation for the development of nuclear physics and electronics shortly thereafter. This course will enhance learning of reactor physics, radiation safety, electronics, materials science, and chemistry in future courses as well as in your professional and military career.

NUC 245 - Thermodynamics
This course covers basic thermodynamics concepts (energy, temperature, specific heat, enthalpy, entropy, and pressure), properties of gases, vapors, mixtures, and pure substances, First and Second Law of Thermodynamics, Carnot and Rankine power cycles, use of steam tables and Mollier diagrams

NUC 255 - Electrical Theory
Introduction to the fundamentals of charge, AC and DC current, voltage, capacitance, inductance, energy, power, Kirchoff s laws, loop and nodal analysis, and linear voltage-current characteristics.

NUC 320 - Materials
A study of materials used in engineering applications. Topics include atomic bonding, crystalline and non-crystalline structures, diffusion, mechanical and thermal behavior, phase diagrams, kinetics, failure analysis and prevention, structural materials, ceramics, polymers, composites, and materials used in engineering designs. Characteristic properties and methods of conducting common tests and interpreting results will also be discussed in this course.

NUC 325 - Nuclear Materials
This course is a study of radiation effects on metallic and ceramic materials; response of materials in a reactor environment; metallurgy of uranium, thorium, and plutonium; properties of oxides and carbides; creep, swelling, densification, stress, corrosion, and cracking.

NUC 330 - Reactor Core Fundamentals
A study of the basics of neutron chain reaction systems. Topics include neutron cross sections, flux, reaction rates, fission processes, neutron production, neutron multiplication, six-factor formula, reactivity, subcritical multiplication, prompt and delayed neutron fractions, reactor period, reactivity coefficients, control rod worth, and fission product poisons.

NUC 350 - Plant Systems Overview
Overview of the basic aspects of design, layout and function of all major systems associated with nuclear power plant designs typically used for U.S. power production. The approach to the course is to build a power plant system by system. Covers major system components, controls and their design features. Emphasizes the systems' interconnection and functions. The systems' interconnection and functions will also be emphasized. Systems are grouped/classified regarding their use and characteristics, e.g. production vs. safety, primary (nuclear interface) vs. balance of plant, active vs. passive.

NUC 495 - Integrated Technology Assessment (Capstone)
A capstone course for the B.S. Nuclear Engineering Technology program. It requires students to reflect on their past academic and professional experiences and use the information gained from this reflective exercise to develop learning statements related to the Nuclear Engineering Technology degree outcomes. The learning statements must be supported by documented evidence that demonstrates that the outcomes have been met. Students learn how to develop an online portfolio during the first four weeks of this 15-week course, and then work under the guidance of a faculty mentor during the remainder of the semester to compose learning statements, compile appropriate evidence, and create the Integrated Technology Assessment portfolio.

All NUC 495 Students are required to complete an online examination designed to assess the basic knowledge and understanding achieved by senior undergraduates in business. This examination will be delivered directly in the course, consist of 120 multiple-choice questions, and last three and half hours.

TECH 201 - Foundations of Technology Problem Solving
An introduction to the basic concepts of calculus and their applications in engineering technology. Use of limits, derivatives, and integrals to solve problems related to different engineering technology disciplines.

TECH 202 - Foundations of Technology Problem Solving II
A continuation of TECH 201. Focuses on the applications of calculus in engineering technology. Topics include sequences and series, polar coordinates, introduction to ordinary differential equations, eigenvalue solutions, and Laplace transform methods.

CHE 101L - General Chemistry I Laboratory
This laboratory course provides students with experience using the experimental approach to understand scientific measurement, the properties of substances and the interactions between different types of matter.

PHYS 201 - Physics I
The study of Newton’s laws, torque, work, energy, power, impulse, momentum, uniform circular motion, moment of inertia, fluid statics, Bernoulli’s equation, temperature, specific heat, heat of combustion, heat transfer, the ideal gas law, thermodynamics, mechanical waves, and sound. The technical math to be applied in the course will be reviewed at the beginning of the course.

PHYS 202 - Physics I Laboratory
Students ordinarily register for this physics lab concurrently with Physics I. The laboratory covers a wide range of basic topics in Physics I. The activities are chosen to give students an opportunity to perform the experiments and record observations. In these lab students, measure, experiment, observe, discover and understand the close relationship between the experimental observations and principles under study.

PHYS 203 - Physics II
The study of charge, Coulomb's law, electric field, electric potential, capacitors, inductors, magnetic fields, circuits, the electromagnetic spectrum, geometric optics, wave optics, and quantum theory.

PHYS 204 - Physics II Laboratory
The laboratory covers a wide range of basic topics in Physics II. The activities are chosen to give students an opportunity to perform the experiments and record observations. In this lab student's measure, experiment, observe, discover and understand the close relationship between the experimental observations and principles under study.

Excelsior College Bachelor of Science in Cyber Operations
Program Course Descriptions

This degree requires 120 credit hours**:**

- Cyber Operations Component (51 credit hours, including a minimum 15 upper level)
- Arts and Sciences Component (60 credit hours)
- Free Electives Component (9 credit hours, including Information Literacy)

IT 240 – Introduction to C++ Programming

This course is an introduction to the C++ programming language through a study of the concepts of program specification and design, algorithm development, and coding and testing using a modern software development environment. The student will grasp the basics of procedural programming in addition to receiving an introduction to non-procedural (object oriented) programming. Topics covered include fundamentals of algorithms, problem solving, programming concepts, control structures, arrays, strings, classes and objects. This course serves, not only as an introduction to programming in C++, but as a preparation for a more advanced C++ course involving object oriented data types, data structures, and algorithmic development.

CYS 250: Fundamentals of Information Assurance

This course will focus on providing you with insights, guidance and best practices on the principles of Information Security. Students develop a understanding of the technologies and methods utilized to defend systems and networks. They learn to describe, evaluate, and operate a defensive network architecture employing multiple layers of protection using technology appropriate for secure mission accomplishment. Students will also examine the various types of vulnerabilities (design and/or implementation weaknesses), their underlying causes, their identifying characteristics, the ways in which they are exploited, and potential mitigation strategies.

CYS 260: Governance, Legal and Compliance

To minimize liabilities and reduce risks from cyber security threats and reduce the losses from legal action, the information security practitioner must understand governance, compliance and the legal environment and stay informed of emerging laws and regulations. This course will introduce you to the challenges of governance, ethics, legal and regulatory compliance through the eyes of information security professionals. We will examine compliance requirements in response to key mandates and laws including Sarbanes-Oxley, HIPPAA, Privacy, Gramm-Leach-Bliley the Foreign Corrupt Practices Act (FCA) and the Payment Card Industry Data Security Standards (PCI DSS). Lastly, we will examine some of the challenges of compliance and ethics in the practice of Information Security.

ELE C 202: Microprocessors

Principles and applications of microprocessors, including hardware and software, interfacing, assembly language programming, and microprocessor-based systems. Eight, 16, and 32-bit microprocessor technology and features are presented. This course contains a lab component.

IT 321 – Computer Systems Architecture

This course provides an Introduction to the basic components and structure of the computer and the evolution of computer systems. Considers in detail the operation of the CPU, memory, input/output, instruction set architecture, pipelining, operating systems, and communications. The course focuses on the coverage of modern architectures, key system features, networking, and distributed services.

IT 360: Operating Systems
This course provides an Induction to the basic components and structure of the computer and the evolution of computer systems. Considers in detail the operation of the CPU, memory, input/output, instruction set architecture, pipelining, operating systems, and communications. The course focuses on the coverage of modern architectures, key system features, networking, and distributed services.

IT 442 – Internetworking with TCP/IP
This course focuses on the broad outlines of TCP/IP and its application to organizational networks. The course will provide the skills required to recognize, analyze and troubleshoot a broad range of TCP/IP related networking problems. The structure of Internet Packets, IP addressing and the various layers of the TCP/IP protocol suite will be analyzed in detail. This will be accomplished by a combination of hands-on lab activities and discussions that focus on developing the skills required to plan, design and maintain networks., The course will also address current trends and issues relevant to internetworking with TCP/IP.

IT 406: Computer Forensics
Emphasizes the technical and legal aspects of electronic evidence and the computer forensic investigative process. Topics include the discovery and recovery of electronic evidence stored on or transmitted by computers, networks, and cellular devices.

IT 422: Advanced Networking
This course builds on the basic networking concepts and focuses on several advanced networking topics including wireless and mobile networking, near field communications, RFID (Radio Frequency Identification) and the use of cryptography and encryption in data transmission and networking. This course will also discuss privacy and security issues related to the use of these networking technologies.

CYS 456 – Secure Mobile and Cloud Computing Environments
This course covers the secure design and management of ubiquitous computing environments formed by the convergence of fixed and mobile devices, shared services, cloud computing, and other Internet-based computing methods. Students learn best practices and challenges associated with managing these heterogeneous environments and insuring their ability to communicate in a secure manner.

IT 410: Fundamentals of Cryptography
In this course students will learn the history of cryptography and its role in information assurance. Students will examine the inner workings of various cryptographic models and techniques and will be able to identify the appropriate uses of symmetric and asymmetric encryption. Students will learn how to assign measures of strength based on cryptographic algorithms and keys. This course will focus on applied cryptography and students will examine various situations and identify the level of cryptographic strength that is needed as well as the implementation factors related to its suitability for use.Lastly, student will understand the common pitfalls amnd weaknesses associated with the implementation of cryptography techniques and will understand the challenges and limitations of various key management systems.

CYS 345: Cybersecurity Defense in Depth
The course examines the world of cybersecurity risks and defenses which poses significant threats to governments and businesses. This course will provide knowledge, skills, and techniques to identify and address the many cybersecurity threats facing our world today. This course will provide a framework for current and future cybersecurity threats by first examining the history of cybersecurity. The course will then apply lessons learned in the past to current cybersecurity risks and defenses. Lastly, the course will attempt to predict future cybersecurity concerns and the necessary preparations needed to defend against them. This course will examine how IT security threats are constantly evolving and provide insight into cybersecurity defenses from business and government perspective using real-world scenarios to demonstrate actual cybersecurity threats and the strategies used to defend against those threats.

CYS 426: Cyber Attacks and Defenses
This course investigates security issues, vulnerabilities, and mechanisms to identify, respond to and prevent cyber attacks and to build active defense systems. The course will follow the formal ethical hacking methodology including reconnaissance, scanning and enumeration, gaining access, escalation of privilege, maintaining access and reporting. Ethical Hackers are computer and network experts who attack security systems on behalf of owners, seeking vulnerabilities that a malicious hacker could exploit

CYS 400: Reverse Engineering
This course will focus on providing students the knowledge, skills, and hands-on experience in using reverse engineering to deduce the design of a software component to determine how it accomplishes its goals. Specific topics include reverse engineering software tools and techniques for software recovery such as malware analysis, decompilation of code, intellectual property protections such as digital rights management, and communication protocols utilizing static and dynamic techniques.

CYS 450: Security Focused Risk Management
This course will focus on providing students with insights, guidance and best practices in security focused risk management. Students will review the fundamental principles of security focused risk management. Students will utilize a disciplined and standard approach to risk management including risk identification, risk assessment, risk prioritization, and risk prevention or mitigation. Students will learn to identify classes of possible vulnerabilities, threats, attack vectors, consequences and mitigation strategies

CYS 470 – Secure Software Development and Analysis
In today's environment perimeter and infrastructure security is not enough to mitigate security attacks against data and information stored, transmitted and processed by computer systems. In order to design and build secure IT systems, all elements of the system need to be secure. Unfortunately, more and more security vulnerabilities are exploited due to insecure software systems. This course gives insight, guidance and best practices in the design, development and testing of secure software systems

CYS 495 – Cyber Operations Capstone
The Capstone course is the culmination of the program coursework in which the student demonstrates their mastery of various concepts, tools and techniques acquired by the student including computer security technology and principles, information assurance fundamentals, cryptography, secure programming, reverse engineering, risk management, legal and compliance issues, governance and management issues. The Capstone course provides the student with an opportunity to apply their cyber security knowledge and experience in a focused research project.

Excelsior College Bachelor of Science in Information Technology – Cybersecurity Technology Concentration Program Course Descriptions

This degree requires 120 credit hours**:**

- Information Technology Component including the Cybersecurity Technology Concentration requirements (48 credit hours, including a minimum15 upper level)
- Arts and Sciences Component (60 credit hours)
- Free Electives Component (12 credit hours, including Information Literacy)

Information Technology Component

IT 210 – Object Oriented Programming

Covers problem solving and algorithm development using the object-oriented programming language Java. Introduction to object-oriented features including encapsulation, inheritance, and polymorphism. Examines the development of processes of design, coding, debugging, and documentation. Focuses on techniques of good programming style.

IT 321 – Computer System Architecture

This course provides an Induction to the basic components and structure of the computer and the evolution of computer systems. Considers in detail the operation of the CPU, memory, input/output, instruction set architecture, pipelining, operating systems, and communications. The course focuses on the coverage of modern architectures, key system features, networking, and distributed services.

IT 360 – Operating Systems

Introduction to the basic components and structure of a generic operating system. Considers in detail processes, process management and synchronization, threads, interrupts and interrupt handling, memory management, virtual memory management, resource allocation, and an introduction to file systems, protection, and security.

IT 350 – Business Data Communications

This course provides overview and practical application of the current theory and practice of business data communications and networks. There will be emphasis on the role of the telecommunications industry in the growth of information societies and their reliance on technical services to stimulate economic growth. The course will examine the seven-layered Open Systems Interconnection (OSI) reference model, standards, protocols and the notion of network architecture to manage information and communications.

IT 370 – Database Management Systems

Examines the technology and impact of the design of database systems on the organization. Covers the application, design, and implementation of database systems. Topics include an introduction to basic database concepts, database design principles including E-R diagrams and database normalization, SQL queries, transaction management, distributed databases, data warehousing, and database administration. Course focuses on the relational model.

IT 418 – Software Systems Analysis and Design

Concepts and techniques of modern systems analysis and design. Examines approaches to systems analysis and design, including traditional approaches to the system development life cycle and modeling of system requirements and design. Describes the role of the analyst in investigating current systems, defining IT requirements, working with technical and non-technical staff, and making recommendations. Topics include the system development environment, types of information systems, rapid application development, role of the

systems analyst, initiating and planning a systems development project, determining systems requirements, process modeling, logic modeling, project documentation, understanding the elements of systems design, designing the user interface, designing system interfaces, and controls and security considerations.

IT 380 – Overview of Computer Security
Offers an in-depth look at operating system security concepts and techniques. Examines theoretical concepts of computer security. Explores security strategies, the advancement of security implementation, and timeless problem-solving strategies.

IT 390 – Project Management
Explores system development life cycle (SDLC) and project life cycle to enhance skills in budget and timeline management. Use of project management software to design project schedules, using bar charts, PERT and critical path method.

IT 495 – Integrated Technology Assessment (Capstone)
A capstone course for the B.S. Information Technology program. It requires students to reflect on their past academic and professional experiences and use the information gained from this reflective exercise to develop learning statements related to the Information Technology degree outcomes. The learning statements must be supported by documented evidence that demonstrate that the outcomes have been met. Students learn how to develop an online portfolio during the first four weeks of this 15-week course, and then work under the guidance of a faculty mentor during the remainder of the semester to compose learning statements, compile appropriate evidence, and create the Integrated Technology Assessment portfolio.

Cybersecurity Technology Component

CYS 245 – Introduction to Cybersecurity
This course provides introduction to the world of Cybersecurity, and it expects no previous knowledge of the subject. In order to help students understand the threat, the course begins with a discussion of how hackers operate, reviewing some of the more common Hacker methods and reconnaissance activities. The course then introduces the different terminology, products, services, and elements of Cybersecurity, including both the Physical Security threats and the defenses. The course provides an introduction to security protocols and their role within a secure network infrastructure, and provides an overview of a variety of security technologies like firewalls, router security, Virtual Private Networks (VPNs), and wireless security. The course also includes a discussion of security policies and protocols, giving the student and appreciation of the importance of security policy. The course also addresses current topics in Cybersecurity such as the Internet, E-Mail, Social Media, and Google Hacking.

CYS 300 – Computer System Security Fundamentals
This course provides an introduction to all aspects of computer security. It describes threats and types of attacks against computers to enable students to understand and analyze security requirements and define security policies. In the course we will discuss major models in computer security such as Bell-La Padula, Biba and Clark-Wilson, and compare their properties and roles in implementation. Security mechanisms and enforcement issues will be introduced and security features of major application systems will be discussed as practical examples. Other topics include, cryptography. Planning for security, risk management, security standards, law and ethics.

CYS 345 – Cybersecurity Defense in Depth
The course examines the world of cybersecurity risks and defenses which poses significant threats to governments and businesses. This course will provide knowledge, skills, and techniques to identify and address the many cybersecurity threats facing our world today. This course will provide a framework for current and future cybersecurity threats by first examining the history of cybersecurity. The course will then apply lessons learned in the past to current cybersecurity risks and defenses. Lastly, the course will attempt to predict future cybersecurity concerns and the necessary preparations needed to defend against them. This course will examine how IT security threats are constantly evolving and provide insight into cybersecurity defenses from business and government perspective using real-world scenarios to demonstrate actual cybersecurity threats and the strategies used to defend against those threats.

CYS/CJ 387 – White Collar Crime
This course focuses on topics and issues in the area of white-collar crime. It examines and contrasts the treatment of corporate and white-collar offenders by the criminal justice and regulatory justice systems. The course explores the nature and scope of white-collar crimes, crime types, case studies and the etiology of offending.

CYS 455 – Business Continuity
A course designed to provide a broad coverage of topics related to security in the business environment. Coverage of methods for physical security in addition to the security measures involving hardware, software, secure and unsecure protocols, authentication, and processes used to prevent access. Emphasis on the development of a business continuity plan and disaster recovery plan will provide essential details to mitigate the effect of a breach in security or in the event of a disaster.

CYS 456 – Securing Mobile and Cloud Computing Envirornments
This course covers the secure design and management of ubiquitous computing environments formed by the convergence of fixed and mobile devices, shared services, cloud computing, and other Internet-based computing methods. Students learn best practices and challenges associated with managing these heterogeneous environments and insuring their ability to communicate in a secure manner.

CYS/CJ 475 – Large-Scale Cyber Crime and Terrorism
This course will examine Cyber Crime and Terrorism in global context and focus on large scale incidents that effect international security. The foundation of the course will emphasize the evolution of Cyber Crime and Terrorism within the context of globalization and the increasing complexity of Cyber Crime and international, nation-less decentralized terror networks. The course will discuss the relationship of cyber crime and uses of information technology that cultivated and sustained current international terror networks. The course will also discuss emerging trends and potential threats such as Electromagnetic Pulse Attacks (EMPs) and methods (and limitations) to confront Large Scale Cyber Crime and terrorism such as advanced data mining techniques by the Intelligence Community and use of Fusion Centers.

CYS 460 – Cybersecurity Investigations and Case Studies (Capstone)
This course is a capstone course for the Undergraduate Certificate in Cybersecurity. It provides a comprehensive analysis of the methods, tools, and best practices for handling, responding and Investigating cybersecurity incidents and product vulnerabilities. It covers building a security Incidence Response Team (IRT) and a Product Security Team for security vulnerability handling. Students review legal issues from a variety of national perspectives and consider practical aspects of coordination with other organizations.

Excelsior College Undergraduate Certificate in Cybersecurity Course Descriptions

This certificate requires 16 credit hours.

CYS 245 – Introduction to Cybersecurity
This course provides introduction to the world of Cybersecurity, and it expects no previous knowledge of the subject. In order to help students understand the threat, the course begins with a discussion of how hackers operate, reviewing some of the more common Hacker methods and reconnaissance activities. The course then introduces the different terminology, products, services, and elements of Cybersecurity, including both the Physical Security threats and the defenses. The course provides an introduction to security protocols and their role within a secure network infrastructure, and provides an overview of a variety of security technologies like firewalls, router security, Virtual Private Networks (VPNs), and wireless security. The course also includes a discussion of security policies and protocols, giving the student and appreciation of the importance of security policy. The course also addresses current topics in Cybersecurity such as the Internet, E-Mail, Social Media, and Google Hacking.

CYS 300 – Computer System Security Fundamentals
This course provides an introduction to all aspects of computer security. It describes threats and types of attacks against computers to enable students to understand and analyze security requirements and define security policies. In the course we will discuss major models in computer security such as Bell-La Padula, Biba and Clark-Wilson, and compare their properties and roles in implementation. Security mechanisms and enforcement issues will be introduced and security features of major application systems will be discussed as practical examples. Other topics include, cryptography. Planning for security, risk management, security standards, law and ethics.

CYS 345 – Cybersecurity Defense in Depth
The course examines the world of cybersecurity risks and defenses which poses significant threats to governments and businesses. This course will provide knowledge, skills, and techniques to identify and address the many cybersecurity threats facing our world today. This course will provide a framework for current and future cybersecurity threats by first examining the history of cybersecurity. The course will then apply lessons learned in the past to current cybersecurity risks and defenses. Lastly, the course will attempt to predict future cybersecurity concerns and the necessary preparations needed to defend against them. This course will examine how IT security threats are constantly evolving and provide insight into cybersecurity defenses from business and government perspective using real-world scenarios to demonstrate actual cybersecurity threats and the strategies used to defend against those threats.

CYS /CJ 475 – Large-Scale Cyber Crime and Terrorism
This course will examine Cyber Crime and Terrorism in global context and focus on large scale incidents that effect international security. The foundation of the course will emphasize the evolution of Cyber Crime and Terrorism within the context of globalization and the increasing complexity of Cyber Crime and international, nation-less decentralized terror networks. The course will discuss the relationship of cyber crime and uses of information technology that cultivated and sustained current international terror networks. The course will also discuss emerging trends and potential threats such as Electromagnetic Pulse Attacks (EMPs) and methods (and limitations) to confront Large Scale Cyber Crime and terrorism such as advanced data mining techniques by the Intelligence Community and use of Fusion Centers.

CYS/CJ 387 – White Collar Crime
This course focuses on topics and issues in the area of white-collar crime. It examines and contrasts the treatment of corporate and white-collar offenders by the criminal justice and regulatory justice systems. The

course explores the nature and scope of white-collar crimes, crime types, case studies and the etiology of offending.

CYS 460 - Cybersecurity Investigations and Case Studies
This course is a capstone course for the Undergraduate Certificate in Cybersecurity. It provides a comprehensive analysis of the methods, tools, and best practices for handling, responding and Investigating cybersecurity incidents and product vulnerabilities. It covers building a security Incidence Response Team (IRT) and a Product Security Team for security vulnerability handling. Students review legal issues from a variety of national perspectives and consider practical aspects of coordination with other organizations.

Excelsior College Master of Science in Cybersecurity Program Course Descriptions

This degree requires 30 credit hours

CYS 585 – Digital Crime Prevention and Investigation
This course provides an in-depth analysis of the digital defense planning, technologies, and methods to safeguard organizational networks, databases, and applications; and the proper handling of electronic evidence (e-evidence) in digital crime investigations. Presents a plan-protect-respond framework of digital security and the interaction of policies, implementation, and oversight; and how to perform a computer forensic investigation. Regulatory and legal electronic records management (ERM) and e-mail retention requirements are thoroughly covered. Students learn how to search, analyze, and report e-evidence and the legal requirements for presenting admissible evidence to the court. recovery and analysis of digital evidence, addressing legal and technical issues.

CYS 541 – Ethics, Legal, and Compliance Issues in Cybersecurity
Coursework examines the ethical, legal, and regulatory compliance issues related to the practice of cyber security. Focuses on the requirements, challenges, and dilemmas of data protection, due diligence, privacy laws, fraud and risk management, intellectual property, and ethical corporate codes of conduct. Covers key mandates and laws, including the Foreign Corrupt Practices Act (FCA) and the Payment Card Industry Data Security Standards (PCI DSS). To minimize liabilities and reduce risks from electronic, physical threats and reduce the losses from legal action, the information security practitioner must understand the current legal environment and , stay informed of emerging laws and regulations.

CYS 560 – Information Assurance
This course will focus on providing you with insights, guidance and best practices on the principles of Information Security. We will examine the foundations of information security as defined by experts and ISC2 which is considered a definitive source for Information Security best practices. We will examine Information Security using the 10 domains of knowledge as our guidebook. We will use course textbooks, other sources, and case studies to support our discussions. We will learn to apply some of the Information Security knowledge and skills through individual activities. The course will include an opportunity to apply the course topics to a mock digital crime scene.

CYS 575 – IT Risk Analysis and Management
The course examines Information Security Risk Analysis and Management from a business perspective. The course will provide an overview of the key aspects of risk analysis and management including asset identification and associated risk identification, qualitative and quantitative risk assessment and prioritization, determination of risk mitigation strategies, budgeting for risk, and ongoing risk management. This course will provide knowledge, skills, and techniques to identify, prioritize and manage the many IT security risks facing businesses today. Students will also examine how IT Risk Management supports IT governance and decision making by businesses. The role of risk analysts, auditors, security personnel, and management will be discussed.

CYS 522 – Advanced Networking
This course builds on the basic networking concepts and focuses on several advanced networking topics including wireless and mobile networking, near field communications, RFID (Radio Frequency Identification) and the use of cryptography and encryption in data transmission and networking. This course will also discuss privacy and security issues related to the use of these networking technologies.

CYS 501 – Communication Security
This course is an introduction to network security fundamentals, security policies, networking threats, and technologies. Design and implementation of secure communications network management and network scanning are covered. Technical topics are Internet Protocol Security (IPSec), Virtual Private Network (VPN), Internet Controls Message Protocol (ICMP), Network Address Translation (NAT) and Dynamic Host Configurations Protocol (DHCP) design considerations and device hardening. Students learn how to implement a security plan, itemize security threats, and list the elements if security in network systems. Honeypots, sinkholes and other network defenses are examined. Real world cases are discussed.

CYS 526 - Cyber Attacks and Defenses
This course investigates security issues, vulnerabilities and mechanisms to identify, respond to, and prevent cyber attacks and to build active defense systems. The course will follow the formal ethical hacking methodology, including reconnaissance, scanning and enumerations, gaining access, escalation of privilege, maintain access and reporting. Ethical Hackers are computer and network experts who attack security systems on behalf of its owners, seeking vulnerabilities that a malicious hacker could exploit. Students will have hands-on experience in ethical hacking and vulnerability assessment tools

BUS 530 - Project Management Principles and Applications
Introduces the discipline of project management from the perspective of the professional practitioner. Uses the Project Management Body of Knowledge as a framework for managing projects in today s business environment.

CYS 595 – Capstone Project in Cybersecurity
This capstone course for the MS in Cybersecurity examines computer security technology and principles, including cryptography, authentication, access control, and database security; software security, management issues, including physical and infrastructure security, human factors, and security auditing. This course also covers IT security management, risk assessment, and legal and ethical considerations.

Excelsior College Master of Business Administration with a Cybersecurity Management Concentration Program Course Descriptions

This degree requires 33-48 credit hours**:**

- Foundation Requirements (0-15 credit hours, waivable)
- MBA Core Courses (24 credit hours)
- Cybersecurity Management Concentration (9 credit hours)

Cybersecurity Management Concentration

CYS 541 – Ethics, Legal, and Compliance Issues in Cybersecurity
Coursework examines the ethical, legal, and regulatory compliance issues related to the practice of cyber security. Focuses on the requirements, challenges, and dilemmas of data protection, due diligence, privacy laws, fraud and risk management, intellectual property, and ethical corporate codes of conduct. Covers key mandates and laws, including the Foreign Corrupt Practices Act (FCA) and the Payment Card Industry Data Security Standards (PCI DSS). To minimize liabilities and reduce risks from electronic, physical threats and reduce the losses from legal action, the information security practitioner must understand the current legal environment and , stay informed of emerging laws and regulations.

CYS 575 – IT Risk Analysis and Management
The course examines Information Security Risk Analysis and Management from a business perspective. The course will provide an overview of the key aspects of risk analysis and management including asset identification and associated risk identification, qualitative and quantitative risk assessment and prioritization, determination of risk mitigation strategies, budgeting for risk, and ongoing risk management. This course will provide knowledge, skills, and techniques to identify, prioritize and manage the many IT security risks facing businesses today. Students will also examine how IT Risk Management supports IT governance and decision making by businesses. The role of risk analysts, auditors, security personnel, and management will be discussed.

CYS 560 – Information Assurance
This course will focus on providing you with insights, guidance and best practices on the principles of Information Security. We will examine the foundations of information security as defined by experts and ISC2 which is considered a definitive source for Information Security best practices. We will examine Information Security using the 10 domains of knowledge as our guidebook. We will use course textbooks, other sources, and case studies to support our discussions. We will learn to apply some of the Information Security knowledge and skills through individual activities. The course will include an opportunity to apply the course topics to a mock digital crime scene.

Excelsior College Graduate Certificate in Cybersecurity Management
Course Descriptions

This certificate requires 16 credit hours.

CYS 541 – Ethics, Legal, and Compliance Issues in Cybersecurity
Coursework examines the ethical, legal, and regulatory compliance issues related to the practice of cyber security. Focuses on the requirements, challenges, and dilemmas of data protection, due diligence, privacy laws, fraud and risk management, intellectual property, and ethical corporate codes of conduct. Covers key mandates and laws, including the Foreign Corrupt Practices Act (FCA) and the Payment Card Industry Data Security Standards (PCI DSS). To minimize liabilities and reduce risks from electronic, physical threats and reduce the losses from legal action, the information security practitioner must understand the current legal environment and , stay informed of emerging laws and regulations.

CYS 560 – Information Assurance
This course will focus on providing you with insights, guidance and best practices on the principles of Information Security. We will examine the foundations of information security as defined by experts and ISC2 which is considered a definitive source for Information Security best practices. We will examine Information Security using the 10 domains of knowledge as our guidebook. We will use course textbooks, other sources, and case studies to support our discussions. We will learn to apply some of the Information Security knowledge and skills through individual activities. The course will include an opportunity to apply the course topics to a mock digital crime scene.

CYS 575 – IT Risk Analysis and Management
The course examines Information Security Risk Analysis and Management from a business perspective. The course will provide an overview of the key aspects of risk analysis and management including asset identification and associated risk identification, qualitative and quantitative risk assessment and prioritization, determination of risk mitigation strategies, budgeting for risk, and ongoing risk management. This course will provide knowledge, skills, and techniques to identify, prioritize and manage the many IT security risks facing businesses today. Students will also examine how IT Risk Management supports IT governance and decision making by businesses. The role of risk analysts, auditors, security personnel, and management will be discussed.

CYS 565 – Security Management Awareness
Security Management awareness provides important and cost effective methods to protect sensitive information. Through a structured environment of physical, computer and network security measures, implementation of effective user training, establishment of policies and procedures, and sharing of knowledge and expertise within an organization to protect sensitive information each student is provided essential information to create and maintain a secure environment.

CYS 590 – Special Topics in Cybersecurity (Capstone)
This course is designed to explore the most up to date technologies used to combat and mitigate the evolving threats within the domain of cybersecurity. Through the analysis of vulnerabilities, failure analysis, and continuous improvement of first line defenses, and knowledge of relevant standards, the cybersecurity expert must be prepared for threats of an unknown origin at all times.

Worcester Polytechnic Institute Graduate Programs in Power Systems Engineering Course Descriptions

Power Systems Engineering

Power Systems Engineering programs at WPI are technically focused and intended for the professional engineer looking to elevate their knowledge and expertise specifically in power systems engineering.

Master of Engineering in Power Systems Engineering

This degree requires 30 credit hours**:**

- Graduate-level coursework in Electrical and Computer Engineering (21 credit hours, including a minimum of 15 in Power Systems Engineering)
- Graduate-level coursework from Engineering, Science, or the School of Business (9 credit hours)

ECE 5500 – Power System Analysis

This graduate-level course examines the principles of Power Systems Analysis. It will begin with a review of AC circuit analysis. The course will then cover the topics of transmission line parameter calculation, symmetrical component analysis, transformer and load modeling, symmetrical and unsymmetrical fault analysis, power flow, and power systems stability.

Prerequisites: Knowledge of circuit analysis, basic calculus and differential equations, elementary matrix analysis and basic computer programming.

ECE 5511 – Transients in Power Systems

This graduate-level course introduces the student to the effects of electromagnetic transients in distribution systems. Topics include transient analysis, lightning and switching surges, mechanisms of transient generation, insulation coordination, grounding, surge protection devices, and shielding.

Prerequisite: ECE 5500 Power System Analysis

ECE 5512 – Electromechanical Energy Conversion

This graduate-level course will further explore alternating current circuits, three phase circuits, basics of electromagnetic field theory, magnetic circuits, inductance, and electromechanical energy conversion. Topics also include ideal transformer, iron-core transformer, voltage regulation, efficiency equivalent circuit, and three phase transformers. Induction machine construction, equivalent circuit, torque speed characteristics, and single phase motors, synchronous machine construction, equivalent circuit, power relationships phasor diagrams, and synchronous motors will be covered. Direct current machine construction, types, efficiency, power flow diagram, and external characteristics will be discussed.

ECE 5520 – Power System Protection and Control

This graduate-level course seeks to provide an understanding of how interconnected power systems and their components are protected from abnormal events such as faults (short circuits), over-voltages, off-nominal frequency and unbalanced phase conditions. This subject is presented from a theoretical viewpoint, however, many practical examples and applications are included that emphasize the limitations of existing protective equipment. Course content is not specific to any particular manufacturer's equipment.

The course begins with a brief review of power system operation, three-phase system calculations and the representation (modeling) of power system elements. The modeling of current transformers under steady-state and transient conditions is presented with emphasis on the impact on protective devices. A unit on system grounding and its impact on protective device operation are included. Course emphasis then shifts to protective devices and their principles of operation. Both electromechanical and numeric relay designs are covered. The final course segments cover specific applications such as pilot protection of transmission lines, generator protection and transformer protection.

Prerequisite: ECE 5500 Power System Analysis

ECE 5521 – Protective Relaying
This graduate-level course is the first of a two course sequence that covers both the principles and practices of power system protective relaying. The course seeks to provide an understanding of how interconnected power systems and their components are protected from abnormal events such as faults (short circuits), over-voltages, off-nominal frequency and unbalanced phase conditions. This subject is presented from a theoretical viewpoint, however, many practical examples are included that emphasize the limitations of existing protective equipment. Course content is not specific to any particular manufacturer's equipment. The course begins with a brief review of the nature of power system operation, power system faults and other abnormal conditions. The nature and objectives of protective relaying are covered next with emphasis on how the power system can be monitored to detect abnormal conditions. The computational tools needed to analyze system operation and apply protective relaying are covered next, including the per-unit system, phasors and symmetrical components. The modeling of current transformers under steady-state and transient conditions is presented with emphasis on the impact on protective devices. A unit on system grounding and its impact on protective device operation is included. Course emphasis then shifts to protective devices and their principles of operation. Both electromechanical and numeric relay designs are covered.
Prerequisite: To be familiar with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background recommended. ECE 5500 Power System Analysis or equivalent background experience is suggested. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.

ECE 5522 – Advanced Applications in Protective Relaying
This graduate-level course covers advanced topics in the principles and practices of power system protective relaying. The course seeks to provide an understanding of how protective relays are applied to protect power system components. While the subject is presented from a theoretical viewpoint, many practical examples are included. Examples specific to both new installations and existing, older facilities will be included. Course content is not specific to any particular manufacturer's equipment. The course begins with applications of protective devices to generators. This will include distributed generation as well as wind-turbine and inverter-connected sources. Transformer protection is covered next, including application procedures for older, electromechanical relays as well as modern numeric relay designs. A unit on bus protection is covered next, including all typical high-speed and time backup bus protection schemes. Transmission line and distribution feeder protection is covered in detail including both conventional and communications-assisted schemes. The course ends with a unit on other protection applications such as under frequency load shedding, reclosing and out-of-step relaying.
Prerequisite: ECE 5521 Protective Relaying. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.

ECE 5523 – Power System Dynamics
This graduate-level course is concerned with modeling, analyzing and mitigating power system stability and control problems. The course seeks to provide an understanding of the electromechanical dynamics of the interconnected electric power grid. This subject is presented from a theoretical viewpoint; however, many practical examples are included. The course begins with a description of the physics of the power system, frequency regulation during "steady-state" operation, dynamic characteristics of modern power systems, a review of feedback control systems, power system frequency regulation, and a review of protective relaying. This is followed by material on synchronous machine theory and modeling. Simulation of power system dynamic response, small signal stability, transient stability analysis using SIMULINK and effects of non-traditional power sources on systems dynamics will also be covered. Power system stabilizers, load modeling and under frequency load shedding are covered in the final lectures.
Prerequisite: Familiarity with the basics of Laplace Transforms, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis topics recommended. (ECE 5500 Power System Analysis and ECE 5511 Transients in Power Systems or equivalent background experience is suggested.)

ECE 5530 – Power Distribution
This graduate-level course introduces the fundamentals of power distribution systems, apparatus, and practices suited to new and experienced utility distribution engineers. Topics include distribution system designs,

transformers and connections, practical aspects of apparatus and protection, principles of device coordination, grounding, voltage control, and power quality.
Prerequisites: Prior courses in magnetism and three-phase circuits. An electric machines course would be recommended.

ECE 5531 – Power System Operation and Planning
This graduate-level course deals with modern operation, control and planning for power systems. Topics include: Characteristics of generating units; Economic Dispatch; Unit Commitment; Effects of the transmission system on power delivery; Optimal Power Flow and Location Marginal Pricing; Power System Security; State Estimation for Power Systems; Power System Reliability Evaluation. Software tools such as MATLAB and power system simulator software will be used both in the classroom and in some homework assignments.

ECE 5540 – Power Transmission
This graduate-level course focuses on the theory and current professional practice in problems of electric power transmission. It begins with a review of the theory of AC electric power transmission networks and addresses a range of challenges related to reactive power and voltage control as well as steady-state and transients stability. Students will learn in detail the principles of traditional reactive power compensation (shunt reactors and capacitors); series compensation and modern static reactive compensation like SVC, STATCOM and other Flexible AC Transmission Systems (FACTS) devices. The effects of each of these types of compensation on static and dynamic voltage control, reactive power requirement and steady-state and transient stability problems are covered from theoretical as well as practical aspects. Particular attention is given to the mathematical models and principles of operation of many types of compensation systems. Basic principles of operation and control of High-Voltage DC (HVDC) systems and their impact on steady-state and dynamics of power system will be covered as well.
Prerequisite: ECE 5500 Power System Analysis.

ECE 579S/CS 525S – Computer and Network Security
This course provides a comprehensive introduction to the field of computer and network security. Security architectures and protocols and their impact on computers and networks are examined. Critical computer and network security aspects are identified and examined from the standpoints of both the user and the attacker. Computer system and network vulnerabilities are examined, and mitigating approaches are identified and evaluated. Both the principles and practice of computer and network security are introduced. The basic issues to be addressed by a computer and network security capability are explored. The practice of computer and network security: practical applications that have been implemented and are in use to provide security are surveyed.
Prerequisites: Working knowledge of computers, and basic computer networks

Graduate Certificate in Power Systems Engineering: Protection and Control

This certificate requires 12 credit hours.

ECE 5500 – Power System Analysis
This graduate-level course examines the principles of Power Systems Analysis. It will begin with a review of AC circuit analysis. The course will then cover the topics of transmission line parameter calculation, symmetrical component analysis, transformer and load modeling, symmetrical and unsymmetrical fault analysis, power flow, and power systems stability.
Prerequisites: Knowledge of circuit analysis, basic calculus and differential equations, elementary matrix analysis and basic computer programming.

ECE 5511 – Transients in Power Systems
This graduate-level course introduces the student to the effects of electromagnetic transients in distribution systems. Topics include transient analysis, lightning and switching surges, mechanisms of transient generation, insulation coordination, grounding, surge protection devices, and shielding.
Prerequisite: ECE 5500 Power System Analysis

ECE 5521 – Protective Relaying
This graduate-level course is the first of a two course sequence that covers both the principles and practices of power system protective relaying. The course seeks to provide an understanding of how interconnected power systems and their components are protected from abnormal events such as faults (short circuits), over-voltages, off-nominal frequency and unbalanced phase conditions. This subject is presented from a theoretical viewpoint, however, many practical examples are included that emphasize the limitations of existing protective equipment. Course content is not specific to any particular manufacturer's equipment. The course begins with a brief review of the nature of power system operation, power system faults and other abnormal conditions. The nature and objectives of protective relaying are covered next with emphasis on how the power system can be monitored to detect abnormal conditions. The computational tools needed to analyze system operation and apply protective relaying are covered next, including the per-unit system, phasors and symmetrical components. The modeling of current transformers under steady-state and transient conditions is presented with emphasis on the impact on protective devices. A unit on system grounding and its impact on protective device operation is included. Course emphasis then shifts to protective devices and their principles of operation. Both electromechanical and numeric relay designs are covered.
Prerequisite: To be familiar with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background recommended. ECE 5500 Power System Analysis or equivalent background experience is suggested.

ECE 5522 – Advanced Applications in Protective Relaying
This graduate-level course covers advanced topics in the principles and practices of power system protective relaying. The course seeks to provide an understanding of how protective relays are applied to protect power system components. While the subject is presented from a theoretical viewpoint, many practical examples are included. Examples specific to both new installations and existing, older facilities will be included. Course content is not specific to any particular manufacturer's equipment. The course begins with applications of protective devices to generators. This will include distributed generation as well as wind-turbine and inverter-connected sources. Transformer protection is covered next, including application procedures for older, electromechanical relays as well as modern numeric relay designs. A unit on bus protection is covered next, including all typical high-speed and time backup bus protection schemes. Transmission line and distribution feeder protection is covered in detail including both conventional and communications-assisted schemes. The course ends with a unit on other protection applications such as under frequency load shedding, reclosing and out-of-step relaying.
Prerequisite: ECE 5521 Protective Relaying.

Power Systems Management

Power Systems Management from WPI is a highly-specialized program combining technical and management aspects of power systems and is intended for the professional engineer looking to gain knowledge and skills for a managerial career.

Master of Science in Power Systems Management

This degree requires 30 credit hours**:**

- Graduate-level coursework in Power Systems Engineering (at least 12 credit hours, but no more than 15)
- Graduate-level coursework from the School of Business (at least 12 credit hours, but no more than 14)
- Electives – Graduate-level coursework in mathematics, science, or system dynamics (6 credit hours)

ECE 5500 – Power System Analysis

This graduate-level course examines the principles of Power Systems Analysis. It will begin with a review of AC circuit analysis. The course will then cover the topics of transmission line parameter calculation, symmetrical component analysis, transformer and load modeling, symmetrical and unsymmetrical fault analysis, power flow, and power systems stability.

Prerequisites: Knowledge of circuit analysis, basic calculus and differential equations, elementary matrix analysis and basic computer programming.

ECE 5511 – Transients in Power Systems

This graduate-level course introduces the student to the effects of electromagnetic transients in distribution systems. Topics include transient analysis, lightning and switching surges, mechanisms of transient generation, insulation coordination, grounding, surge protection devices, and shielding.

Prerequisite: ECE 5500 Power System Analysis

ECE 5512 – Electromechanical Energy Conversion

This graduate-level course will further explore alternating current circuits, three phase circuits, basics of electromagnetic field theory, magnetic circuits, inductance, and electromechanical energy conversion. Topics also include ideal transformer, iron-core transformer, voltage regulation, efficiency equivalent circuit, and three phase transformers. Induction machine construction, equivalent circuit, torque speed characteristics, and single phase motors, synchronous machine construction, equivalent circuit, power relationships phasor diagrams, and synchronous motors will be covered. Direct current machine construction, types, efficiency, power flow diagram, and external characteristics will be discussed.

ECE 5520 – Power System Protection and Control

This graduate-level course seeks to provide an understanding of how interconnected power systems and their components are protected from abnormal events such as faults (short circuits), over-voltages, off-nominal frequency and unbalanced phase conditions. This subject is presented from a theoretical viewpoint, however, many practical examples and applications are included that emphasize the limitations of existing protective equipment. Course content is not specific to any particular manufacturer's equipment.

The course begins with a brief review of power system operation, three-phase system calculations and the representation (modeling) of power system elements. The modeling of current transformers under steady-state and transient conditions is presented with emphasis on the impact on protective devices. A unit on system grounding and its impact on protective device operation are included. Course emphasis then shifts to protective devices and their principles of operation. Both electromechanical and numeric relay designs are covered. The final course segments cover specific applications such as pilot protection of transmission lines, generator protection and transformer protection.

Prerequisite: ECE 5500 Power System Analysis

ECE 5521 – Protective Relaying

This graduate-level course is the first of a two course sequence that covers both the principles and practices of power system protective relaying. The course seeks to provide an understanding of how interconnected power

systems and their components are protected from abnormal events such as faults (short circuits), over-voltages, off-nominal frequency and unbalanced phase conditions. This subject is presented from a theoretical viewpoint, however, many practical examples are included that emphasize the limitations of existing protective equipment. Course content is not specific to any particular manufacturer's equipment. The course begins with a brief review of the nature of power system operation, power system faults and other abnormal conditions. The nature and objectives of protective relaying are covered next with emphasis on how the power system can be monitored to detect abnormal conditions. The computational tools needed to analyze system operation and apply protective relaying are covered next, including the per-unit system, phasors and symmetrical components. The modeling of current transformers under steady-state and transient conditions is presented with emphasis on the impact on protective devices. A unit on system grounding and its impact on protective device operation is included. Course emphasis then shifts to protective devices and their principles of operation. Both electromechanical and numeric relay designs are covered.
Prerequisite: To be familiar with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background recommended. ECE 5500 Power System Analysis or equivalent background experience is suggested. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.

ECE 5522 – Advanced Applications in Protective Relaying
This graduate-level course covers advanced topics in the principles and practices of power system protective relaying. The course seeks to provide an understanding of how protective relays are applied to protect power system components. While the subject is presented from a theoretical viewpoint, many practical examples are included. Examples specific to both new installations and existing, older facilities will be included. Course content is not specific to any particular manufacturer's equipment. The course begins with applications of protective devices to generators. This will include distributed generation as well as wind-turbine and inverter-connected sources. Transformer protection is covered next, including application procedures for older, electromechanical relays as well as modern numeric relay designs. A unit on bus protection is covered next, including all typical high-speed and time backup bus protection schemes. Transmission line and distribution feeder protection is covered in detail including both conventional and communications-assisted schemes. The course ends with a unit on other protection applications such as under frequency load shedding, reclosing and out-of-step relaying.
Prerequisite: ECE 5521 Protective Relaying. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.

ECE 5523 – Power System Dynamics
This graduate-level course is concerned with modeling, analyzing and mitigating power system stability and control problems. The course seeks to provide an understanding of the electromechanical dynamics of the interconnected electric power grid. This subject is presented from a theoretical viewpoint; however, many practical examples are included. The course begins with a description of the physics of the power system, frequency regulation during "steady-state" operation, dynamic characteristics of modern power systems, a review of feedback control systems, power system frequency regulation, and a review of protective relaying. This is followed by material on synchronous machine theory and modeling. Simulation of power system dynamic response, small signal stability, transient stability analysis using SIMULINK and effects of non-traditional power sources on systems dynamics will also be covered. Power system stabilizers, load modeling and under frequency load shedding are covered in the final lectures.
Prerequisite: Familiarity with the basics of Laplace Transforms, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis topics recommended. (ECE 5500 Power System Analysis and ECE 5511 Transients in Power Systems or equivalent background experience is suggested.)

ECE 5530 – Power Distribution
This graduate-level course introduces the fundamentals of power distribution systems, apparatus, and practices suited to new and experienced utility distribution engineers. Topics include distribution system designs, transformers and connections, practical aspects of apparatus and protection, principles of device coordination, grounding, voltage control, and power quality.

Prerequisites: Prior courses in magnetism and three-phase circuits. An electric machines course would be recommended.

ECE 5531 – Power System Operation and Planning
This graduate-level course deals with modern operation, control and planning for power systems. Topics include: Characteristics of generating units; Economic Dispatch; Unit Commitment; Effects of the transmission system on power delivery; Optimal Power Flow and Location Marginal Pricing; Power System Security; State Estimation for Power Systems; Power System Reliability Evaluation. Software tools such as MATLAB and power system simulator software will be used both in the classroom and in some homework assignments.

ECE 5540 – Power Transmission
This graduate-level course focuses on the theory and current professional practice in problems of electric power transmission. It begins with a review of the theory of AC electric power transmission networks and addresses a range of challenges related to reactive power and voltage control as well as steady-state and transients stability. Students will learn in detail the principles of traditional reactive power compensation (shunt reactors and capacitors); series compensation and modern static reactive compensation like SVC, STATCOM and other Flexible AC Transmission Systems (FACTS) devices. The effects of each of these types of compensation on static and dynamic voltage control, reactive power requirement and steady-state and transient stability problems are covered from theoretical as well as practical aspects. Particular attention is given to the mathematical models and principles of operation of many types of compensation systems. Basic principles of operation and control of High-Voltage DC (HVDC) systems and their impact on steady-state and dynamics of power system will be covered as well.
Prerequisite: ECE 5500 Power System Analysis.

ECE 579S/CS 525S – Computer and Network Security
This course provides a comprehensive introduction to the field of computer and network security. Security architectures and protocols and their impact on computers and networks are examined. Critical computer and network security aspects are identified and examined from the standpoints of both the user and the attacker. Computer system and network vulnerabilities are examined, and mitigating approaches are identified and evaluated. Both the principles and practice of computer and network security are introduced. The basic issues to be addressed by a computer and network security capability are explored. The practice of computer and network security: practical applications that have been implemented and are in use to provide security are surveyed.
Prerequisites: Working knowledge of computers, and basic computer networks

OIE 541 – Operations Risk Management
Operations risk management deals with decision making under uncertainty. It is interdisciplinary, drawing upon management science and managerial decision-making, along with material from negotiation and cognitive psychology. Classic methods from decision analysis are first covered and then applied, from the perspective of business process improvement, to a broad set of applications in operations risk management and design including: quality assurance, supply chains, information security, fire protection engineering, environmental management, projects and new products. A course project is required (and chosen by the student according to his/her interest) to develop skills in integrating subjective and objective information in modeling and evaluating risk (An introductory understanding of statistics is assumed.)

OIE 598E – Engineering Economics
The intention of this course is to aid all engineering students in understanding economics and business constraints on engineering decision making. Topics may include but will not be limited to: evaluation of alternative; the six time-value-of-money factors; present worth, annual cash flow and rate-of-return analysis; incremental analysis; depreciation and income taxes; replacement analysis; inflation; handling probabilistic events; public economy; break-even and minimum cost points; and foreign exchange.

MIS 576 – Project Management
This course presents the specific concepts, techniques and tools for managing projects effectively. The role of the project manager as team leader is examined, together with important techniques for controlling cost, schedules

and performance parameters. Lectures, case studies and projects are combined to develop skills needed by project managers in today's environment.

OBC 500 – Group and Interpersonal Dynamics in Complex Organizations
This practice-based course simulates a complex organization with critical interdependencies at interpersonal, group, and intergroup levels. Students will be asked to make sense of their experiences through class discussions, individual reflection and readings in organization studies. This course is intended to be a student's first course in organizational studies.

ME 593Z – Renewable Energy
This course provides an introduction to renewable energy, outlining the challenges in meeting the energy needs of humanity and exploring possible solutions in some detail. Specific topics include: use of energy and the correlation of energy use with the prosperity of nations; historical energy usage and future energy needs; electricity generation from the wind; wave/ocean energy, geo-thermal and solar-thermal energy; overview of fuel cells, biofuels, photovoltaics, and nuclear power, their role and prospects; distribution of energy and the energy infrastructure; energy storage, and energy for transportation.

Graduate Certificate in Power Systems Management

This certificate requires 18 credit hours**:**

- Graduate-level coursework in Power Systems Engineering (at least 9 credit hours, but no more than 12)
- Graduate-level coursework from the School of Business (at least 6 credit hours, but no more than 9)

ECE 5500 – Power System Analysis
This graduate-level course examines the principles of Power Systems Analysis. It will begin with a review of AC circuit analysis. The course will then cover the topics of transmission line parameter calculation, symmetrical component analysis, transformer and load modeling, symmetrical and unsymmetrical fault analysis, power flow, and power systems stability.
Prerequisites: Knowledge of circuit analysis, basic calculus and differential equations, elementary matrix analysis and basic computer programming.

ECE 5511 – Transients in Power Systems
This graduate-level course introduces the student to the effects of electromagnetic transients in distribution systems. Topics include transient analysis, lightning and switching surges, mechanisms of transient generation, insulation coordination, grounding, surge protection devices, and shielding.
Prerequisite: ECE 5500 Power System Analysis

ECE 5512 – Electromechanical Energy Conversion
This graduate-level course will further explore alternating current circuits, three phase circuits, basics of electromagnetic field theory, magnetic circuits, inductance, and electromechanical energy conversion. Topics also include ideal transformer, iron-core transformer, voltage regulation, efficiency equivalent circuit, and three phase transformers. Induction machine construction, equivalent circuit, torque speed characteristics, and single phase motors, synchronous machine construction, equivalent circuit, power relationships phasor diagrams, and synchronous motors will be covered. Direct current machine construction, types, efficiency, power flow diagram, and external characteristics will be discussed.

ECE 5520 – Power System Protection and Control
This graduate-level course seeks to provide an understanding of how interconnected power systems and their components are protected from abnormal events such as faults (short circuits), over-voltages, off-nominal frequency and unbalanced phase conditions. This subject is presented from a theoretical viewpoint, however, many practical examples and applications are included that emphasize the limitations of existing protective equipment. Course content is not specific to any particular manufacturer's equipment.
The course begins with a brief review of power system operation, three-phase system calculations and the representation (modeling) of power system elements. The modeling of current transformers under steady-state and transient conditions is presented with emphasis on the impact on protective devices. A unit on system grounding and its impact on protective device operation are included. Course emphasis then shifts to protective devices and their principles of operation. Both electromechanical and numeric relay designs are covered. The final course segments cover specific applications such as pilot protection of transmission lines, generator protection and transformer protection.
Prerequisite: ECE 5500 Power System Analysis

ECE 5521 – Protective Relaying
This graduate-level course is the first of a two course sequence that covers both the principles and practices of power system protective relaying. The course seeks to provide an understanding of how interconnected power systems and their components are protected from abnormal events such as faults (short circuits), over-voltages, off-nominal frequency and unbalanced phase conditions. This subject is presented from a theoretical viewpoint, however, many practical examples are included that emphasize the limitations of existing protective equipment. Course content is not specific to any particular manufacturer's equipment. The course begins with a brief review of the nature of power system operation, power system faults and other abnormal conditions. The nature and objectives of protective relaying are covered next with emphasis on how the power system can be monitored to

detect abnormal conditions. The computational tools needed to analyze system operation and apply protective relaying are covered next, including the per-unit system, phasors and symmetrical components. The modeling of current transformers under steady-state and transient conditions is presented with emphasis on the impact on protective devices. A unit on system grounding and its impact on protective device operation is included. Course emphasis then shifts to protective devices and their principles of operation. Both electromechanical and numeric relay designs are covered.
Prerequisite: To be familiar with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background recommended. ECE 5500 Power System Analysis or equivalent background experience is suggested. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.

ECE 5522 – Advanced Applications in Protective Relaying
This graduate-level course covers advanced topics in the principles and practices of power system protective relaying. The course seeks to provide an understanding of how protective relays are applied to protect power system components. While the subject is presented from a theoretical viewpoint, many practical examples are included. Examples specific to both new installations and existing, older facilities will be included. Course content is not specific to any particular manufacturer's equipment. The course begins with applications of protective devices to generators. This will include distributed generation as well as wind-turbine and inverter-connected sources. Transformer protection is covered next, including application procedures for older, electromechanical relays as well as modern numeric relay designs. A unit on bus protection is covered next, including all typical high-speed and time backup bus protection schemes. Transmission line and distribution feeder protection is covered in detail including both conventional and communications-assisted schemes. The course ends with a unit on other protection applications such as under frequency load shedding, reclosing and out-of-step relaying.
Prerequisite: ECE 5521 Protective Relaying. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.

ECE 5523 – Power System Dynamics
This graduate-level course is concerned with modeling, analyzing and mitigating power system stability and control problems. The course seeks to provide an understanding of the electromechanical dynamics of the interconnected electric power grid. This subject is presented from a theoretical viewpoint; however, many practical examples are included. The course begins with a description of the physics of the power system, frequency regulation during "steady-state" operation, dynamic characteristics of modern power systems, a review of feedback control systems, power system frequency regulation, and a review of protective relaying. This is followed by material on synchronous machine theory and modeling. Simulation of power system dynamic response, small signal stability, transient stability analysis using SIMULINK and effects of non-traditional power sources on systems dynamics will also be covered. Power system stabilizers, load modeling and under frequency load shedding are covered in the final lectures.
Prerequisite: Familiarity with the basics of Laplace Transforms, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis topics recommended. (ECE 5500 Power System Analysis and ECE 5511 Transients in Power Systems or equivalent background experience is suggested.)

ECE 5530 – Power Distribution
This graduate-level course introduces the fundamentals of power distribution systems, apparatus, and practices suited to new and experienced utility distribution engineers. Topics include distribution system designs, transformers and connections, practical aspects of apparatus and protection, principles of device coordination, grounding, voltage control, and power quality.
Prerequisites: Prior courses in magnetism and three-phase circuits. An electric machines course would be recommended.

ECE 5531 – Power System Operation and Planning
This graduate-level course deals with modern operation, control and planning for power systems. Topics include: Characteristics of generating units; Economic Dispatch; Unit Commitment; Effects of the transmission system on power delivery; Optimal Power Flow and Location Marginal Pricing; Power System Security; State Estimation for

Power Systems; Power System Reliability Evaluation. Software tools such as MATLAB and power system simulator software will be used both in the classroom and in some homework assignments.

ECE 5540 – Power Transmission
This graduate-level course focuses on the theory and current professional practice in problems of electric power transmission. It begins with a review of the theory of AC electric power transmission networks and addresses a range of challenges related to reactive power and voltage control as well as steady-state and transients stability. Students will learn in detail the principles of traditional reactive power compensation (shunt reactors and capacitors); series compensation and modern static reactive compensation like SVC, STATCOM and other Flexible AC Transmission Systems (FACTS) devices. The effects of each of these types of compensation on static and dynamic voltage control, reactive power requirement and steady-state and transient stability problems are covered from theoretical as well as practical aspects. Particular attention is given to the mathematical models and principles of operation of many types of compensation systems. Basic principles of operation and control of High-Voltage DC (HVDC) systems and their impact on steady-state and dynamics of power system will be covered as well.
Prerequisite: ECE 5500 Power System Analysis.

ECE 523. Power Electronics
The application of electronics to energy conversion and control. Electrical and thermal characteristics of power semiconductor devices—diodes, bipolar transistors and thyristors. Magnetic components. State-space averaging and sampled-data models. Emphasis is placed on circuit techniques. Application examples include dc-dc conversion, controlled rectifiers, high-frequency inverters, resonant converters and excitation of electric machines.
Prerequisites: ECE 3204 and undergraduate courses in modern signal theory and control theory; ECE 504 is recommended.

The Virtual High School High School Program Course Descriptions

Mathematics of Electricity: Careers in Electric Power
This course is designed to introduce (and excite) students with what a career in electric power industry has to offer and what mathematics are needed in order to be employed in this career track. The goal is to show students WHY they need to learn the mathematics they are asked to learn. This course is tied to national mathematics standards and linked to the International Technology Educational Association (ITEA) standards. This is an instructor-led course. Students receive elective high school credit for this 15-week online semester course.

Renewable Energy and the Smart Grid
Energy is essential in the lives of each and every person. The online course *Renewable Energy Sources* explores the topics of energy, nonrenewable and renewable energy sources, function, operation and vision of the Smart Grid, and careers in the energy industry. The curriculum is divided into three main sections. The first section includes various activities designed to help understand energy and electricity which includes basic concepts such as forms, states, conversions, efficiency, and conservation. The second section describes renewable energy resources, including solar, wind, hydropower, geothermal and others and it explores the impact of renewable energy resources on power generation. The last section is about the Smart Grid and includes topics such as energy storage, impacts of technologies on the industry, energy delivery, and careers in the energy industry.