ONLINE COURSE DESCRIPTION CATALOG




EPCE

ENERGY PROVIDERS COALITION FOR EDUCATION

Premier Resource for Industry-Driven Online

ENERGY EDUCATION

This course description catalog serves as a reference for courses, certificates, degrees and programs offered by the EPCE education partner institutions.

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Bismarck State College (BSC)

INTRODUCTORY COURSES

Orientation to the Electrical Industry This online, non-college credit course will familiarize students with today's electrical industry. The course begins by looking at the history of the industry and at those who played major roles in its creation, development and structure. The course will familiarize participants 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.

Industrial Aptitude Test Prep Course This online, non-college credit course will expose students to a variety of lessons and questions focused 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 participants discover their strengths as well as their weaknesses. Once participants 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 a person's self-confidence as they proceed and help them avoid "test anxiety" that causes low test scores.

ELECTRIC POWER TECHNOLOGY PROGRAM (ELPW)

Course requirements for Certificate in Electric Power Technology:

- Complete 53 semester credits of technical core courses, including 12 semester hours in a specialization area of Electric Power Technology, and
- Complete 4 semester credits of general education from any two areas of study

Course requirements for AAS degree in Electric Power Technology:

- Complete 53 semester credits of technical core courses, including 12 semester hours in a specialization area of Electric Power Technology, and
- Complete 15 semester credits of general education

For more information on certificate/degree plans and tuition, or to contact the ELPW advisor, please visit **http://epceonline.org/electric-power-technology-details.**

The Electric Power Technology program is available online with flexible scheduling options to provide an ideal learning environment. Courses can be taken individually or per the recommended semester schedule.

Semester 1 Courses

Introduction to the Electrical Industry & Power Grid - ELPW 111 - 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. Students then study the history behind electrical utility industry, how the electrical system in the United States was established and how Thomas Edison and George Westinghouse influenced the development of electrical systems. They learn how the electrical industry was first regulated and how regulation of the industry has changed. Students learn 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, they study how the electrical industry is segmented into utility sectors, such as investor-owned, federally owned, publicly owned and cooperatively owned utilities.

DC Fundamentals - ENRT 106 - 2 Credits
This course covers basic direct current theory and application. Students will study methods of producing direct current voltage, including batteries, and magnetic fields. Students will learn to calculate voltage, current, resistance, and power in series, parallel, and combination DC circuits. The construction and operation of rotating DC machines including DC generators and DC motors will also be covered.

AC Fundamentals - ENRT 108 - 3 Credits
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 operation principles.

Industrial Safety & Health - ELPW 114 - 3 Credits
This course provides standard safety, health and environmental practices performed in the electrical industry. Students study safe work practices, including personal protective equipment, chemical safety, fire protection, and tool and machine safety. Students will then learn about the electrical safety and protection. Throughout the course, personal responsibility required for safe and environmentally sound work habits will be reinforced.

Technical Communication - ELPW 117 - 3 Credits
In this course, students will learn the proper writing techniques used within the industry through practical industrial writing scenarios such as safety incident, work order request, equipment log and compliance report. In addition, students will study the appropriate interpersonal skills needed to communicate effectively with coworkers and customers including resolving on the job conflicts and establishing positive working relationships. Students will also learn what is considered acceptable behavior in the workplace and how to recognize unacceptable behaviors.

Semester 2 Courses

Electrical System Fundamentals - ELPW 105 - 3 Credits
This course will discuss the basic electrical power grid system from the electrical generation facility to your home usage. Students will study the different types of electrical power production including: fossil fired, hydroelectric, gas turbine, combine cycle, nuclear power and renewable energy sources such as wind, solar, and geothermal. The course will also cover what the future of the electrical system might look like using fuel cell and smart grid technology.

Electrical System Components - ELPW 112 - 3 Credits
This course provides in-depth look into the components used in the transmission of electricity. Students begin with an introduction to the generation of electric power. Students will then learn how switchyards, substations, overhead transmission systems, and underground transmission systems transmit that power at the proper voltage levels and provide system protection. Components such as transformers, circuit breakers, regulators, capacitor banks, tap changers, disconnects, current and potential transformers, relays, and lightning arrestors will be examined in detail. Students will also study the various types of electrical conductors, structures, and insulators used to transmit electricity.

Industrial Prints & Diagrams - ELPW 120 - 4 Credits
This course introduces students to the different schematics used in power plant operations and electrical transmission and distribution systems. Students will gain an understanding of the standard symbols and how to read them. Students learn how to read basic piping and instrumentation diagrams, how to interpret single line electrical diagrams and how 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. Throughout the course, students will learn to use the diagrams to troubleshoot system problems and safely isolate sections of the electrical system.

Applied Electronics - ENRT 221 - 3 Credits
This course focuses on the electronic components and devices that are critical in the operation of equipment common in industrial and energy facilities. Students will understand their function and how to troubleshoot them.

Semester 3 Courses

Automation & Control - ENRT 224 - 3 Credits
Students learn the control devices used to operate motors and generators in an industrial or energy environment. Some of the equipment covered: relays, contactors, motor starters, PLCs and variable frequency drives.

Power System SCADA - ENRT 230 - 3 Credits
This course introduces the theories, design and application of Supervisory Control and Data Acquisition (SCADA) systems. Topics include equipment, system configuration, communication and security of the SCADA network.

Advanced Electrical Systems - ELPW 204 - 4 credits
This course provides students with a complete understanding of the design and operation of electrical transmission and distribution systems. Students begin by studying the basic principles of transmission and distribution circuits, including the advantages and disadvantages of AC and DC transmission. Students will also learn some of the procedures used by system operators and line crews to maintain the safe and effective delivery of power during adverse conditions and the steps necessary to restore power after outages. An introduction to distribution system automation is also provided.

Electrical System Protection - ELPW 206 - 4 credits
This course covers philosophies and principles used to protect the electrical system from abnormal and fault conditions, beginning with the generator. Instrument transformers, protective relays, and system grounding principles are covered.

Semester 4 - Choose one specialization area or 12 total credits from the areas below

Line Construction Specialization

Classes offered in the fall semesters

Transformers - ELPW 250 - 4 Credits
This course begins by reviewing basic transformer design and operation. The course also covers 3-phase transformers, single-phase loads for 3-phase transformers, and the connections used in such transformers. The course introduces students to installation procedures and maintenance procedures.

Underground Line Construction - ELPW 230 - 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.

Overhead Transmission & Distribution Line Construction - ELPW 210 - 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.

Substation Specialization

Classes offered in the spring semesters

Substation Construction & Maintenance - ELPW 251 - 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 and panel wiring, as well as a wide variety of installation procedures for electrical components and protection equipment.

Substation Relays - ELPW 211 - 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.

Substation Operations - ELPW 231 - 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 system design specialization.

System Design Specialization *

Classes offered in the spring semesters

** Students need the ability to apply geometry, trigonometry, and algebra throughout the courses in this specialization.*

Advanced Math - ELPW 208 - 4 Credits

This course covers algebra, geometry and trigonometry needed for energy technicians working in the electrical system design and metering specialization areas. The course covers the fundamental concepts of algebra, equations, functions and graphs. The course also covers trigonometric functions, laws of sines and cosines, vectors and analytic geometry.

Electric System Design - ELPW 240 - 4 Credits

In this course, students will be introduced to the basic components and operations of electric utility distribution substations and circuit feeders. Their functions, typical design parameters and the coordination of their protective devices are presented to form a complete picture of the working "systems" they comprise. Topics include transformers, bus configurations, regulators, capacitors, circuit breakers, reclosers, relays, fusing, arresters, reliability, power quality and economics.

Civil Design - ELPW 252 - 4 Credits

In this course students 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 design considerations. Customer requirements, design layout considerations, and new construction permitting requirements are studied.

Metering Specialization *

Classes offered in the fall semesters

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

Advanced Math - ELPW 208 - 4 Credits

This course covers algebra, geometry and trigonometry needed for energy technicians working in the electrical system design and metering specialization areas. The course covers the fundamental concepts of algebra, equations, functions and graphs. The course also covers trigonometric functions, laws of sines and cosines, vectors and analytic geometry.

Fundamentals of Metering - ELPW 213 - 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.

Single-Phase & Polyphase Metering - ELPW 233 - 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.

Advanced Metering Technology - ELPW 253 - 2 Credits

This course introduces students to various metering system designs and application options. The students study the metering system components, associated wiring configurations and instrument transformer variations. Topics 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.

ELECTRICAL TRANSMISSION SYSTEMS TECHNOLOGY PROGRAM (ETST)

Course requirements for Certificate in Electrical Transmission Systems Technology:

- Complete 51 semester credits of technical core courses in Electrical Transmission Systems Technology
- Complete at least 4 semester credits of general education from two areas of study

Course requirements for AAS in Electrical Transmission Systems Technology:

- Complete 51 semester credits of technical core courses in Electrical Transmission Systems Technology
- Complete at least 15 semester credits of general education

For more information on certificate/degree plans and tuition, or to contact the ETST advisor, please visit **http://epceonline.org/electrical-transmission-systems-technology-details.**

The Electrical Transmission Systems Technology program is available with flexible scheduling options to provide an ideal learning environment. Courses can be taken individually or per the recommended semester schedule.

Semester 1 Courses

Power Industry Concepts - ETST 240 - 3 Credits

This course covers the basic role system operators and electrical dispatchers play in the electric power industry. In addition, students will study the history, development and evolution of the electric industry since inception. This course also explores the effects of deregulation of modern day electrical markets. This course concludes with the working environment of system operators, including some of the challenges they face, such as shift work, certification and the tremendous amount of responsibility operating in a real-time market.

DC Fundamentals - ENRT 106 - 2 Credits- 30 CEHs

This course covers basic direct current theory and application. Students will study methods of producing direct current voltage, including batteries, and magnetic fields. Students will learn to calculate voltage, current, resistance, and power in series, parallel, and combination DC circuits. The construction and operation of rotating DC machines including DC generators and DC motors will also be covered.

AC Fundamentals - ENRT 108 - 3 Credits - 32 CEHs

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 operation principles.

Electrical Generation Theory – ETST 250 – 4 Credits – 35 CEHs

This course covers the design and construction of large electrical generators. Students study the sources of voltage and the design and types of A.C. and D.C. generators and related auxiliary equipment. Students also study the design and operation of A.C. and D.C. motors.

Semester 2 Courses

Substations - ETST 254 - 3 Credits - 39 CEHs

This course covers the basic equipment found in switchyards and substations. Also included are the function and types of substations, related transmission and distribution systems and how each system is tied to one another.

Transformers - ETST 256 - 3 Credits - 34 CEHs

This course furthers a students understanding by introducing basic diagrams, transformers, and basic substation safety and inspection. Topics covered in this course will include interpreting one-line diagrams, exploring power and specialty transformers, and lock-out/tag-out (LOTO) procedures for transformers.

Protective Relaying - ETST 258 - 4 credits - 54 CEHs
This course focuses on protective relaying of substation equipment and transmission lines. Details found in this course include practical understanding and identification of protective and control equipment, zones of protection, protection schemes, and relay communication systems.

Electrical Diagram Interpretation - ETST 260 - 2 Credits - 13 CEHs
This course covers electrical diagrams including single line diagrams, schematic diagrams and logic diagrams. This course focuses on the system operators perspective and the role diagram comprehension plays in an operators job performance.

Semester 3 Courses

Power System Operations - ETST 262 - 3 Credits - 30 CEHs
This course covers the basic roles and responsibilities of system operators including transmission operations, market operations, reliability, balance and interchange and scheduling. The goal of this course is to introduce the multitude of positions found in a typical transmission control center.

Interconnected System Operations - ETST 266 - 3 Credits - 35 CEHs
This course covers the operation of power pools, regional reliability organizations and independent system operators and the role of each. In addition, this course covers interconnected switching procedures between utilities.

Power Flow - ETST 268 - 3 Credits - 30 CEHs
In this course, students study the control of power flow through interconnected systems and the operation of parallel power systems. The topics include generator synchronization, phase angle, VAR control and line voltage regulation. Procedures for controlling electrical power flows to maintain steady state conditions across the power grid are also a focus of this course.

System Operator Work Practices - ETST 270 - 3 Credits - 32 CEHs
In this course students will learn the role a system operator plays in the delivery of power and the operation and maintenance of the transmission system. Students will learn what is expected of a system operator including desired personal characteristics, working environment, employer's expectations/qualifications, educational and training requirements, certification requirements, role in performing reliability functions, tasks and duties and behavior required under code of conduct and other regulatory and legislative orders.

Semester 4 Courses

Power System Safety - ETST 272 - 3 Credits - 23 CEHs
This course covers the safe operating practices, system isolation procedures, and accident prevention procedures used in the transmission and distribution of power. Emphasis will be placed on electrical system lock out and safety procedures.

SCADA Systems and Communications- ETST 274 - 3 Credits - 24 CEHs
This course covers supervisory control and data acquisition systems and the application of various communications technologies used in the electric industry.

Power System Economics - ETST 276 - 3 Credits - 36 CEHs
This course covers economic factors governing electrical system operations. Costs of generation, transmission and distribution are explained. The organization of markets for electrical energy and how this structure affects participating companies' operational and investment decisions are discussed. The effects of congestion, transmission losses and penalty factors are studied. Load management, scheduling and pricing are a focus as well.

Power System Emergency Concepts - ETST 278 - 3 Credits - 32 CEHs
This course concentrates on the concepts involved in the emergency operations of the interconnected power system. Learners will study all of the NERC Emergency Preparedness and Operations Standards (EOP) that govern those operations. Topics include emergency planning, recognition of, and reaction to, power system emergencies and abnormal conditions, as well as system restoration and the implementation and coordination of the proper procedure to restore the electrical system to a safe operating condition.

Reliability Policies & Procedures - ETST 280 - 3 Credits - 35 CEHs
This course familiarizes and helps students understand the policies and procedures that ensure the reliability of the power system. North American Electric Reliability Corporation (NERC) standards, as well as other regulatory agency policies, are explained and discussed. Government agencies, reliability regions, and state reliability concerns also are defined and discussed.

ENERGY SERVICES & RENEWABLE TECHNICIAN PROGRAM (ESRE)

Course requirements for Certificate in Energy Services & Renewable Technician:

- Complete 54 semester credits of technical core courses in Renewable Generation Technology
- Complete at least 4 semester credits of general education from two areas of study
- Complete the Practical Applications course that includes hands on work at the BSC lab

Course requirements for AAS in Energy Services & Renewable Technician:

- Complete 54 semester credits of technical core courses in Renewable Generation Technology
- Complete at least 16 semester credits of general education
- Complete the Practical Applications course that includes hands on work at the BSC lab*

For more information on certificate/degree plans and tuition, or to contact the ESRE advisor, please visit: **http://epceonline.org/energy-services-renewable-technician-details**

The Energy Services & Renewable Technician program is available online with hands on coursework and flexible scheduling options to provide an ideal learning environment. Online students are required to complete two weeks of lab activities on the BSC campus. Courses can be taken individually or per the recommended semester schedule.

Semester 1 Courses

Electrical & Safe Work Practices - ESRE 210 - 3 credits
This course covers specific work practices in the areas of basic electrical safety, principles of electricity, basic process controls, elevated work and rigging. OSHA standards and safe permitting practices are components of this course.

Mechanical Drive Systems - ESRE 216 - 4 credits
Introducing the fundamentals of mechanical drives and the application of mechanical skills and knowledge to the industrial setting. Topics covered will include couplings, chain drives, pulley drives, motor leveling and alignment, bearings, gaskets and gear drives. Demonstration by the student in the areas of torqueing, measurements, gap adjustments and shaft alignments is included.

Hydraulic Fundamentals - ESRE 213 - 3 credits This course covers principles and operation of hydraulic systems. Hydraulic system analysis and troubleshooting in the lab setting is part of this course.

Solar & Distributed Grid Systems - ESRE 218- 4 credits
This course includes an in-depth study of grid-direct solar arrays, small wind systems and other distributed grid systems. Curriculum also includes sizing and installation of systems.

Semester 2 Courses

Automation & Control - ENRT 224 - 3 credits
Students learn the control devices used to operate motors and generators in an industrial or renewable power generation facility. Some of the equipment covered: relays, contactors, motor starters, PLCs and variable frequency drives.

Applied Electronics - ENRT 221 - 3 credits
This course focuses on the electronic components and devices that are critical in the operation of renewable energy facilities. Students will understand their function and how to troubleshoot them.

Commercial Wind Systems - ESRE 226 - 3 credits
Commercial wind turbine systems are the focus of this course. The interoperation of the subsystems in a commercial wind turbine, the tracking and data acquisition using SCADA systems and the distribution of the generated power are covered in this course. The technician's role in the successful operation of the facility is another component of this course.

Energy Technician Applications & Troubleshooting - *ESRE 228 - 5 credits
This course, primarily a hands-on course, takes the core technician skills learned and integrates them into practice. Lab systems included are hydraulic, mechanical, electric motors/ motor control, PLCs, and other control systems. This course will develop and test the students troubleshooting skills and prepare them to work safely and effectively in an industrial or renewable power generation facility. Students enrolling in the online option will be required to complete two weeks of lab activities on the BSC Campus.

Semester 3 Courses

Heat Transfer,Fluid Flow & Thermodynamics - ENRT 118 - 3 credits
Students enrolled in this course will study heat transfer, fluid flow and the conservation of energy. Specific equipment design considerations based on thermodynamic principles will be covered.

Safety, Health & Environment - ENRT 105 - 3 credits
This course covers the personal protective equipment and proper safe work practices and procedures commonly used in the energy industry. Students will also gain a working knowledge of standard safety, health and environmental practices and regulations set by various government entities.

Mechanical Fundamentals - ENRT 107 - 3 credits
This course introduces mechanical concepts commonly found in a plant setting. Topics covered include hand tools, piping, valves, steam traps and strainers. In addition, pumps, compressors, drivers, fans and rotating equipment are covered. Bearings, seals and lubrication are a focus in this course, as well as heat exchanger designs. Plant terminology and operator expectations are covered also.

Plant Equipment & Systems - ENRT 110 - 4 credits
This course introduces equipment used in the power, process and renewable industries. Valves, piping, pumps, compressors, generators, turbines, motors, lubrication systems, heat exchangers, furnaces, boilers, cooling towers, separators, reactors, and distillation columns are covered. The utilization of this equipment within systems will be covered.

Semester 4 Courses

Print Reading- ENRT 112 - 3 credits
This course covers schematics, prints, and piping and instrument diagrams used in the energy industry. Students will learn how to read and interpret block and single-line diagrams, which will prepare them for the logic and electrical schematics included in this course.

Industrial SCADA - ENRT 240 - 3 credits
An introduction to the design, assembly, programming and operation of Supervisory Control and Data Acquisition (SCADA) systems, including Human Machine Interface (HMI) systems. Wiring and networking of programmable controllers to SCADA software and an HMI device is one part of this course. SCADA system application, operation and troubleshooting in manufacturing and energy sectors is included.

Power Generation, Components & Protection - PWRP 224 - 3 credits
Students enrolled in this course will study the design and construction of large industrial generators used in the production of electricity. Students will study the various exciter designs and operation and the various auxiliary equipment that supports generator operation. Students enrolled in this course will study the electrical systems from the main generator through the switchyard.

Instrumentation & Control - ENRT 116 - 4 credits This course provides a comprehensive study of instrumentation components, control theory, control systems and typical controllers associated with the operation of energy facilities.

Smart Grid Courses

Smart Grid, Smart Customer: The online, non-college credit 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.

Renewable Energy Sources and the Smart Grid: This online, non-college credit 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.

Operation Considerations for the Smart Grid: This online, non-college credit 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

Impact of the Smart Grid: This online, non-college credit 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

Course requirement for Certificate in Instrumentation and Technology:

- Complete 52 semester credits of technical core courses in Electronics and Instrumentation and Control. On campus ICTL labs are not required.
- Complete 4 semester credits of general education from any two areas of study.

Course requirement for AAS in Instrumentation and Technology:

- Complete 58 semester credits of technical core courses in Electronics and Instrumentation and Control including ICTL labs offered on campus only.
- Complete 16 semester credits of general education.

Smart Grid Smart Customer

Instrumentation and Controls

The Instrumentation & Control Program was created to educate and prepare students for careers in power plants, process facilities, water treatment facilities, or any other industrial location that utilizes automation. The program provides the knowledge needed for an entry level position as an instrument technician. This program combines theory and hands-on training with state-of-the-art instruments, working processes, and computerized control systems.

1st Semester Courses - Fall semesters only

Direct Current Analysis - ELEC 100 - 4 credits
The study of the concepts of current, voltage and resistance through problem solving and schematic drawings as they apply to DC circuits analysis. Concurrent registration in, or previous successful completion of, the associated lab is required.

Direct Current Analysis Lab - ELEC 100L - 1 credit
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. Concurrent registration in, or previous successful completion of the associated lecture is required.

Solid State Devices - ELEC 118 - 4 credits
The study of semiconductor physics, fundamentals of semiconductors, power supplies, transistors, characteristics of biasing circuits, amplifier properties, and FET characteristics and applications. Concurrent registration in, or previous successful completion of, the associated lab is required.

Solid State Devices Lab - ELEC 118L - 1 credit
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. Concurrent registration in, or previous successful completion of the associated lecture is required.

Digital Electronics I - ELEC 114 - 3 credits
The study of number systems, logic gates, Boolean algebra, and combination logic circuits. Concurrent registration in, or previous successful completion of, the associated lab is required

Digital Electronics I Lab - ELEC 114L - 1 credit
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. Concurrent registration in, or previous successful completion of the associated lecture is required.

2nd Semester Courses - Spring semesters only

Active Devices - ELEC 130 - 4 credits
Prerequisites: ELEC 100, 100L, 114, 114L, 118, and 118L or equivalent and approval of instructor.
The study of various electronic devices and circuitry including; Thyristors, Operational Amplifiers, and Regulated Power Supplies. Concurrent registration in, or previous successful completion of, the associated lab is required.

Active Devices Lab - ELEC 130L - 1 credit
The lab portion of the course a lab/lecture, which provides hands-on verification of the theory, presented in class. Concurrent registration in, or previous successful completion of the associated lecture is required.

AC Analysis - ELEC 120 - 4 credits
Prerequisites: ELEC 100, 100L, 114, 114L, 118, and 118L or equivalent and approval of instructor.
The study of dB, complex numbers, RC, RI and RLC circuits, resonance, and passive and active filters. Concurrent registration in, or previous successful completion of, the associated lab is required.

AC Analysis Lab - ELEC 120L - 1 credit
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory, presented in class. Concurrent registration in, or previous successful completion of the associated lecture is required.

Digital Electronics II - ELEC 115 - 3 credits
Prerequisites: ELEC 100, 100L, 114, 114L, 118, and 118L or equivalent and approval of instructor.
The study of arithmetic circuits, code converters, decoders, encoders, multiplexers, demultiplexers, multivibrators, and flip-flops. Concurrent registration in, or previous successful completion of, the associated lab is required.

Digital Electronics II Lab - ELEC 115L - 1 credit
The lab portion of the course is a lab/lecture, which provide hands-on verification of the theory presented in class. Concurrent registration in, or previous successful completion of the associated lecture is required.

3rd Semester - Fall semesters only

Mechanical Practices - ICTL 205 - 4 credits
Prerequisite: Completion of first year Electronics/Telecommunications Technology Program or departmental approval.
This course covers the types of bolts and their ratings, properties of materials, pipe sizes and threads, types of tubing/application, hoses and their fittings, tubing bending, gaskets and O rings. Other topics include instrument installation, compression fittings, introduction to conduit bending and proper use of conduit fittings and flex conduit.

Mechanical Practices Lab - ICTL 205L - 1 credit
Prerequisite: Completion of first year Electronics/Telecommunications Technology Program.
Co-requisite: ICTL 205 or equivalent and departmental approval.
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. This lab is only available on campus.

Instrument Drawings and Documentation - ICTL 215 - 4 credits
Prerequisite: Completion of first year Electronics/Telecommunications Technology Program or departmental approval.
Topics covered in this course include plant terminology, piping and industrial diagrams (P&ID), electrical and wiring diagrams, graphs, charts, documentation of settings and records keeping, calibration practices and standards, flow, pressure, position, level, temperature and analytical measurements. The use and care of test equipment is also covered.

Instrument Drawings and Documentation Lab - ICTL 215L - 1 credit
Prerequisite: Completion of first year Electronics/Telecommunications Technology Program.
Co-requisite: ICTL 215 or equivalent and departmental approval.
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. This lab is only available on campus.

Input and Output Devices - ICTL 225 - 4 credits
Prerequisite: Completion of first year Electronics/Telecommunications Technology Program or departmental approval.
In this course students will study measurement sensors such as proximity sensors and switches, motion detectors, analog and smart transmitters, and temperature devices. Other topics include valves and their types, valve positioners, current to pneumatic (I/P) converters, electric drives and motor starters, dampers and linkages.

Input and Output Devices Lab - ICTL 225L - 1 credit
Prerequisite: Completion of first year Electronics/Telecommunications Technology Program.
Co-requisite: ICTL 225 or equivalent and departmental approval.
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. This lab is only available on campus.

4th Semester - Spring semesters only

Motors and Controllers - ICTL 235 - 4 credits
Prerequisite: Completion of the third semester of the I&C program or departmental approval.
Topics of study include types of AC and DC motors, stepper motors, motor theory, types of motor controls, three phase power, Y and delta configurations, variable speed drives (variable frequency and variable DC), motor and other electrical equipment protection (breakers and overloads).

Motors and Controllers Lab - ICTL 235L -1 credit
Prerequisite: Completion of the third semester of the I&C program or departmental approval.
Co-requisite: ICTL 235 or equivalent and departmental approval.
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. This lab is only available on campus.

Controls - ICTL 245 - 4 credits
Prerequisite: Completion of the third semester of the I&C program or departmental approval.
The student will gain a basic understanding of major components of the following types of controllers: programmable logic controllers (PLC), personal computers (PC), distributive control systems (DCS). Programming ladder logic, relay logic, function block control logic, relay logic, digital communications, networking, common and typical controller I/O types will be studied.

Controls Lab - ICTL 245L - 1 credit
Prerequisite: Completion of the third semester of the I&C program or departmental approval.
Co-requisite: ICTL 245 or equivalent and departmental approval.

The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class.This lab is only available on campus.

Automation Overview - ICTL 255 - 4 credits
Prerequisite: Completion of the third semester of the I&C program or departmental approval.
Students will learn to demonstrate a process control loop by building, commissioning, troubleshooting and operating a simulated control loop using interlocking logic and control processor algorithms including proportions, integral and derivative (PID) and loop tuning. Students will participate in tours of different facilities such as power plants, refineries, manufacturing facilities, coal gasification plant and food processing plants.

Automation Overview Lab - ICTL 255L - 1 credit
Prerequisite: Completion of the third semester of the I&C program or instructor's approval.
Co-requisite: ICTL 255 or equivalent and departmental approval.
The lab portion of the course is a lab/lecture, which provides hands-on verification of the theory presented in class. This lab is only available on campus.

NUCLEAR POWER TECHNOLOGY PROGRAM (NUPT)

Course requirements for Certificate in Nuclear Power Technology:

- Complete 52 semester credits of technical core courses in Nuclear Power Technology
- Complete 4 semester credits of general education from any two areas of study

Course requirements for AAS in Nuclear Power Technology:

- Complete either 52 semester credits of technical core courses in Nuclear Power Technology- Non-licensed Operator Track OR 57 semester credits of technical core courses in Nuclear Power Technology- Instrumentation and Control Track.
- Complete 15 semester credits of general education

The Associates of Applied Science degree in Nuclear Power Technology, offered by Bismarck State College's National Energy Center for Excellence, is approved by the Nuclear Uniform Curriculum Program (NUCP), managed by the Nuclear Energy Institute (NEI). For more information, please visit: **http://epceonline.org/nucp**

For more information on certificate/degree plans and tuition, or to contact the NUPT advisor, please visit: **http://epceonline.org/Cert-AAS-Nuclear-Power-Technology-details**

Semester 1 Courses

Non-licensed Operator AND Instrumentation & Control Tracks

Overview of Nuclear Energy - NUPT 101 - 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 important events which occurred at commercial nuclear plants, and a look towards the future of the electrical generating industry.

Nuclear Mathematical Fundamentals - NUPT 103 - 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.

Classical Physics - NUPT 105 - 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.

Engineering Drawings, Diagrams and Schematics - NUPT 107 - 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.

Semester 2 Courses

Non-licensed Operator AND Instrumentation & Control Tracks

Courses offered in Spring semesters

Mechanical Science - NUPT 113 - 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.

Nuclear Plant Chemistry - NUPT 215 - 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.

Electrical Science - NUPT 109 - 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.

Nuclear Physics - NUPT 213 - 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.

Non-licensed Operator Track

Semester 3 Courses

Heat Transfer, Fluid Flow & Thermodynamics - NUPT 217 - 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.

Instrumentation & Control - NUPT 111 - 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.

Science of Radiological Protection - NUPT 221 - 3 Credits

This course will provide the student with a broad, in-depth knowledge of radiological protection principles.

Material Science - NUPT 219 - 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.

Semester 4 Courses

Reactor Theory - NUPT 220 - 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 life cycle. Other topics include reactivity which provides an understanding of what criticality means in terms of reactor operation. Lastly, a discussion of reactor shutdown operation and decay heat removal and significant reactor events.

Nuclear Plant System Component Design and Function - NUPT 225 - 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.

Reactor Safety Design - NUPT 223 - 3 Credits

This course will provide the student with a broad, in-depth knowledge of reactor safety design and protection principles.

Conduct of Facility Operations - NUPT 227 - 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.

Instrumentation & Control Track

Semester 3 Courses

Instrument Drawings and Documentation - ICTL 215 - 4 credits
Topics covered in this course include plant terminology, piping and industrial diagrams (P&ID), electrical and wiring diagrams, graphs, charts, documentation of settings and records keeping, calibration practices and standards, flow, pressure, position, level, temperature and analytical measurements. The use and care of test equipment is also covered.

Heat Transfer, Fluid Flow & Thermodynamics - NUPT 217 - 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.

Instrumentation & Control - NUPT 111 - 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.

Input and Output Devices - ICTL 225 - 4 credits
In this course students will study measurement sensors such as proximity sensors and switches, motion detectors, analog and smart transmitters, and temperature devices. Other topics include valves and their types, valve positioners, current to pneumatic (I/P) converters, electric drives and motor starters, dampers and linkages.

Semester 4 Courses

Motors and Controllers - ICTL 235 - 4 credits
Topics of study include types of AC and DC motors, stepper motors, motor theory, types of motor controls, three phase power, Y and delta configurations, variable speed drives (variable frequency and variable DC), motor and other electrical equipment protection (breakers and overloads).

Nuclear Plant System Component Design and Function - NUPT 225 - 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.

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

Instrumentation & Control II - NUPT 229 - 4 Credits
In this course, the student will be exposed to advanced instrumentation and control concepts pertinent to technicians working in the nuclear industry. The course will delve into the theory of operation for a number of digital components and systems, and explain important systems common to all nuclear power plants that employ these concepts. The course will also delve into the certain mechanical and electrical processes to demonstrate how these relate to the instrumentation and control systems governing them.

Please note: Upon completion of the Nuclear Power Technology program, BSC has articulation agreements with Excelsior College so you can seamlessly continue your education and move to the next level of degree.

POWER GENERATION TECHNOLOGY PROGRAM (PWRP)

Course requirements for Certificate in Power Generation Technology:

- Complete 52 semester credits of technical core courses in Power Generation Technology
- Complete at least 4 semester credits of general education from two areas of study
- Complete the ENRT 220 Practical Applications course that includes "hands on" work at either a Power Generating Plant or at the BSC lab.

Course requirements for AAS in Power Generation Technology:

- Complete 52 semester credits of technical core courses in Power Generation Technology
- Complete at least 15 semester credits of general education
- *Complete the ENRT 220 Practical Applications course that includes "hands on" work at either a Power Generating Plant or at the BSC lab.

The Power Generation Technology program is available online with flexible scheduling options to provide an ideal learning environment. A hands-on job shadow experience is required to complete this program. Courses can be taken individually or per the recommended semester schedule.

For more information on certificate/degree plans and tuition, or to contact the PWRP advisor, please visit:
http://epceonline. org/power-plant-technology-details

Semester 1 Courses

Introduction to Energy Technology - ENRT 101 - 3 credits

An introduction to the expanding energy industry. Students will learn about a variety of energy facilities from traditional to renewable, including but not limited to fossil fuel power plants, petroleum refineries, ethanol and biodiesel facilities, gasification plants, wind farms, geothermal and hydro power production facilities, natural gas processing facilities, petroleum production, water and wastewater treatment and others. The role of the technician in these facilities will be a focus, as will be the expectations and culture of the industry.

Safety, Health & Environment - ENRT 105 - 3 credits

This course covers the personal protective equipment and proper safe work practices and procedures commonly used in the energy industry. Students will also gain a working knowledge of standard safety, health and environmental practices and regulations set by various government entities.

Mechanical Fundamentals - ENRT 107 - 3 credits

This course provides an introduction to mechanical concepts commonly found in a plant setting. Topics covered include hand tools, piping, valves, steam traps and strainers. In addition, pumps, compressors, drivers, fans and rotating equipment are covered. Bearings, seals and lubrication are a focus in this course, as well as heat exchanger designs. Plant terminology and operator expectations are covered also.

Plant Equipment & Systems - ENRT 110 - 4 credits

This course provides an introduction to equipment used in the power, process and renewable industries. Valves, piping, pumps, compressors, generators, turbines, motors, lubrication systems, heat exchangers, furnaces, boilers, cooling towers, separators, reactors, and distillation columns are covered. The utilization of this equipment within systems will be covered.

Semester 2 Courses

Print Reading -ENRT 112 - 3 credits

This course covers schematics, prints, and piping and instrument diagrams used in the energy industry. Students will learn how to read and interpret block and single-line diagrams, which will prepare them for the logic and electrical schematics included in this course.

Automation & Control - ENRT 224 - 3 credits

Students learn the control devices used to operate motors and generators in an industrial or energy environment. Some of the equipment covered: relays, contactors, motor starters, PLCs and variable frequency drives.

Electrical Fundamentals - ENRT 104 - 3 credits

This course covers basic direct current theories and applies those to the electrical system and related equipment. Students will also study basic DC circuit calculations. This course will also cover basic alternating current theories and apply those theories to electrical systems and related equipment. Students will study various methods of producing a voltage. Students will also study essential generator and motor design, construction and operating principles.

Instrumentation & Control - ENRT 116 - 4 credits

This course provides a comprehensive study of instrumentation components, control theory, control systems and typical controllers associated with the operation of energy facilities.

Semester 3 Courses

Heat Transfer, Fluid Flow & Thermodynamics - ENRT 118 - 3 credits

Students enrolled in this course will study heat transfer, fluid flow and the conservation of energy. Specific equipment design considerations based on thermodynamic principles will be covered.

Water Purification & Treatment - ENRT 120 - 3 credits

This course covers industrial water treatment processes. Students will study boiler water treatment, raw water treatment and the design and operation of ion exchangers. The course also covers cooling water treatment equipment and waste water treatment equipment and systems.

Steam Generation - ENRT 205 - 3 credits

In this course the various types of boilers, systems, components and auxiliary systems associated with steam generators are covered. Different designs of boilers will be covered including low/high pressure, fire tube/water tube, negative/positive draft, drum type and others. Boiler operation, combustion, safety and emission control equipment will be covered along with efficiency measures.

Operations, Troubleshooting & Communication - ENRT 215 - 3 credits

Students will gain the knowledge necessary to comprehend overall plant operations and respond to abnormal operating conditions. Students also will participate in root cause analysis exercises while troubleshooting different operating scenarios. This course provides instruction in the different types of troubleshooting techniques, procedures, and methods used to solve process problems. Students will use existing knowledge of equipment, systems and instrumentation to understand the operation of an entire unit in a facility. Students study concepts related to commissioning, normal startup, normal operations, normal shutdown, turnarounds, and abnormal situations, as well as the process technician's individual and team role in performing tasks associated with these concepts within an operating unit.

Semester 4 Courses

Applied Electronics - ENRT 221 - 3 credits

This course focuses on the electronic components and devices that are critical in the operation of equipment common in industrial and energy facilities. Students will understand their function and how to troubleshoot them.

Boilers & Environmental Protection - PWRP 207 - 3 credits

Recommended prerequisite: ENRT 205 In this course, students will gain a more thorough understanding of the various types of boilers, systems, components and auxiliary systems associated with steam generation. Topics covered include low/high pressure, fire tube/water tube, negative/positive draft, drum type, supercritical and fluidized bed boilers. Boiler operation, combustion, safety and emission control equipment will be covered along with efficiency measures.

Turbines & Combined Cycle - PWRP 210 - 3 credits

Students enrolled in this course will study all the elements that make up a gas turbine and a combined cycle unit. This course also covers the safe and efficient operation of gas turbines and heat recovery steam generators and their different applications as used in combine cycle and cogeneration configurations. Coal gasification is also studied. This course covers basic steam turbine construction and design and associated auxiliary systems. Students will learn how thermal energy is converted to mechanical energy as the steam passes through a typical industry steam turbine. Students will also study the auxiliary systems associated with steam turbine operation, including extraction steam systems, gland steam sealing systems, turbine lube oil systems, seal oil systems, instrumentation and control devices and protective schemes used during abnormal operating conditions. Steam turbine start-up and shut-down procedures will also be studied.

Power Generation, Components & Protection - PWRP 224 - 3 credits

Students enrolled in this course will study the design and construction of large industrial generators used in the production of electricity. Students will study the various exciter designs and operation and the various auxiliary equipment that supports generator operation. Students enrolled in this course will study the electrical systems from the main generator through the switchyard.

Practical Applications - *ENRT 220 - 2 credits

Online students are required to contact their advisor prior to registering. Students will participate in hands-on lab activities, internships or industry job shadowing to gain entry-level job competencies. Students may not complete this course before their final semester at BSC.

WATER AND WASTEWATER TECHNOLOGY PROGRAM (WATR)

Course requirements for Certificate in Water and Wastewater Technology:

- Complete 30 semester credits of technical core courses in Water and Wastewater Technology
- Complete the ENRT 220 Practical Applications course that includes "hands on" work at either a Water or Wastewater treatment facility.

For more information on certificate/degree plans and tuition, or to contact the WATR advisor, please visit: **http://epceonline. org/Water-and-Wastewater-Technology-Details**

The Water and Wastewater Technology program is available online with flexible scheduling options to provide an ideal learning environment. A hands-on job shadow experience is required to complete this program. Courses can be taken individually or per the recommended semester schedule

Semester 1 Courses

Introduction to the Water Industry - WATR 101 - 3 credits
This course provides an overview of the water treatment program and the water treatment industry. It introduces students to water and wastewater treatment occupations and processes. Students study operator roles, industry requirements, common terminology and basic equipment as well as water use and characteristics.

Safety, Health & Environment - ENRT 105 - 3 credits
This course covers the personal protective equipment and proper safe work practices and procedures commonly used in the energy industry. Students will also gain a working knowledge of standard safety, health and environmental practices and regulations set by various government entities.

Mechanical Fundamentals - ENRT 107 - 3 credits
This course provides an introduction to mechanical concepts commonly found in a plant setting. Topics covered include hand tools, piping, valves, steam traps and strainers. In addition, pumps, compressors, drivers, fans and rotating equipment are covered. Bearings, seals and lubrication are a focus in this course, as well as heat exchanger designs. Plant terminology and operator expectations are covered also.

Applied Algebra - MATH 137 - 3 credits
An intermediate algebra course for students enrolled in technology programs. Topics include properties of real numbers, algebraic expressions, factoring, formula manipulation, graphing, linear equations, quadratic equations, solving systems of equations, simultaneous equations, exponents, radicals and logarithmic equations. NOTE: This course satisfies general education requirements for the AAS, diploma and certificate, but not for the AA and AS degrees. Refer to the online catalog for updated placement information.

Print Reading - ENRT 112 - 3 credits
This course covers schematics, prints, and piping and instrument diagrams used in the energy industry. Students will learn how to read and interpret block and single-line diagrams, which will prepare them for the logic and electrical schematics included in this course.

Instrumentation & Control - ENRT 116 - 4 credits
This course provides a comprehensive study of instrumentation components, control theory, control systems and typical controllers associated with the operation of energy facilities.

Semester 2 Courses

Laboratory Procedures - WATR 105 - 2 credits
Students will be introduced to the chemical makeup of water and the impurities that must be removed for purification processes. Common procedures for testing and monitoring water and wastewater quality will be studied along with the calculation of chemical dosages and feed rates.

Water Treatment I - WATR 110 - 3 credits
This course will cover water sources and protection with a focus on pre-and primary methods and equipment. Filtration, clarification and basic softening methods will also be studied along with pump types and applications. An emphasis will be placed on operating procedures and troubleshooting for each type of process.

Water Treatment II - WATR 115 - 3 credits
This course will instruct students on secondary and final treatment methods, processes and equipment. Disinfection methods and distribution systems will be covered in detail along with sampling, monitoring and reporting based on governmental regulations. Routine operator duties along with problem solving methods will be identified.

Wastewater Treatment - WATR 120 - 3 credits
This course is designed to assist students in understanding the processes and equipment used in a wastewater treatment plant. The concepts used for biological treatment and troubleshooting the various processes will be emphasized. Collection systems operation and maintenance will also be covered.

Practical Applications - ENRT 220 - 3 credits ***Online students are required to contact their advisor prior to registering.*** In addition to coursework students will complete an internship/ job shadow experience at a water treatment facility or hands-on lab activities at BSC's National Energy Center of Excellence. This experience will require students to observe and assist in the daily operations of a functional water or wastewater treatment facility. The hands-on training is expected to include lab testing, process checks, basic problem solving and routine maintenance activities. Students may not complete this course before their final semester at BSC.

CYBERSECURITY AND COMPUTER NETWORKS

This degree program combines system administration fundamentals with a foundation in cybersecurity concepts. Classes focus on best practices to implement, administer, and secure computer systems and data networks.

Graduates will be prepared to install operating systems, configure networks, manage servers, and other typical system administration tasks while maintaining fundamental security practices.

Computing Requirements
Students are required to have their own modern computers, meeting minimum requirements outlined at https://bismarckstate.edu/academics/programs/careertechnicalprograms/computersupport/laptop/. Students should also have access to high speed Internet.

Cybersecurity and Computer Networks AAS Degree Plan

Prescribed Technical Program Total 45-48
General Education Total 15-16
Total Degree Credits 60-64

Prescribed Technical Program Requirements

Computer Hardware - CIS 128 - 3 credit hours
Typically Offered: FALL, SPRING | Students learn the functionality of hardware and software components as well as suggested best practices in maintenance and safety issues. The students, through hands–on activities and labs, learn to assemble and configure a computer, install operating systems and software, and troubleshoot hardware and software problems. In addition, this course helps students prepare for the CompTIA A+ certification.

Principles of Information Security - CIS 147 - 3 credit hours
Typically Offered: FALL, SPRING | This course introduces students to the field of information security. Topics covered include basic security principles, terminology, legal and ethical issues, as well as examining security from business and personal perspectives.

Windows Client Administration - CIS 212 - 3 credit hours
Typically Offered: FALL, SPRING | The course helps learners to gain the knowledge and skills to install, configure, customize, optimize, and troubleshoot the Microsoft Windows operating system in a stand–alone and network environment. This course provides a foundation for Microsoft Certified Solutions Associate (MCSA) certification.

Networking Fundamentals I - CIS 164 - 3-4 credit hours
Typically Offered: FALL, SPRING, SUMMER | This course teaches the fundamentals of network communications. Students will learn practical and conceptual skills that create a foundation to understanding basic networking. By the end of the course, students will be able to build simple Local Area Networks, perform basic device configuration, and implement IP addressing schemes. In addition to gaining practical networking experience, this course helps to prepare students for the Cisco Certified Network Associate (CCNA) certification exam.

Networking Fundamentals II - CIS 165 - 3-4 credit hours
Prerequisite: CIS 164 or instructor approval
Typically Offered: SPRING | This course teaches the architecture, components, and operations of devices for network communication. Students will learn to configure switches and routers to meet small network requirements. By the end of the course, students can configure and troubleshoot routers and switches. In addition to gaining practical networking experience, this course helps to prepare students for the Cisco Certified Network Associate (CCNA) certification exam.

Introduction to Programming - CIS 185 - 3 credit hours
Typically Offered: FALL, SPRING | This course uses the Python language to provide an introduction to computer programming. Topics include programming fundamentals, logic development, top–down program design, and application creation.

Implementing a Windows Network Infrastructure - CIS 216 - 3 credit hours
Prerequisite: CIS 212 or instructor approval
Typically Offered: SPRING | This course helps learners who will be responsible for configuring, managing, and troubleshooting a network infrastructure that uses the Microsoft Windows Server products. Students will learn how to install and manage a Microsoft Server and it roles. DHCP, DNS, RRAS, and File and Print services will be explored along with other roles and services. This course provides a foundation for Microsoft Certified Solutions Associate (MCSA) certification.

Computer and Network Security - CIS 255 - 3 credit hours
Prerequisite: CIS 147 or instructor approval
Typically Offered: SPRING | This course introduces students to technologies and practices used to secure computers and networks. Topics covered include cryptography, secure authentication, logging, device security, and other aspects of enterprise security. Extensive networking and operating system knowledge recommended. In addition to gaining practical security experience, this course helps students prepare for the CompTIA Security+ certification

Linux Fundamentals - CIS 107 - 3 credit hours
Typically Offered: FALL, SPRING | This course introduces students to the Linux operating system. It provides practical skills using command line utilities, managing processes and file systems, as well as installing and maintaining software. In addition to gaining practical Linux experience, this course helps to prepare students for the CompTIA Linux+ certification exams.

Implementing a Windows Active Directory Infrastructure - CIS 214 - 3 credit hours
Prerequisite: CIS 216 or instructor approval
Typically Offered: FALL | This course provides students with the knowledge and skills necessary to install, configure, and administer Microsoft Windows Active Directory services. The course also focuses on implementing Group Policy and performing the Group Policy–related tasks that are required to centrally manage users and computers. This course provides a foundation for Microsoft Certified Solutions Associate (MCSA) certification.

Intermediate Networking I - CIS 26 - 3-4 credit hours
Prerequisite: CIS 165 or instructor approval
Typically Offered: FALL | In this course students learn to configure advanced router and switch functionality. Network communication within larger enterprises is also examined. In addition to gaining practical networking experience, this course helps to prepare students for the Cisco Certified Network Associate (CCNA) certification exam.

Cybersecurity Operations - CIS 274 - 3 credit hours
Prerequisite: CIS 147 or instructor approval
Typically Offered: FALL | This course teaches core security skills needed for monitoring, detecting, investigating, analyzing and responding to security events, thereby protecting systems and organizations from cybersecurity risks, threats and vulnerabilities.

Linux System Administration - CIS 223 - 3 credit hours
Prerequisite: CIS 107 or instructor approval
Typically Offered: SPRING | This course covers topics relating to the administration of Linux computer systems. It provides experience in user management, task scheduling, system logging, shell scripting, system security, and other common system administration tasks. In addition to gaining practical Linux experience, this course helps to prepare students for the CompTIA Linux+ certification exams.

Intermediate Networking II - CIS 268 - 3- 4 credit hours
Prerequisite: CIS 267 or instructor approval
Typically Offered: SPRING | In this course, students learn to connect communication networks. Network management and Wide Area Networking concepts will be examined. In addition to gaining practical networking experience, this course helps to prepare students for the Cisco Certified Network Associate (CCNA) certification exam.

Cybersecurity and Computer Networks Capstone - CIS 269 - 3 credit hours
Typically Offered: SPRING | A capstone course for the Cybersecurity and Computer Networks program. This class prepares students to enter the IT workforce. Students will compete in a national cybersecurity competition, prepare resumes, job shadow, and discuss other employment related topics. It is recommended that students take this course during their last semester in the Cybersecurity and Computer Networks program. [Note: take this course or complete 3 credits in CIS 197/297]

Cooperative Education/Internship - CIS 197/297 - 3 credit hours
Typically Offered: FALL, SPRING, SUMMER | Cooperative education and internships provide students with real–world experience in business and industry as they explore careers or gain experience in chosen fields of study. The work experiences must be directly related to the discipline under which the credits are to be awarded. [Note: complete 3 credits in CIS 197/297 or complete CIS 269]

Ethical Hacking and Network Defense - CIS 282 - 3 credit hours
Prerequisite: CIS 255 or instructor approval
Typically Offered: SPRING | This course provides experience securing computer network resources. The tools and methodologies attackers use will be examined, as well as defenses against them.

Additional General Education Requirements
ENGL 110 College Composition I
COMM 110 Fundamentals of Public Speaking
or ENGL 120 College Composition II
or ENGL 125 Introduction to Professional Writing
MATH 210 Elementary Statistics
3 credits from Arts, Humanities, Behavioral Science, or Social Science (e.g. PHIL 220 Introduction to Logic)

CIS 107 Linux Fundamentals 3

Linux Fundamentals - CIS 107 - 3 credits
Typically Offered: FALLSPR | This course introduces students to the Linux operating system. It provides practical skills using command line utilities, managing processes and file systems, as well as installing and maintaining software. In addition to gaining practical Linux experience, this course helps to prepare students for the CompTIA Linux+ certification exams.

Linux System Administration - CIS 223 - 3 credits
Prerequisite: CIS 107 or departmental approval.
Typically Offered: FALL | This course covers topics relating to the administration of Linux computer systems. It provides experience in user management, task scheduling, system logging, shell scripting, system security, and other common system administration tasks. In addition to gaining practical Linux experience, this course helps to prepare students for the CompTIA Linux+ certification exams.

Implementing a Microsoft Windows Active Directory Infrastructure - CIS 214 - 3 credits
Prerequisite: CIS 216.
Typically Offered: FALL | This course provides students with the knowledge and skills necessary to install, configure, and administer Microsoft Windows Active Directory services. The course also focuses on implementing Group Policy and performing the Group Policy-related tasks that are required to centrally manage users and computers. This course provides a foundation for Microsoft Certified Solutions Associate (MCSA) certification.

Intermediate Networking II - CIS 268 - 4 credits
Prerequisite: CIS 267, or departmental approval.
Typically Offered: SPRING | In this course, students learn to connect networks together. Topics covered include Wide Area Networks, Frame Relay communication, broadband connectivity, and site-to-site VPNs. This is the fourth of four courses providing a foundation for the Cisco Certified Network Associate (CCNA) certification.

Cybersecurity and Computer Networks Capstone - CIS 269 - 3 credits: 3
Typically Offered: SPRING | A capstone course for the Cybersecurity and Computer Networks program. This class prepares students to enter the IT workforce. Students will compete in a national cybersecurity competition, prepare resumes, job shadow, and discuss other employment related topics. It is recommended that students take this course during their last semester in the Cybersecurity and Computer Networks program.

Intermediate Networking I - CIS 267 - 4 credits
Prerequisite: CIS 165 or departmental approval.
Typically Offered: FALL | In this course, students learn to configure advanced router and switch functionality. Topics covered include single-area OSPF, multi-area OSPF, and the EIGRP routing protocols. STP, default gateway redundancy, and EtherChannel are also addressed. This is the third of four courses providing a foundation for the Cisco Certified Network Associate (CCNA) certification.

CIS 197/297 Cooperative Education/Internship

Cybersecurity Operations - CIS 274 - 3 credits
Typically Offered: FALL | This course teaches core security skills needed for monitoring, detecting, investigating, analyzing and responding to security events, thereby protecting systems and organizations from cybersecurity risks, threats and vulnerabilities.

Ethical Hacking and Network Defense - CIS 282 - 3 credits
Prerequisite: CIS 255 or departmental approval.
Typically Offered: FALLSPR | This course provides experience securing computer network resources. The tools and methodologies attackers use will be examined, as well as defenses against them.

General Education Course

- **MATH 210 Elementary Statistics (Required) 3**
- **PHIL 220 Introduction to Logic (Recommended) 3**
- **ENGL 110 College Composition I 3**

Communications II

(Select one of the following:)

- **COMM 110 Fundamentals of Public Speaking**
- **ENGL 120 College Composition II**
- **ENGL 125 Introduction to Professional Writing**

Cybersecurity and Computer Networks - 3 Year Plan

- **Prescribed Technical Program 45-48**
- **General Education 15-16**
- **Total Degree Credits 60-64**

Prescribed Technical Program Requirements

Microcomputer Hardware I - CIS 128 - 3 credits
Typically Offered: FALLSPR | Students learn the functionality of hardware and software components as well as suggested best practices in maintenance and safety issues. The students, through hands-on activities and labs, learn to assemble and configure a computer, install operating systems and software, and troubleshoot hardware and software problems. In addition, this course helps students prepare for the CompTIA A+ certification.

Principles of Information Security - CIS 147 - 3 credits
Typically Offered: FALLSPR | This course introduces students to the field of information security. Topics covered include basic security principles, terminology, legal and ethical issues, as well as examining security from business and personal perspectives.

Networking Fundamentals I - CIS 164 - 4 credits
Typically Offered: FASPSU | This course focuses on learning the fundamentals of networking. Students will learn both the practical and conceptual skills that build the foundation for understanding basic networking. By the end of the course, student will be able to build simple LANs, perform basic configurations for routers and switches, and implement IP addressing schemes.

Networking Fundamentals II - CIS 165 - 4 credits
Prerequisite: CIS 164.
Typically Offered: SPRING | This course focuses on learning the architecture, components, and operations of routers and switches in a small network. Students learn to configure a router and a switch for basic functionality. By the end of this course, students will be able to configure and troubleshoot routers and switches. Some topics include RIPv1, RIPv2, virtual LANs, and inter-VLAN routing in IPv4 and IPv6 networks.

Microsoft Windows Operating System Client - CIS 212 - 3 credits
Typically Offered: FALLSPR | The course helps learners to gain the knowledge and skills to install, configure, customize, optimize, and troubleshoot the Microsoft Windows operating system in a stand-alone and network environment. This course provides a foundation for Microsoft Certified Solutions Associate (MCSA) certification.

Implementing a Microsoft Windows Active Directory Infrastructure - CIS 214 - 3 credits
Prerequisite: CIS 216.
Typically Offered: FALL | This course provides students with the knowledge and skills necessary to install, configure, and administer Microsoft Windows Active Directory services. The course also focuses on implementing Group Policy and performing the Group Policy-related tasks that are required to centrally manage users and computers. This course provides a foundation for Microsoft Certified Solutions Associate (MCSA) certification.

Implementing a Microsoft Windows Network Infrastructure - CIS 216 - 3 credits
Typically Offered: SPRING | This course helps learners who will be responsible for configuring, managing, and troubleshooting a network infrastructure that uses the Microsoft Windows Server products. Students will learn how to install and manage a Microsoft Server and it roles. DHCP, DNS, RRAS, and File and Print services will be explored along with other roles and services. This course can help provide a foundation for the Microsoft Certified Technology Specialist (MCTS) and Microsoft Certified IT Professional (MCITP) certifications.

Computer and Network Security - CIS 255 - 3 credits
Typically Offered: SPRING | This course introduces students to technologies and practices used to secure computers and networks. Topics covered include cryptography, authentication, VPNs, and other aspects of enterprise security. Extensive networking and operating system knowledge is recommended. In addition to practical security-related experience, this course helps to prepare students for the CompTIA Security+ certification exam.

CIS 267 Intermediate Networking I 3-4

Intermediate Networking I - CIS 267 - 4 credits
Prerequisite: CIS 165 or departmental approval.
Typically Offered: FALL | In this course, students learn to configure advanced router and switch functionality. Topics covered include single-area OSPF, multi-area OSPF, and the EIGRP routing protocols. STP, default gateway redundancy, and EtherChannel are also addressed. This is the third of four courses providing a foundation for the Cisco Certified Network Associate (CCNA) certification.

Intermediate Networking II - CIS 268 - 4 credits
Prerequisite: CIS 267, or departmental approval.
Typically Offered: SPRING | In this course, students learn to connect networks together. Topics covered include Wide Area Networks, Frame Relay communication, broadband connectivity, and site-to-site VPNs. This is the fourth of four courses providing a foundation for the Cisco Certified Network Associate (CCNA) certification.

PHIL 220 Introduction to Logic (Recommended) 3

- **ASC 082 Effective Reading 1 2**
- **ASC 91 Algebra Prep I 1 2**
- **ASC 95 College Writing Prep II 1 2**
- **ASC 94 College Writing Prep I 1 2**
- **ASC 96 College Writing Prep III 1 2**
- **ENGL 110 College Composition I 3**

Communications II (Select one of the following:)

- **COMM 110 Fundamentals of Public Speaking**
- **ENGL 120 College Composition II**
- **ENGL 125 Introduction to Professional Writing**

Ask an Educational Consultant at: **epceonline.org/educational-consultant**

Excelsior College

BACHELOR OF PROFESSIONAL STUDIES IN TECHNOLOGY MANAGEMENT

Course requirements for Bachelor of Professional Studies in Technology Management:

- Professional component: 45 credit hours (must include at least 15 upper level applied to a concentration and 9 upper level credits applied to the technology management core courses or professional electives)
- Additional credit component: 45 credit hours (including information literacy, Cornerstone and 6 upper-level credits)
- Arts and sciences: 30 credit hours (including 9 upper level)

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/bachelor-professional-studies-technology-management-details**

GENERAL EDUCATION (DEGREE SPECIFIC REQUIREMENTS):

Business Ethics – BUS 323 – 3 credits
This course explores the nature of ethical business environments within the private and public sector. Today's complex, dynamic global environment requires business professionals who acknowledge, understand, and act appropriately when faced with inherent ethical challenges. This course prepares business professionals for these challenges by exploring ethics theory, personal values, and impacts of organizational culture. This leads to a deeper understanding of how ethical principles relate to the organizations in which people function, and the effects of organization's ethics on its reputation, functioning and performance.

Intermediate Algebra – MAT 114 – 3 credits
Covers an intermediate level of algebra in order to prepare students for subsequent courses in mathematics. Major topics include real numbers and algebraic expressions, equations and inequalities, functions and graphs, systems of equations and inequalities, polynomial expressions and functions, rational and radical expressions, and quadratic equations and functions.

OR

Business Statistics – BUS 233 – 3 credits
Develops skills in the essential tools used for statistical analysis and decision making in business. Covers descriptive and inferential statistics. Emphasizes research techniques such as sampling and experimental design concepts for single and multiple sample groups.

PROFESSIONAL CORE:

Financial Accounting – ACC 211 – 3 credits
Develops skills of basic financial accounting principles in the pursuit of organizational goals and strategies. Topics covered include financial statement analysis, accounting information systems, operating decisions, and financing.

Management Concepts and Applications - BUS 341 – 3 credits
A study of fundamental management theories, examining the manager's role in today's global business environment. Topics include the role of managers in the business environment, strategies for planning and decision making, organization and controls, leadership, motivation, staffing, and managing change.

Effective November 1, 2019, all newly admitted students at Excelsior College, including those enrolling through a partnership, will be required to complete the following:

- a new IND 101/IND 301 course focused on increasing student success, retention, and completion that is required to be completed as their first Excelsior course
- a newly revised information literacy course (INL 102) that is required to be completed within their first 13 Excelsior credits

The new IND 101/IND 301 course, which will be required of all students across all programs, encourages students' confidence and comfort with the Excelsior online experience, instills the courage to handle challenging material, inspires intellectual curiosity, and builds a sense of belonging with their peers and faculty.

The newly revised information literacy course is designed to address competencies that prepare students for their professional lives. It is a self-paced, 1-credit class focused on cyber literacy, the life cycle of information, finding and evaluating high-quality and low-quality sources, interpreting and processing information, and synthesizing and using information effectively.

Business Leadership – BUS 452 – 3 credits
Focuses on research findings about leadership, leadership practice, and leadership skill development. Explores and evaluates leadership practices, behaviors, and personal attributes of leaders and includes case studies of leaders and organizations. The course balances theory with real-world applications for a practical, skill-building approach to leadership.

Introduction to Computers – IT 221 – 3 credits
This course provides students with a fundamental knowledge of the computer system and its components, including computer hardware and architecture, application software, operating systems, networks, and the Internet. Advanced topics such as information privacy and security, database and data warehouse, data mining, and legal, ethical, and privacy issues in the information technology field will also be introduced in this course. Additionally, students will participate in learning activities to develop the needed skills to work with Microsoft Office suite.

Project Management – IT 390 – 3 credits
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.

TECHNOLOGY CORE:

Technology and Society – TECH 230 – 3 credits
Considers technological change from historical, artistic, a nd philosophical perspectives and its effect on human needs and concerns. Emphasis is placed on the causes and consequences of technological change and the evaluation of the implications of technology.

Economic Analysis for Technologists – TECH 330 – 3 credits
The application of economics and decision theory to the evaluation of engineering alternatives in planning, developing, constructing, and managing engineering projects.

Introduction to Energy Utilization – TECH 340 – 3 credits
Introduction to current and potential energy sources, the link between energy and wealth, and the consequences of action or inaction concerning energy and the environment.

Technology Management Capstone: Integrated Technology Assessment – TECH 490 – 3 credits
An online portfolio development experience that 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 Bachelor of Professional Studies in Technology Management 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 module of the 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 Management Assessment report.

CONCENTRATIONS:

Electrical Technology Concentration

A concentration in electrical technology focuses on training and preparing the students with the knowledge and practical skills in electrical technology along with electrical circuits, electrical systems, and electrical equipment. It is centered on design, assembly, testing, maintenance, repairing, and upgrading of electrical circuits, components, and equipment. The electrical technology outcomes are geared towards providing students with fundamental as well as applied knowledge in electrical systems, electrical equipment, and processes. These will prepare the students for positions in operating, repairing, and upgrading of electrical circuits, electrical systems, and electrical equipment.

Upon successful completion of the Excelsior College Bachelors of Professional Studies with an Electrical Technology concentration, the student will be able to: 1. Identify, formulate, and present solutions to a variety of technical problems in the area of electrical technology. 2. Demonstrate competency in the analysis, interpretation, and application of data in the area of electrical technology.

Digital and Analog Communication – ELEC 331 – 3 credits
This is a technology focused course covering the principles and applications of analog and digital communication circuits. Analysis of modulation and demodulation (AM, FM, PM), radio frequency (RF) transmitters and receivers, digital communication techniques, coding and multiplexing, network communications and protocols, transmission lines and media, wave propagation, optical fibers, wired and wireless communications, communication test equipment and troubleshooting, and communication standards are covered.

Electrical Theory – NUC 255 – 3 credits
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.

Applied Instrumentation and Control – TECH 225 – 3 credits

This course focuses on instrumentation, temperature, pressure, and flow measurements, transducers, pneumatic and hydraulic systems, programmable logic controllers, and process control. In this course the students will have the opportunities to explore the characteristics and operations of different types of transducers and measuring instruments. The importance of system models as well as its relationship between process control will also be covered.

Electrical Power Distribution – TECH 233 – 3 credits

This course provides students a comprehensive overview of commercial Electrical Power Distribution. Students examine power system flow dynamics along with those elements and facilities associated with electrical power generation, its transmission, and subsequent distribution to gain a working understanding of Electrical Power Distribution. Additionally, students assess frameworks associated with economic, regulatory, and energy accounting practices to gain in depth understanding of how and why telemetry, communication, and control requirements are vital to maintaining electrical power system stability and reliability.

Information Technology Concentration

A concentration in information technology focuses on training and preparing students to stay up-to-date with the rapidly changing technical environment. The information technology concentration is a technical discipline centered on the design, assembly, testing, and maintenance of computer circuitry and peripheral hardware. The concentration also emphasizes the information system concepts, principles, and practices, and problem solving of information technology domains. The information technology outcomes are geared toward providing students with a foundational knowledge of information technology in a wide variety of subject areas and preparing students for positions including information technicians, database management systems, software management, data communications, information security, and network management. Upon successful completion of the Excelsior College Bachelors of Professional Studies with an information technology concentration, the student will be able to:

1. Analyze and apply a range of information system concepts, principles, and practices in the context of solving problems across a spectrum of information technology domains.
2. Develop computer-based applications using appropriate information technology concepts and principles.

Business Data Communication – IT 250 – 3 credits

This course provides overview and application of the concepts and practices of data communications and networking within a business environment. Topics of this course include data communications models, protocols, standards, and services; networking technologies and communication media; network topology, design, and architecture; network management; wireless technologies; network security; and cryptography. Students will practice their knowledge and skills through hands-on labs and assignments, which is based on real-world business case scenarios.

Database Management Systems – IT 370 – 3 credits

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.

Wed Design and Development – IT 371 – 3 credits

This course will provide practical instruction on the design, creation, and maintenance of web pages. The course will cover the fundamental principles of web programming and formatting. This will include learning the difference between client side and server side scripting technologies, effective use of web authoring tools and code development. The course will also cover web design standards and the need for integrating human computer interaction principles in web design. The final project in the course will enable learners to apply current development and production practices to design web pages.

Overview of Computer Security – IT 380 – 3 credits

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. Nuclear Technology Concentration A concentration in information technology focuses on training and preparing students to stay up-to-date with the rapidly changing technical environment. The information technology concentration is a technical discipline centered on the design, assembly, testing, and maintenance of computer circuitry and peripheral hardware. The concentration also emphasizes the information system concepts, principles, and practices, and problem solving of information technology domains. The information technology outcomes are geared toward providing students with a foundational knowledge of information technology in a wide variety of subject areas and preparing students for positions including information technicians, database management systems, software

management, data communications, information security, and network management. Upon successful completion of the Excelsior College Bachelors of Professional Studies with an information technology concentration, the student will be able to:

1. Analyze and apply a range of information system concepts, principles, and practices in the context of solving problems across a spectrum of information technology domains.
2. Develop computer-based applications using appropriate information technology concepts and principles.

Nuclear Technology Concentration

Introduction to Heat Transfer and Fluid Mechanics – NUC 250 – 3 credits

This course provides a fundamental grounding in the principles of heat, heat transfer, and fluid mechanics, as they apply to power plant operation. While designed to meet the requirements of the Nuclear Uniform Curriculum Program, specifically Section 1.1.5 Heat Transfer and Fluid Flow of ACAD 08-006 for Non-Licensed Nuclear Operators, this course has broad applicability for anyone interested in power plant technology, regardless the heat source used. The course covers the following broad topics: Temperature, its measurement, and pressure-temperature relationships in power plant steam and water systems; Heat, its various forms, mechanisms and mechanics of heat transfer, and the related power plant components used to transfer heat; Fluid mechanics as they relate to heat and heat transport in power plant steam systems; Fluid mechanics as they relate to power plant water systems

Reactor Core Functions – NUC 330 – 3 credits

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.

Plant Systems Overview – NUC 350 – 3 credits

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. Systems are grouped/classified regarding their use and characteristics, e.g. production vs. safety, primary (nuclear interface) vs. balance of plant, active vs. passive.

Renewable Energy Technology Concentration

A concentration in renewable energy technology focuses on training and preparing students to stay current with the renewable energy industry. The renewable energy technology concentration is a technical discipline centered on renewable energies such as solar, wind, water, and geothermal. The concentration also emphasizes the political and economic influences on the renewable energy business. The renewable energy technology outcomes are geared toward providing students with a foundational knowledge of renewable energy in a wide variety of subject areas and preparing students for positions in the renewable energy industry including an understanding of economics and politics associated with renewable energy. Upon successful completion of the Excelsior College Bachelors of Professional Studies with a renewable energy technology concentration, the student will be able to:

1. Identify and discuss renewable energy technologies being used commercially and residentially
2. Perform an analysis of political and economic influences on the renewable energy business.

Electrical Power Distribution – TECH 233 – 3 credits

Design, operation, and technical details of modern power distribution systems including generating equipment, transmission lines, plant distribution, and protective devices Includes calculations of fault current, system load analysis, rates, and power economics.

Renewable Energy Overview I: Solar and Geothermal – TECH 250 – 3 credits

Overview of Solar (Photovoltaic) energy, Solar Thermal energy, and Geothermal energy. Also describes green building technologies (sustainable systems design). Political, economic, and environmental impact will also be discussed.

Renewable Energy Overview II: Wind and Water – TECH 251 – 3 credits

Overview of wind energy and water energy in both commercial and noncommercial applications. Continued discussion from TECH*250 regarding sustainable system design regarding green building technologies. Political, economic, and environmental impact will also be discussed.

Energy Industry Fundamentals – TECH 260 – 3 credits

The purpose of the Energy Industry Fundamentals course is to ensure students gain an understanding of the energy industry. The Energy Industry Fundamentals course aligns with tiers 4 and 5 of the Energy Competency Model developed by the Center for Energy Workforce Development (CEWD) and the U.S. Department of Labor. As such, it covers such basics as emerging principles

and concepts that impact the energy industry; compliance with safety and health procedures; how electric power and natural gas generation, transmission, and distribution work; a range of entry-level energy careers; and hot topics in energy. The course prepares students for the CEWD Energy Industry Fundamentals certificate exam. This is a 3-credit course, requiring a minimum of 18 hours of course engagement each week in an 8-week term (refer to the Credit Hours Calculation Policy in the Student Handbook), Course engagement includes such activities as discussions, reading, study time, and assignments.

Introduction to Energy Utilization – TECH 340 – 3 credits
Introduction to current and potential energy sources, the link between energy and wealth, and the consequences of action or inaction concerning energy and the environment.

BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

Course requirements for Bachelor of Science in Information Technology:

- Technical component (including concentration requirements): 48 credit hours (must include at least 15 credits at the upper level)
- Arts and Sciences: 60 credit hours
- Free electives: 12 credit hours (including information literacy and cornerstone course)

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/bachelor-science-information-technology-details**

GENERAL EDUCATION (DEGREE SPECIFIC REQUIREMENTS):

Business Ethics – BUS 323 – 3 credits
This course explores the nature of ethical business environments within the private and public sector. Today's complex, dynamic global environment requires business professionals who acknowledge, understand, and act appropriately when faced with inherent ethical challenges. This course prepares business professionals for these challenges by exploring ethics theory, personal values, and impacts of organizational culture. This leads to a deeper understanding of how ethical principles relate to the organizations in which people function, and the effects of organization's ethics on its reputation, functioning and performance.

Communication – TBD – 3 credits
Courses in speech, written composition, technical writing, or similar courses in either written or oral communications are applicable toward the communications requirements. Consult with an Excelsior College advisor.

Discrete Structures – TECH 205 – 3 credits
Covers an intermediate level of algebra in order to prepare students for subsequent courses in mathematics. Major topics include real numbers and algebraic expressions, equations and inequalities, functions and graphs, systems of equations and inequalities, polynomial expressions and functions, rational and radical expressions, and quadratic equations and functions.

Business Statistics – BUS 233 – 3 credits
Develops skills in the essential tools used for statistical analysis and decision making in business. Covers descriptive and inferential statistics. Emphasizes research techniques such as sampling and experimental design concepts for single and multiple sample groups.

OR

Statistics – MAT 201 –3 credits
Develops the statistical skills of collecting, organizing, summarizing, and analyzing information to draw conclusions or answer questions. Major topics include descriptive statistics, frequency distributions, probability, binomial and normal distributions, statistical inference, linear regression, and correlation. Duplication Note: MAT201 duplicates BUS233: Business Statistics and MAT215: Statistics for Health Care Professionals. Credit in only one of these courses will be applied toward graduation. MAT201 also duplicates the Excelsior College Examination MATX210. Students will receive credit for either the course or the examination, as both will not be applied toward graduation. *Prerequisite: Suggested Prerequisite: It is recommended that students have taken two courses in Algebra, or MAT 105 Essential Algebra and Statistics*

OR

One additional math course at the level of College Algebra or above.

INFORMATION TECHNOLOGY COMPONENT:

Fundamentals of Programming – IT 211 – 3 credits
This is an introductory programming course that covers problem solving and algorithm development using the popular programming language Python. Python is the programming language that is used to run applications like: YouTube, Google, DropBox, Instagram, Spotify, and Reddit. This course offers an introduction to basics programming concepts as well as reinforces the logical, systematic thinking required to develop basic algorithms. Also, the course examines the development of processes of design, coding and debugging. Good programming style is emphasized throughout the course.

Business Data Communications – IT 250 – 3 credits
This course provides overview and application of the concepts and practices of data communications and networking within a business environment. Topics of this course include data communications models, protocols, standards, and services; networking technologies and communication media; network topology, design and architecture; network management; wireless technologies; network security; and cryptography. Students will practice their knowledge and skills through hands-on labs and assignments, which is based on real-world business case scenarios.

Intermediate Programming – IT 313 – 3 credits
This is an intermediate programming course that covers problem-solving and algorithm development using the popular programming language Java. Java is one of the most popular languages used in object-oriented programming. This will prepare students to code and debug programs and applications written in the Java language, a common expectation in IT.

Operating Systems and Computer Systems - IT 361 – 3 credits
In this course, the architecture of a modern computer system and the organization of an operating system are emphasized. Course topics include an overview of computer architecture, central processing unit architecture and instructions, arithmetic and logical operations, structure of modern operating systems, operating system functions, concurrency and synchronization, process control, interprocess communication, memory organization and management, file systems, interfaces to network structures, protection and security, and virtualization concepts. These concepts are reinforced with practical applications using a personal computer, Raspberry Pi, and computer programs and scripts. Completion of the course requires students to perform several lab exercises that investigate and apply key architecture and operating system features, and development of computer programs and shell scripts. A final project is assigned where students apply the concepts to demonstrate mastery of the subject matter.

Database Management Systems – IT 370 – 3 credits
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.

Web Design and Development – IT 371 – 3 credits
This course will provide practical instruction on the design, creation and maintenance of web pages. The course will cover the fundamental principles of web programming and formatting. This will include learning the difference between client side and server side scripting technologies, effective use of web authoring tools and code development. The course will also cover web design standards and the need for integrating human computer interaction principles in web design. The final project in the course will enable learners to apply current development and production practices to design web pages.

Human-Computer Interactive Design – IT 375 – 3 credits
"Interaction design is heavily focused on satisfying the needs and desires of the people who will use the product." This course examines human-computer interaction (HCI) and focuses on all aspects of user interface (UI) + user experience (UX) design. Students will explore the fundamental concepts and methods involved in designing digital products, mobile applications, and websites. Students will be challenged to create a startup digital product in the form of a phone app, tablet app, or Web app/website. The course will be broken down into 8 stages (modules) which will break down the entire process that professional designers use every day to design the apps and/or websites that we love using today. Students will begin with the product brief (description, problem, audience, platform, etc.) and end with a high-fidelity prototype of their newly designed mobile app or website. Each module will include assignments, discussions, and other activities related directly to that module.

Overview of Computer Security – IT 380 – 3 credits
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.

Project Management – IT 390 – 3 credits
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.

System Administration – IT 460 – 3 credits
This course provides learners with the knowledge and hands-on skills necessary to administer systems and its resources. Topics covered include directory services, user account management, file and print services, load balancing, security and user/client administration. Students will setup and manage a fully functioning computer network of systems. Furthermore, through hands-on (labs) assignments, students deal with challenges designed to help them install, configure, and manage servers.

Integrated Technology Assessment Bix – IT 495 – 3 credits
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.
CONCENTRATIONS (minimum 15 credits):

Cybersecurity Technology Concentration

The Cybersecurity Technology concentration focuses on providing broad coverage on the technical, operational, and legal dimensions of cybersecurity. Students of this concentration will attain a holistic view of implementing effective cybersecurity programs appropriate to the environment. The curriculum focuses on areas such as organizational, network, application security issues as well as penetration testing, incidence response, and digital forensics. This will enable students to utilize a variety of cybersecurity tools and techniques in protecting information assets in organizations. The Cybersecurity Technology concentration will prepare students in positions such as security analyst, security architect, IT security coordinator, or penetration tester.

Upon successful completion of the Excelsior College Bachelor of Science in Information Technology with a concentration in Cybersecurity Technology, the learner will be able to:

1. Apply cybersecurity best practices in managing various computing environments comprised of heterogeneous devices and services,
2. Define and protect data assets in organizations by mitigating risks and integrating business continuity, and
3. Identify and analyze the impact of large scale cybercrime incidents on international security and terrorism.

Computer Forensics – IT 406 – 3 credits
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.

Cyber Attacks and Defenses – CYS 426 – 3 credits
This course investigates security issues, vulnerabilities, and mechanisms to identify, respond to and prevent cyberattacks 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, 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.

Business Continuity – CYS 455 – 3 credits
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.

Network and Application Security – CYS 403 – 3 credits
This course covers the main concepts and models of network and application security, which includes: security models and threats, access control, secure routing and switching, cryptography and secure communication, and how to mitigate security threats. This is a 3-credit course, requiring a minimum of 18 hours of course engagement each week in an 8-week term, or 9 hours per week in a 15-week term.

Organizational Information Security – CYS 401 – 3 credits
This course will prepare students to recognize information security threats, enable them to plan, develop, and communicate policies and practices to mitigate those risks, and respond to security information and event management (SIEM) incidents as they occur from a management perspective. Students will understand the complexities of communicating information security threats to senior management in addition to staffing, training, and leading IT staff capable of protecting the network and safeguarding IT assets. The CYS401 Organizational Information Security course is a brand new course in the Undergraduate Cyber Program.

Network Operations Concentration

The Network Operations concentration focuses on providing students with the critical knowledge and skills in telecommunications and networking, and preparing students for careers including, but not limited to, network technician, network administrator, network engineer, and network architect. Our curriculum incorporates courses in network design and network project management, network operating systems and network administration, wireless systems, RFID technology, and network security, which is designed to guide students through the process of planning, designing, managing and securing network and telecommunications systems.

Upon successful completion of the Excelsior College Bachelor of Science in Information Technology with a concentration in Network Operation, the student will be able to:

1. Apply advanced networking techniques and network operating system principles toward the operation of a robust network,
2. Integrate wireless technology solutions into the network infrastructure, and
3. Apply telecommunication management principles into the management of networks.

Advanced Networking – IT 422 – 3 credits

A study of the architecture, implementation and related protocols of (1) Broadband technologies such as ISDN, SMDS, DSL, Cable, WDM, DWDM and SONET, (2) Packet Switching Technologies such as switching methodologies, X.25, Frame Relay, and ATM, (3) TCP/IP topics such as IP protocol, TCP protocol, IP addressing and routing, ARP, and routing protocols. Other topics include the basic structure of the global Internet, and network security issues such as intrusion detection, firewalls, encryption, and digital signatures, the basics of VPNs (Virtual Private Networks) and their advantages and disadvantages.

Network Operating Systems – IT 424 – 3 credits

Identifies the main functions of operating systems and network operating systems, and distinguishes between the two. Examines and compares the basic features of common network operating systems such as Novell NetWare, all versions of Windows, Unix, and Linux. Discusses the common examples of network utility software and Internet software, software licensing agreements, and network security and backup/recovery issues.

Wireless Technology – IT 426 – 3 credits

Describes the infrastructures, components, and protocols of a wide range of wireless technologies. The course commences with a brief review of networking fundamentals including software and hardware used for interconnection of traditional wired networks. Examines existing wireless technologies such as global positioning satellite (GPS), cellular digital packet data (CDPD), general packet radio service (GPRS), infra-red (IR), the operation and protocols for simplex tone and data paging systems, and local multi-point communication systems (LMCS). Addresses future technologies such as Bluetooth, digital audio broadcast (DAB) and IMT2000.

Telecommunications Management – IT 428 – 3 credits

Focuses on the management of diverse network systems involving a set of layered responsibilities, which ensure that network communications channels are continuously available and perform optimally from source to destination. Topics include differentiating between technical, financial and operational responsibilities, network capacity planning and traffic analysis techniques, measurement of network reliability and availability, basic hardware and software network diagnostic tools, network security issues, and network help desk operations.

Prerequisite: A background in Data Communications and Computer Networking (or equivalent coursework/experience).

Network Systems Design and Management – IT 430 – 3 credits

This course covers network design and management principles that network analysts, architects, engineers, and administrators must consider when planning, designing, implementing, and maintaining their network. Course topics include network management functions, network and system architectures, data and network communications technologies and protocols, server architectures and network operating systems, network security, and network and system administration. Additional topics covered that impact network design and management include network management tools and applications, wireless network architectures, interoperability, cloud computing, and virtualization.

General Concentration

Recognizing that the Information Technology field is continuously evolving, the Bachelor of Science in Information Technology program offers the general option concentration. This customizable concentration provides flexibility in designing students' area of focus in order to meet ever-changing job demands and also to build upon students' current achievements. Our course offerings cover a wide range of IT specialties, which help students stay competitive in today's job market.

Approved IT Electives – TBD – 15 credits

Consult with an Excelsior College Academic Advisor.

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING TECHNOLOGY

Course requirements for Bachelor of Science in Electrical Engineering Technology:

- Technical component (including concentration requirements): 57 credit hours (must include at least 16 credits at the upper level)
- Arts and Sciences: 60 credit hours
- Free electives: 7 credit hours (including information literacy and cornerstone course)

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/bseet-details**

GENERAL EDUCATION (DEGREE SPECIFIC REQUIREMENTS):

Business Ethics – BUS 323 – 3 credits

This course explores the nature of ethical business environments within the private and public sector. Today's complex, dynamic global environment requires business professionals who acknowledge, understand, and act appropriately when faced with inherent ethical challenges. This course prepares business professionals for these challenges by exploring ethics theory, personal values, and impacts of organizational culture. This leads to a deeper understanding of how ethical principles relate to the organizations in which people function, and the effects of organization's ethics on its reputation, functioning and performance.

Communication – TBD – 3 credits

Courses in speech, written composition, technical writing, or similar courses in either written or oral communications are applicable toward the communications requirements. Consult with an Excelsior College advisor.

Foundations of Technology Problem Solving I – TECH 201 – 4 credits

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.

Foundations of Technology Problem Solving II – PHYS 202 – 4 credits

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.

Physics I – PHYS 201 – 3 credits

This course includes a study of linear motion, Newton's Laws & friction, torque, work, energy, power, impulse, momentum, uniform circular motion, angular kinematics & dynamics, moment of inertia, fluid statics, temperature, specific heat, heat of combustion, heat transfer, the ideal gas law, thermodynamics, and mechanical waves. Some of the mathematics to be applied in the course will be reviewed as needed. This course is recommended for technical coursework and careers.

Physics II – PHYS 203 – 3 credits

This course includes a study of electric charge, electric and magnetic forces, the electromagnetic field, light optics, and modern physics. This course is recommended for technical coursework and careers.

Physics I Laboratory – TECH 202 – 1 credit

OR

Physics II Laboratory – PHYS 204 – 1 credit

The activities are chosen to give students an opportunity to perform the experiments and record observations. In this lab students measure, experiment, observe, discover and understand the close relationship between the experimental observations and principles under study.

General Chemistry I – CHE 101 – 3 credits

General Chemistry examines topics including chemical nomenclature, measurement, states of matter, the atom, chemical bonding, solutions, stoichiometry, and thermochemistry, and how these apply in the world around us. The purpose of this course is to introduce you to the world of chemistry, which covers such topics as the structure of the atom and the basic physical laws that govern matter. You learn about the processes chemists and scientists use to determine the composition and nature of matter.

LAB REQUIREMENTS:

Seven Technology labs are required. Four must be from the following: DC Circuits, AC Circuits, Digital Electronics, Electronics I, Electronics II, Microprocessors. The other three must be in the concentration.

ELECTRICAL ENGINEERING TECHNOLOGY COMPONENT CORE REQUIREMENTS:

Circuit Theory I – ELEC 152 – 4 credits

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.

Circuit Theory II – ELEC 153 – 4 credits
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.

Electronics I – ELEC 160 – 4 credits
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.

Electronics II – ELEC 161 – 4 credits
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.

Digital Electronics – ELEC 201 – 4 credits
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.

Microprocessors – ELEC 202 – 4 credits
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.

Object Oriented Programming – IT 210 – 3 credits
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.

Project Management – IT 390 – 3 credits
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.

Integrated Technology Assessment Capstone – ELEC 495 – 3 credits
This is the required capstone course for the Bachelor of Science in Electrical 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 Bachelor of Science in Electrical Engineering Technology outcomes. The learning statements must be supported by documented evidence that demonstrate that the outcomes have been met. All ELEC 495 students are required to complete an online examination designed to assess the basic knowledge and understanding achieved by senior undergraduates in electrical engineering technology.

CONCENTRATIONS (15 credits):

Electronics Concentration

Electronics Concentration Gain foundational knowledge of electronics hardware and software and become equipped to stay up-to-date with the rapidly changing technology environment. This concentration focuses on the analysis, design, assembly, testing, upgrading, and maintenance of electronics, computers, and communications hardware, so that students are prepared for various positions in the field.

Digital and Analog Communications – ELEC 331 – 3 credits
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.

Advanced Digital Design – ELEC 306 – 3 credits
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.

Business Data Communications – IT 250 – 3 credits
This course provides overview and application of the concepts and practices of data communications and networking within a business environment. Topics of this course include data communications models, protocols, standards, and services; networking technologies and communication media; network topology, design and architecture; network management; wireless

technologies; network security; and cryptography. Students will practice their knowledge and skills through hands- on labs and assignments, which is based on real-world business case scenarios.

Control Systems – ELEC 321- 3 credits
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.

Microcontrollers – ELEC 307 – 3 credits
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.

Nanotechnology Concentration

Prepare for positions in micro- and nano-electronics R&D and manufacturing, nano-materials, and nano-medicine technology by taking courses related to nanotechnology processes, equipment, and hardware. This concentration addresses the analysis, design, assembly, testing, upgrading, and maintenance of nanotechnology processes and equipment, developing highly functional nano-materials, and grasping/shaping societal implications of nanotechnology.

Introduction to Nanotechnology – ELEC 305 – 3 credits
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.

Basic Nanofabrication Process – ELEC 310 – 3 credits
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.

Nanotechnology Process Equipment – ELEC 410 – 3 credits
This course presents the equipment used in nanofabrication processes at the manufacturing level as well as research and development stages. It 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, including equipment for doping, layer deposition, device evaluation, and packaging. This course contains a lab component.

Introduction to Nanofabrication Manufacturing Technology – ELEC 415 – 3 credits
This course is an introduction to the fundamentals and applications of nanofabrication manufacturing technology. Topics include etching and micromachining, nanogrinding, laser-based nanofabrication, pulse water drop micromachining, diamond nanogrinding, and commercialization issues of nanotechnology. This course contains a lab component.

Micro-electrical Mechanical Systems – ELEC 420 – 3 credits
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.

Power Systems Concentration

Stay up-to-date with the rapidly modernizing power electronics and power systems technology environment with this concentration centered on the analysis, design, assembly, testing, upgrading, and maintenance of DC/AC power conversion systems, electric power generation and distribution, and power control technologies. The concentration also emphasizes the analysis, design, development, operation, and troubleshooting of single phase and three-phase electric motors and electric machines, data acquisition, and instrumentation.

Programmable Logic Controllers – ELEC 210 – 3 credits
This course introduces students to programmable logic controllers (PLCs). Topics covered include PLC programming, troubleshooting, networking, and industrial applications.

Generation and Transmission of Electric Power – ELEC 360 – 3 credits
This course will examine electric power generation and transmission systems; power flow; economic scheduling of electric power generation; transmission operations; and power system faults.

Power Electronics – ELEC 350 – 3 credits
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.

Electric Machines – ELEC 345 – 3 credits
Principles and applications of DC motors and generators, ideal transformers and three-phase transformers, three-phase induction machines, equivalent circuit of the induction motor, synchronous generators, and motors.

Instrumentation and Data Acquisition – ELEC 370 – 3 credits
This course provides and introduction to virtual instrumentation and data acquisition. Topics covered include virtual instruments, sub virtual instruments, structures, and data acquisition.

BACHELOR OF SCIENCE IN NUCLEAR ENGINEERING TECHNOLOGY

Course requirements for Bachelor of Science in Nuclear Engineering Technology:

- Technical component: 48 credit hours (must include at least 16 credits at the upper level)
- Arts and Sciences: 60 credit hours
- Free electives: 16 credit hours (including information literacy and cornerstone course)

For more information on tuition, or to contact an advisor, please visit **http://epceonline.org/bs-nuclear-engineering-technology**

GENERAL EDUCATION (DEGREE SPECIFIC REQUIREMENTS):

Business Ethics – BUS 323 – 3 credits
This course explores the nature of ethical business environments within the private and public sector. Today's complex, dynamic global environment requires business professionals who acknowledge, understand, and act appropriately when faced with inherent ethical challenges. This course prepares business professionals for these challenges by exploring ethics theory, personal values, and impacts of organizational culture. This leads to a deeper understanding of how ethical principles relate to the organizations in which people function, and the effects of organization's ethics on its reputation, functioning and performance.

Communication – TBD – 3 credits
Courses in speech, written composition, technical writing, or similar courses in either written or oral communications are applicable toward the communications requirements. Consult with an Excelsior College advisor.

Atomic and Nuclear Physics – NUC 240 – 4 credits
This course 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. It 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.

Thermodynamics – NUC 245 – 3 credits
This course provides students with the understanding of thermodynamics principles and how thermodynamic principles apply to systems, including the importance of understanding thermodynamic principles for nuclear power plant operations. Topics include Zeroth Law, First Law, Second Law, closed system, open system, entropy, Mollier Diagram, the Carnot and Rankine cycles, and efficiency for the Carnot and Rankine cycles power cycles. This course contains laboratory work based on a Generic Pressurized Water Reactor (PWR) simulator

Physics I – PHYS 201 – 3 credits
This course includes a study of linear motion, Newton's Laws & friction, torque, work, energy, power, impulse, momentum, uniform circular motion, angular kinematics & dynamics, moment of inertia, fluid statics, temperature, specific heat, heat of combustion, heat transfer, the ideal gas law, thermodynamics, and mechanical waves. Some of the mathematics to be applied in the course will be reviewed as needed. This course is recommended for technical coursework and careers.

Physics II – PHYS 203 – 3 credits
This course includes a study of electric charge, electric and magnetic forces, the electromagnetic field, light optics, and modern physics. This course is recommended for technical coursework and careers.

Physics I Laboratory – PHYS 202 – 1 credit

OR

Physics II Laboratory – PHYS 204 – 1 credit

The activities are chosen to give students an opportunity to perform the experiments and record observations. In this lab students measure, experiment, observe, discover and understand the close relationship between the experimental observations and principles under study.

General Chemistry I – CHE 101 – 3 credits

General Chemistry examines topics including chemical nomenclature, measurement, states of matter, the atom, chemical bonding, solutions, stoichiometry, and thermochemistry, and how these apply in the world around us. The purpose of this course is to introduce you to the world of chemistry, which covers such topics as the structure of the atom and the basic physical laws that govern matter. You learn about the processes chemists and scientists use to determine the composition and nature of matter.

General Chemistry Laboratory I – CHE 101L – 1 credits

This 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.

Intermediate Algebra – MAT 114 – 3 credits or above

Covers an intermediate level of algebra in order to prepare students for subsequent courses in mathematics. Major topics include real numbers and algebraic expressions, equations and inequalities, functions and graphs, systems of equations and inequalities, polynomial expressions and functions, rational and radical expressions, and quadratic equations and functions.

Foundations of Technology Problem Solving I – TECH 201 – 4 credits

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.

Foundations of Technology Problem Solving II – TECH 202 – 4 credits

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.

NUCLEAR ENGINEERING TECHNOLOGY COMPONENT CORE REQUIREMENTS:

Circuit Theory I – ELEC 152 – 4 credits

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.

AND

Circuit Theory II – ELEC 153 – 4 credits

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. (both courses, ELEC 152 and ELEC 153, must be completed)

OR

Electrical Theory – NUC 255 – 3 credits

Introduction to the fundamentals of charge, AC and DC current, voltage, capacitance, inductance, energy, power, Kirchhoff's laws, loop and nodal analysis, and linear voltage-current characteristics.

Introduction to Computers – IT 221 – 3 credits

This course provides students with a fundamental knowledge of the computer system and its components, including computer hardware and architecture, application software, operating systems, networks, and the Internet. Advanced topics such as information privacy and security, database and data warehouse, data mining, and legal, ethical, and privacy issues in the information technology field will also be introduced in this course. Additionally, students will participate in learning activities to develop the needed skills to work with Microsoft Office suite.

Fundamentals of Reactor Safety – NUC 271 – 3 credits

The course will provide you with an overview of nuclear reactor plant safety design topics, including basic concepts relating to regulatory requirements, reactor plant safety analysis, reactor protection systems, plant procedural structure, and emergency planning. Additionally, the course will explore significant industry events, including those at Three Mile Island, Chernobyl, and Fukushima, as well as the impact of the 9/11 terrorism event. Course subject matter will reference the Pressurized Water Reactor nuclear plant design.

Material Science – NUC 323 – 3 credits

Material Science is a study of how materials are used in nuclear engineering applications. Topics studied in the course include basic nuclear plant operation overview, atomic bonding, crystalline and noncrystalline structures, diffusion, mechanical and thermal behavior, failure analysis and prevention, structural

materials, ceramics, corrosion, radiation effects on materials, material commonly used in reactor core and nuclear plant design, and material problems associated with reactor core operation.

Health Physics and Radiation Protection – NUC 210 – 3 credits
This course provides a fundamental grounding in the theory and principles of radiation protection relevant to nuclear power plant operations.

Radiation Measurement Lab – NUC 211 – 3 credits
This course provides a fundamental rounding in practical aspects of detection and measurement of radiation and radioactive contamination relevant to nuclear power plant operations.

Plant Systems Overview – NUC 350– 3 credits
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. Systems are grouped/classified regarding their use and characteristics, e.g. production vs. safety, primary (nuclear interface) vs. balance of plant, active vs. passive.

Reactor Core Fundamentals – NUC 330 – 3 credits
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.

Introduction to Heat Transfer and Fluid Mechanics – NUC 250 – 3 credits
This course provides a fundamental grounding in the principles of heat, heat transfer, and fluid mechanics, as they apply to power plant operation. While designed to meet the requirements of the Nuclear Uniform Curriculum Program, specifically Section 1.1.5 Heat Transfer and Fluid Flow of ACAD 08-006 for Non-Licensed Nuclear Operators, this course has broad applicability for anyone interested in power plant technology, regardless the heat source used. The course covers the following broad topics: Temperature, its measurement, and pressure-temperature relationships in power plant steam and water systems; Heat, its various forms, mechanisms and mechanics of heat transfer, and the related power plant components used to transfer heat; Fluid mechanics as they relate to heat and heat transport in power plant steam systems; Fluid mechanics as they relate to power plant water systems

Integrated Technology Assessment – NUC 495 – 3 credits
The Nuclear Engineering Technology Capstone is an in-depth, student-centered course that requires the integration of theory and practical experience. Students will integrate and apply the theory, technical skills, and professional skills they have learned to offer solutions a specific nuclear industry event. The project will analyze the Fukushima Nuclear Accident event from an engineering technical problem, potential consequences if the primary containment failed, and provide a recommendation for a design that would mitigate or prevent future events in which the student will conduct research by exploring, evaluating, and theorizing a solution in a final paper. The capstone course is designed to develop the technical and non-technical competencies of students in an integrated fashion.

CONCENTRATIONS (15 credits):

General Concentration Students selecting the general concentration can customize their experience by choosing free electives in any field of college study, including in professional or technical subjects and arts and sciences. A minimum of 16 credits must be completed, to include information literacy.

Approved Free Electives – TBD – 15 credits
Consult with an Excelsior College Academic Advisor.
Nuclear Cybersecurity Concentration This concentration emphasizes the concepts associated with governance, legal, and compliance of cybersecurity in the nuclear industry. Students gain foundational knowledge of cybersecurity and the impacts of cyber-attacks on nuclear facilities, and are prepared to accept cybersecurity positions within the nuclear industry. A minimum of 16 credits must be completed in this area, to include these requirements:

Nuclear Cybersecurity Concentration

Overview of Computer Security – IT 380 – 3 credits
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.

Governance, Legal, and Compliance – CYS 260 – 3 credits
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, HIPAA, 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.

Cybersecurity Defense in Depth for the Nuclear Industry – CYS 350 – 3 credits
The course examines the world of cybersecurity risks and defenses which poses significant threats to the nuclear industry infrastructure. This course will provide knowledge, skills, and techniques to identify and address the many cybersecurity threats facing the nuclear industry 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 a nuclear industry perspective using real-world scenarios to demonstrate actual cybersecurity threats and the strategies used to defend against those threats.

Business Continuity – CYS 455 – 3 credits
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.

Cybersecurity Investigation and Case Studies for the Nuclear Industry – CYS 465 – 3 credits
This course provides a comprehensive analysis of the methods, tools, and best practices for responding to cyber security incidents and product vulnerabilities in the nuclear industry. It covers building a computer security incident response team (CSIRT) and a product security team (PST) for security vulnerability handling. It includes a discussion of the best practices on conducting a cybersecurity investigation, which minimizes potential damage while ensuring proper handling of electronic data collection. Students review legal issues from a variety of national perspectives and consider the practical aspects of coordination with other organizations.

Information Literacy – INL 102 – 1 credit
An online self-paced course providing a broad overview of information literacy concepts. Introduces skills for locating, using, and evaluating various information resources, as well as discussing the legal and ethical uses of information. Students take five quizzes to help learn course content, and a Pass/Fail grade is determined by the final examination.

Nuclear Leadership Concentration

This concentration emphasizes topics such as business leadership, organizational behavior, change management, leadership communications, and leadership courage/risk management, this concentration prepares graduates to take on leadership roles within the nuclear industry. A minimum of 16 credits must be completed in this area, to include these requirements:

Organizational Behavior – BUS 311 – 3 credits
An overview of human behavior in work organizations. Examines theoretical, empirical, and applications issues from individual, interpersonal, group, and organizational perspectives. Topics include the overview and history of the field, perceptions, attitudes, learning processes, personality, motivation, stress, performance appraisal, group dynamics, leadership, communication, decision making, job design, organizational structure and design, organizational change, and development.

Business Leadership – BUS 452 – 3 credits
Focuses on research findings about leadership, leadership practice, and leadership skill development. Explores and evaluates leadership practices, behaviors, and personal attributes of leaders and includes case studies of leaders and organizations. The course balances theory with real-world applications for a practical, skill-building approach to leadership.

Leading Change in the Nuclear Industry – NUC 280 – 3 credits
Primary focus is preparation of future leaders in the nuclear industry on concepts concerning effective change management associated with the nuclear industry.

Leadership Communications in the Nuclear Industry – NUC 285 – 3 credits
Primary focus is preparation of future leaders in the nuclear industry on concepts concerning effective leadership communications associated with the nuclear industry

Nuclear Leadership – Leadership Courage/Risk Management – NUC 360 – 3 credits
This course details the necessary leadership styles for the nuclear industry. The course focuses on concepts associated with effective leadership, teamwork, ethical decision making, leadership challenges, risk management, organizational structure, and business acumen. Students will develop strategies to transition current nuclear industry styles to transformational and situational leadership styles to meet the challenges facing the nuclear industry.

Information Literacy – INL 102 – 1 credit
An online self-paced course providing a broad overview of information literacy concepts. Introduces skills for locating, using, and evaluating various information resources, as well as discussing the legal and ethical uses of information. Students take five quizzes to help learn course content, and a Pass/Fail grade is determined by the final examination.

BACHELOR OF SCIENCE IN CYBERSECURITY

Course requirements for Bachelor of Science in Cybersecurity:

- Cybersecurity component: 52 credit hours (must include at least 15 credits at the upper level)
- Arts and Sciences: 60 credit hours
- Free electives: 8 credit hours (including information literacy and cornerstone course)

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/certificate-bachelor-in-cybersecurity-details**

GENERAL EDUCATION (DEGREE SPECIFIC REQUIREMENTS):

Business Ethics – BUS 323 – 3 credits
This course explores the nature of ethical business environments within the private and public sector. Today's complex, dynamic global environment requires business professionals who acknowledge, understand, and act appropriately when faced with inherent ethical challenges. This course prepares business professionals for these challenges by exploring ethics theory, personal values, and impacts of organizational culture. This leads to a deeper understanding of how ethical principles relate to the organizations in which people function, and the effects of organization's ethics on its reputation, functioning and performance.

Communication – TBD – 3 credits
Courses in speech, written composition, technical writing, or similar courses in either written or oral communications are applicable toward the communications requirements. Consult with an Excelsior College advisor.

Discrete Structures – TECH 205 – 3 credits
Covers an intermediate level of algebra in order to prepare students for subsequent courses in mathematics. Major topics include real numbers and algebraic expressions, equations and inequalities, functions and graphs, systems of equations and inequalities, polynomial expressions and functions, rational and radical expressions, and quadratic equations and functions.

Business Statistics – BUS 233 – 3 credits
Develops skills in the essential tools used for statistical analysis and decision making in business. Covers descriptive and inferential statistics. Emphasizes research techniques such as sampling and experimental design concepts for single and multiple sample groups.

OR

Statistics – MAT 201 –3 credits
Develops the statistical skills of collecting, organizing, summarizing, and analyzing information to draw conclusions or answer questions. Major topics include descriptive statistics, frequency distributions, probability, binomial and normal distributions, statistical inference, linear regression, and correlation. Duplication Note: MAT201 duplicates BUS233: Business Statistics and MAT215: Statistics for Health Care Professionals. Credit in only one of these courses will be applied toward graduation. MAT201 also duplicates the Excelsior College Examination MATX210. Students will receive credit for either the course or the examination, as both will not be applied toward graduation. *Prerequisite: Suggested Prerequisite: It is recommended that students have taken two courses in Algebra, or MAT 105 Essential Algebra and Statistics*

OR

One additional math course at the level of College Algebra or above.

CYBERSECURITY CORE REQUIREMENTS:

Introduction to Microprocessors – CYS 203 – 3 credits
The course introduces the fundamental principles, operations, and applications of microprocessors. The architecture and organization of microprocessors including hardware, software and peripheral interfacing will be covered. In addition, the basic organization and function of microcontrollers will also be covered. 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

Introduction to Cybersecurity – CYS 245 – 1 credit
The course provides students with an introduction to the basic and fundamental concepts of cyber security from both a technical and managerial perspective. Students will gain insight on common cyber-attacks and the techniques for identifying, detecting and defending against cyber security threats. The course will cover the basics of physical, network and web security as well as standards and laws in Cybersecurity. The knowledge gained in this course will provide students with a concrete foundation to further master the concepts of Cybersecurity.

Governance, Legal, and Compliance – CYS 260 – 3 credits
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, HIPAA, 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. This is a 3-credit course, requiring a minimum of 18 hours of course engagement each week in an 8-week term, or 9 hours per week in a 15-week term (refer to the Credit Hours Calculation Policy in the Student Handbook), Course engagement includes such activities as discussions, reading, study time, and assignments.

Cybersecurity Defense in Depth – CYS 345 – 3 credits
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.

Cyber Attacks and Defense – CYS 426 – 3 credits
This course investigates security issues, vulnerabilities, and mechanisms to identify, respond to and prevent cyberattacks 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, 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.

Security Focused Risk Management – CYS 450 – 3 credits
This course will focus on providing you 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.

Business Data Communications – IT 250 – 3 credits
This course provides overview and application of the concepts and practices of data communications and networking within a business environment. Topics of this course include data communications models, protocols, standards, and services; networking technologies and communication media; network topology, design and architecture; network management; wireless technologies; network security; and cryptography. Students will practice their knowledge and skills through hands-on labs and assignments, which is based on real-world business case scenarios.

Operating Systems – IT 360 – 3 credits
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.

Overview of Computer Security – IT 380 – 3 credits
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.

Computer Forensics – IT 406 – 3 credits
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.

System Administration – IT 460 – 3 credits
This course provides learners with the knowledge and hands-on skills necessary to administer systems and its resources. Topics covered include directory services, user account management, file and print services, load balancing, security and user/client administration. Students will setup and manage a fully functioning computer network of systems. Furthermore, through hands-on (labs) assignments, students deal with challenges designed to help them install, configure, and manage servers.

Cybersecurity Capstone – CYS 496 – 3 credits
This capstone course will examine computer security technologies and principles, including risk management, access control, authentication, software security, security assessment and testing, and legal issues in cybersecurity. This course includes

a final research project that will expose students to real-life scenarios in cybersecurity. This is a 3-credit course, requiring a minimum of 18 hours of course engagement each week in an 8-week term, or 9 hours per week in a 15-week term (refer to the Credit Hours Calculation Policy in the Student Handbook). Course engagement includes such activities as discussions, reading, study time, and assignments.

CONCENTRATIONS (15 credits):

General Concentration

This customizable concentration provides you with the flexibility to design an area of specialization to meet ever-changing job demands and build upon your current achievements. Choose from approved technical electives to meet the degree requirements.

Approved Free Electives – TBD – 15 credits

Consult with an Excelsior College Academic Advisor.
Cyber Operations Concentration The Cyber Operations concentration gives you the opportunity to specialize your skills on the front line of cybersecurity. The courses prepare you to handle cyber incidents and respond to incidents as part of a cyber team. Learn to identify fundamental security design principles that lead to system vulnerabilities, conduct exploits as part of an offensive cyber operation, and apply fundamental security design principles during system design, development, and implementation to minimize vulnerabilities.

Cyber Operations Concentration

Object Oriented Programming – IT 210 – 3 credits

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.

OR

Introduction to Programming – IT 240 –3 credits

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 both procedural and non-procedural (Object Oriented) Programming. Topics covered include fundamentals of algorithms, problem solving, programming concepts, classes and methods, control structures, arrays, and strings. This course will serve not only as an introduction to programming in C++ but also as a preparation for a more advanced C++ course involving data structures and algorithmic development. This course duplicates IT 210. Students cannot receive credit for both courses.

Introduction to Homeland Security – CJ 125 – 3 credits

This course provides an overview of the concept of Homeland Security, and how it has evolved since the September 11th terrorist attacks in New York City. Also covered is the need to balance terrorism threats, natural disasters, and other hazards; the critical role of communications and social media; intelligence and counterterrorism, border security and immigration, transportation safety and security, communications, cybersecurity, and critical infrastructure protection; identification of vulnerabilities, mitigation, prevention, and preparedness; all-hazards response and recovery; statutory actions, critical guidance documents, directives, and legislation; the hierarchical organizational structure of the Department of Homeland Security (DHS), and the various programs and actions undertaken by government agencies, community organizations, and the private sector in support of homeland security concept.

Reverse Engineering – CYS 400 – 3 credits

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.

Secure Software Development – CYS 470 – 3 credits

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.

Large Scale Cybercrime and Terrorism – CYS 475 – 3 credits

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 cybercrime 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.

MASTER OF SCIENCE IN CYBERSECURITY

The Master of Science in Cybersecurity requires 30 total credits, including those in the area of focus.

For information on tuition, or to contact an advisor, please visit: **http://epceonline.org/cybersecurity-graduate-certificate-and-masters-details**

Foundations of Cybersecurity – CYS 500 – 3 credits

This course provides students with knowledge and tools necessary to research cybersecurity threats, identify threats and take action to minimize, mitigate, or eliminate the threats. Additionally, the concepts of continuous training within the organization, and the company-wide impact of cybersecurity are addressed.

Network and Communication Security – CYS 504 – 3 credits

This course is an introduction to network security fundamentals. It is organized in four parts. The first part covers the basics of private key and public key cryptography, including the common encryption algorithms AES, RC4, and RSA. The second part builds on cryptography to design secure protocols for confidentiality, authentication, and data integrity. Examples will include IPSec, SSL/TLS, and VPNs. The third part covers how cyber-attacks proceed from reconnaissance to exploits and intrusions. Particular emphasis is given on web attacks (such as phishing, SQL injection, drive-by downloads) and malware. The last part of the course will describe focus on intrusion prevention, detection, and response. Specific topics include firewalls, spam filters, intrusion detection systems, and risk management. Students will learn about protocols to communicate securely over unsecure networks, and about modern technologies for protecting computers from a wide range of threats. Throughout the course, real world cases are discussed, and students will gain hands-on experience in labs.

Project Management Principles and Application – BUS 530 – 3 credits

This course provides the theoretical framework and practical tools to develop comprehensive understanding of the managerial process in project management. The curriculum is built for the business leaders, professionals, or administrators who are involved in completing special projects and desire to competently utilize professional project management methods and techniques. Throughout its duration, this course will offer numerous examples on how to apply project management strategies and tools to real world projects and situations as well as provide the students with opportunities to practice their learned skills. Available supporting project management technology will be described and the students will receive high-level hands-on training on Microsoft Office Project 2007. In a nutshell, the students will gain a thorough understanding of project management process and techniques which will enable them to optimize the process of their projects and place them onto a path towards successful project completion.

Ethics, Legal, and Compliance Issues in Cybersecurity – CYS 541 – 3 credits

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.

Leadership and Communications in Cybersecurity – CYS 550 – 3 credits

This course will develop the knowledge and skills necessary to design a cybersecurity strategy, including people, process, and technology, in a complex organization. The role of leaders in cybersecurity becomes critical to business success. The course will cover global issues; emphasis will be placed on individual's roles within organizations and how they communicate their ideals to the teams of individuals performing cybersecurity tasks and other stakeholders who provide oversight.

Information Assurance – CYS 560 – 3 credits

This course will provide awareness, guidance, best practices and assessments on the principles of information systems security. We will examine the foundations of information systems security as defined by industry experts and the International Information Systems Security Certification Consortium, or (ISC)2, which is considered a definitive source for information security domain definitions and a premier certification authority. As such, this course will examine information systems security concepts according to the consortium s newly redesigned "eight domains of knowledge" model for their Certified Information Systems Security Professional (CISSP) certification. We will use course

textbooks, open educational resources, current cybersecurity events, research and case studies to support our lectures, discussions and assessments. We will learn to apply some of the information systems security knowledge and skills through individual activities and practice exams. The course will provide you with an opportunity to apply the course subjects to a project that encompasses several of the major topics.

Capstone Project in Cybersecurity – CYS 596 – 3 credits
This is a capstone course which examines computer security technologies and principles, including cryptography, authentication, access control, database and software security, management issues such as physical and infrastructure security, human factors, and security auditing. This course also covers IT security management, risk assessment, and legal and ethical considerations. This is a 3-credit course, requiring a minimum of 18 hours of course engagement each week in an 8-week term, or 9 hours per week in a 15-week term (refer to the Credit Hours Calculation Policy in the Student Handbook), Course engagement includes such activities as discussions, reading, study time, and assignments.

CONCENTRATIONS (9 credits):

General Concentration

Choose from 9 credits worth of approved technical electives to customize the concentration to your career goals.

Approved Technical Electives – TBD – 9 credits
Consult with an Excelsior College Academic Advisor.

Information Assurance Concentration

Designed as a specialization for an individual who desires to be hands on while combating cybersecurity threats, the information assurance concentration prepares students for roles on the front line of defense. Required courses include:

Software and Application Security – CYS 523 – 3 credits
The course teaches you secure programming techniques by focusing on foundational defensive techniques, cutting-edge protection, and security features you can use in your development process. The critical skills needed to succeed as a developer will include Identify security defects in your code, fix security bugs using secure coding techniques, incorporate security into your development process, the use of open source tools to test your applications. The course will also focus on design flaws in existing software packages. This is a 3-credit course, requiring a minimum of 18 hours of course engagement each week in an 8-week term, or 9 hours per week in a 15-week term (refer to the Credit Hours Calculation Policy in the Student Handbook). Course engagement includes such activities as discussions, reading, study time, and assignments.

Cyber Attacks and Defense – CYS 526 – 3 credits
This course investigates security issues, vulnerabilities, and mechanisms to identify, respond to and prevent cyberattacks 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, 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.

Digital Forensics and Investigation – CYS 586 – 3 credits
This course provides an in-depth analysis of the digital defense planning, technologies, and methods to safeguard organizational networks, databases, and applications. It presents a plan-protect-respond framework of digital security; the interaction of policies, implementation, and oversight; and ways to perform a computer forensic investigation.

MASTER OF BUSINESS ADMINISTRATION

The Master of Business Administration requires 36 - 45 total credits:

- Foundation component: 0-9 credit hours (waivable)
- Core component: 27 credit hours
- Concentration component: 9 credit hours

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/cybersecurity-graduate-certificate-and-masters-details**

FOUNDATION REQUIREMENTS:

Managerial Economics – ECO 508 – 3 credits
Discover how to use game theory and economic tools to make strategic decisions based on market structure, consumer behavior, government regulations, and other aspects of commercial business. Learn how supply and demand adjusts to shifts in managerial decision making. This course teaches you how to analyze markets, competitors, customers, employees, and purchasing decisions, and how to respond to market events and maximize profitability using pricing strategies, demand forecasting, and competitive and market structure analysis.

Organizational Behavior – BUS 553 – 3 credits
Take a closer look at organizations from a behavioral science perspective. In this course, you examine the interactive dynamics of formal and informal groups, managerial and decision-making activities, and interpersonal and organizational communication strategies. Topics include: organizational change, stress in the workplace, team conflict and negotiation, employee burnout, motivational leadership, and organizational performance.

Quantitative Analysis – BUS 503 – 3 credits
This course prepares you to apply research methods, statistical analysis, and probability concepts to business decisions. Learn how to develop research questions, write questionnaires and surveys, sample appropriate populations, collect data, compute descriptive statistics, calculate discrete and continuous probability distributions, and construct confidence intervals. Coursework includes applications of central limit theorem, parametric and nonparametric tests of hypothesis and regression analysis, variance and chi-square analysis, and correlation, linear regression, and multiple regression analysis.

CORE BUSINESS ADMINISTRATION REQUIREMENTS:

Accounting for Managers – BUS 500 – 3 credits
In the comprehensive project for this course, you make a final investment recommendation for a real company that you have researched and evaluated in terms of its financial practice and performance measures. Learn how to review a company's business activities, research industry averages, analyze financial statements, and compute debt ratio, gross profit margin, free cash flow times interest earned, and accounts receivable and inventory turnover. Topics include: the balance sheet and accounting cycle; inventory cost flow; liability of proprietorships, partnerships, and corporations; cash versus accrual; cost behavior, profitability analysis; budgeting and capital tools planning for profit and cost control; budget variance analysis; and internal controls and ethics.

Global Business Environment – BUS 502 – 3 credits
Learn how to assess the impact of an organization's international strategy on future global business opportunities, predict how fluctuating exchange rates affect the productivity of international firms, and propose an international market entry strategy based on a host nation's political, economic, and cultural environments. Course material explores cultural factors in international business, global trade and investment; measurement and reporting of foreign direct investments; regional economic integration; the global monetary system; exchange rate risk analysis; foreign market entry strategy; imports, exports, and global chain supply management; mixed sourcing strategy; sustainable international development; global marketing research and development; and personnel management.

Information Technology – BUS 570 – 3 credits
This course covers the strategic, operational, and ethical uses of information technology (IT). Study managerial, social, legal, regulatory, and ethical issues related to computer technology and data management, and examine global and electronic markets and the ways information technology supports customer and supply chain management. Topics include: disruptive IT and architecture, data governance, cloud computing, computer networking, data analytics and business intelligence, the Internet of Things (IoT), on-demand service, cybersecurity and risk management, search engines and social media platforms, e-commerce and e-business systems, enterprise data visualization, and information security and privacy issues.

Leadership Concentration

Leadership – BUS 552 – 3 credits
Grasp leadership fundamentals and define your own leadership style in this course that explores leadership practice in dynamic organizations. Course material shows you how to use goals, roles, and organizational structures to manage business units effectively and foster constructive relationships between leaders and subordinates in difficult workplace situations. Investigate how leaders develop and articulate vision and values, and how to use leadership theories to successfully negotiate, motivate employees, manage teams, cultivate innovation, improve performance, and drive organizational growth.

Finance – BUS 505 – 3 credits
Find out how organizations finance investments and manage day-to-day financial activities such as cash collections and payments. This course teaches you how to apply financial theory to real-life situations and make decisions as a financial manager with an incomplete data set. Learn how to work with financial statements and analyze common ratios to develop long- and short-term financial policies. Instruction also covers: the effect of interest rates on managerial decisions, the time value of money, discounted cash flow valuation, bonds and equity financing, stock valuation, present value, capital budgeting and investment, forecasting and cash flow projection, and project risk.

Marketing – BUS 506 – 3 credits
Deepen your understanding of marketing management, strategy, and tactics in practice. Through case studies, you examine ethical, legal, social, and environmental issues that impact marketing decision making in realistic business scenarios. For your final project, you work on a team to create a strategic marketing plan for a fictional national product or service. The course focuses on the planning process in the context of customers, competition, organizational priorities, and the external environment. Learn how to segment markets, set marketing metrics, create branding and integrated marketing communication strategies, track competitor market positions, select marketing channels, and use digital marketing tactics to promote products and services.

Operations Management – BUS 520 – 3 credits
Get hands-on experience producing a business case analysis, operations forecasting report, and process improvement plan. This course introduces manufacturing, distribution, and service operations, and their role in the organization and international business environments. Study process flow analysis; inventory management for products of steady, perishable, or frequent demand; capacity planning; logistics resource scheduling; supply chain management; quality management; prioritization; and project management.

Project Management Principles and Applications – BUS 530 – 3 credits
Become familiar with methods and tools that enable you to successfully initiate, plan, execute, control, and close a project. This course shows you how to anticipate, mitigate, and avoid project risk, manage resources, use different budgeting methods, resolve conflicts, and choose appropriate communication, reporting, and documentation tools.

MBA Business Strategy Capstone - BUS 699 – 3 credits
In the MBA capstone, you acquire and demonstrate advanced knowledge of how to develop and implement effective business strategies. Gain experience evaluating complex business situations and making strategic decisions under conditions of uncertainty. You'll explore topics including internal and external environments, business ethics and social responsibility, quantitative analysis, accounting and finance, business models, competitive rivalry, international expansion, cooperative strategy, mergers and acquisitions, corporate structure, change management, leadership, and policy. For your final assignment, you create an integrated business portfolio that showcases your area of expertise.

CONCENTRATIONS (9 credits):

General Concentration
Choose from 9 credits approved business electives to customize the concentration to your career goals.

Approved Business Electives – TBD – 9 credits
Consult with an Excelsior College Academic Advisor.
Leadership Concentration Develop your skill at managing organizational changes and applying leadership strategies to manage conflicts in the workplace. This concentration prepares you to design creative solutions and impactful courses of action that support the organization's employees and mission.

Leading Teams – BUS 518 – 3 credits
Success of a team is hinged on the ability of leadership to lead and manage the team, whether that team is local or remote. This course is designed to enhance your leadership skills to lead high performing teams of any type. Self-awareness of leadership styles through theoretical models will be explored as well as when to exhibit certain leadership styles to achieve success through influencing others. Leaders of teams will develop core competencies, such as people skills, team dynamics, designing high performing work teams, motivating teams, and influencing organizational change and culture.

Contingency Planning – BUS 550 – 3 credits
Leaders and managers need to know what the potential causes are and how to sustain control of interruptions. This course examines the planning process in organizations to continually confront the unlikelihood of a disaster occurring causing an unexpected interruption of normal operations. Specifically, it provides an overview of the key elements and strategies of implementing a crisis management program within an organization. Undertaking a business function analysis approach, the students will be able to define anticipated consequences when a disruption of normal organizational operations happens and development a recovery plan built around desired outcomes. Approved Leadership Elective – TBD – 3 credits Consult with an Excelsior College Academic Advisor.

Worcester Polytechnic Institute (WPI)

GRADUATE CERTIFICATE IN POWER SYSTEM ENGINEERING

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/graduate-certificate-power-systems-engineering-details**

Protection and Control Specialization

Four technical courses are required to complete the certificate.

Power System Analysis – ECE 5500

This graduate level course examines the principles of Power System 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.)

Transients in Power System – ECE 5511

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)

OR

Power System Dynamics – ECE 5523

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 System or equivalent background experience is suggested.)

Protective Relaying – ECE 5521

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 manufacturers 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: ECE 5500 Power System Analysis or equivalent background experience is suggested. Familiarity with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background is recommended. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.)

Advanced Applications in Protective Relaying – ECE 5522

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 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.)

Renewable and Distribution Concentration

Five to six technical courses are required to complete the certificate.

Power System Analysis – ECE 5500

This graduate level course examines the principles of Power System 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.)

Transients in Power System – ECE 5511

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)

Power Distribution – ECE 5530

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.)

Power System Protection and Control – ECE 5520

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 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)

OR

Protective Relaying – ECE 5521

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 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: ECE 5500 Power System Analysis or equivalent background experience is suggested. Familiarity with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background is recommended. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.)

Distributed and Renewable Power Generation – ECE 5532

This course introduces the characteristics and challenges of interconnecting increasing numbers of Distributed Energy Resources (DERs) to the Electric Power System (EPS). Topics include: challenges to distribution and transmission system protection; local voltage control; ride through; optimal interconnection transformer configurations; and practical engineering approaches to maintain system reliability and protection. The current and evolving interconnection standard (IEEE 1547) is included. (Prerequisites: ECE 5500 Power System Analysis plus either ECE 5520 Power System Protection and Control or ECE 5521 Protective Relaying. ECE 5530 Power Distribution highly recommended.)

GRADUATE CERTIFICATE IN POWER SYSTEM MANAGEMENT

Six courses are required to complete the certificate.

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/graduate-certificate-power-systems-management-details**

Power System Analysis – ECE 5500

This graduate level course examines the principles of Power System 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.)

Choose 2 or 3 of the following Electrical and Computer Engineering courses:

Transients in Power System – ECE 5511

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)

Electromechanical Energy Conversion – ECE 5512

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.

Power System Protection and Control – ECE 5520

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 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)

Protective Relaying – ECE 5521

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 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: ECE 5500 Power System Analysis or equivalent background experience is suggested. Familiarity with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background is recommended. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.)

Advanced Applications in Protective Relaying – ECE 5522

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 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.)

Power System Dynamics – ECE 5523

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 System or equivalent background experience is suggested.)

Power Distribution – ECE 5530

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.)

Power System Operation and Planning – ECE 5531

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 System; 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.

Power Transmission – ECE 5540

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 transient's 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.)

Power Electronics – ECE 523
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.)*

Choose 2 or 3 of the following Business courses:

Project Management – MIS 576
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.

Group and Interpersonal Dynamics in Complex Organizations – OBC 500
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.

Operations Risk Management – OIE 541
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.)

Optimization Methods for Business Analytics – OIE 598
This course covers mathematical optimization in greater detail beyond the foundational concepts of linear programming. A variety of optimization problem classes will be addressed, likely including integer programming, nonlinear programming, stochastic programming and global optimization. While ensuring an appropriate level of theory, the main emphasis will be the methodological and computational aspects of solving such problems arising in the operational, manufacturing, and service sectors. Recommended background: Previous course(s) in linear algebra, basic knowledge about optimization and linear programming, or consent of the instructor.

Special Topics in Energy Management – BUS 598
The student and faculty work together to develop a course focused on energy management from a business perspective.

MASTER OF ENGINEERING IN POWER SYSTEM ENGINEERING

Course Requirements:
- At least 21 total credit hours in Electrical and Computer Engineering (ECE) with at least 12 credit hours in ECE Power System Engineering courses
- Must include ECE 5500. Power System Analysis
- Up to 9 credit hours from engineering, mathematics, science or business.

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/me-power-systems-engineering-details**

Power System Analysis – ECE 5500 This graduate level course examines the principles of Power System 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.)*

Choose up to 4 courses in Power System Engineering:

Transients in Power System – ECE 5511
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)*

Electromechanical Energy Conversion – ECE 5512
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.

Power System Protection and Control – ECE 5520

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 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)*

Protective Relaying – ECE 5521

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 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: ECE 5500 Power System Analysis or equivalent background experience is suggested. Familiarity with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background is recommended. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.)*

Advanced Applications in Protective Relaying – ECE 5522

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 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.)*

Power System Dynamics – ECE 5523

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 System or equivalent background experience is suggested.)*

Power Distribution – ECE 5530

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.)*

Power System Operation and Planning – ECE 5531

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 System; 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.

Distributed and Renewable Power Generation – ECE 5532

This course introduces the characteristics and challenges of interconnecting increasing numbers of Distributed Energy Resources (DERs) to the Electric Power System (EPS). Topics include: challenges to distribution and transmission system protection; local voltage control; ride through; optimal interconnection transformer configurations; and practical engineering approaches to maintain system reliability and protection. The current and evolving interconnection standard (IEEE 1547) is included. *(Prerequisites: ECE 5500 Power System Analysis plus either ECE 5520 Power System Protection and Control or ECE 5521 Protective Relaying. ECE 5530 Power Distribution highly recommended.)*

Power Transmission – ECE 5540

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 transient's 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.)*

Choose up to 6 additional credit hours from:

- any Electrical and Computer Engineering graduate course including any of the Power System Engineering courses listed above and:

Selected Topics In Computer Engineering – ECE 579

Courses in this group are devoted to the study of advanced topics in computer engineering such as real-time intelligent systems, VLSI design and high-level languages

MASTER OF SCIENCE IN POWER SYSTEM MANAGEMENT

Course Requirements:

- Power System Analysis – ECE 5500
- At least 9 credits but no more than 12 credits in other ECE Power System Engineering courses.* **Credit cannot be awarded for ECE 5521 & 5522 if credit for ECE 5520 has been earned.*
- 12 credit hours of management classes.
- **Remaining credit hours may be taken in:** – Any graduate level course work in engineering, science, or system dynamics** – No more than 15 of the total degree credit hours may be in ECE.

For more information on tuition, or to contact an advisor, please visit: **http://epceonline.org/ms-power-systems-management-details**

Power System Analysis – ECE 5500

This graduate level course examines the principles of Power System 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 Power System Engineering Courses:

Transients In Power System – ECE 5511

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)*

Electromechanical Energy Conversion – ECE 5512

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.

Power System Protection And Control – ECE 5520

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 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)*

Protective Relaying – ECE 5521

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 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: ECE 5500 Power System Analysis or equivalent background experience is suggested. Familiarity with phasors, derivatives, transfer functions, poles and zeros, block diagram and the notion of feedback with basic understanding power system analysis or similar background is recommended. Note: Credit cannot be awarded for this course if credit has already been received for ECE 5520 Power System Protection and Control.)*

Advanced Applications in Protective Relaying – ECE 5522

This graduate level course covers advanced topics in the princip les 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 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.)

Power System Dynamics – ECE 5523
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 System or equivalent background experience is suggested.)*

Power Distribution – ECE 5530
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.)*

Power System Operation and Planning – ECE 5531
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 System; 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.

Distributed and Renewable Power Generation – ECE 5532
This course introduces the characteristics and challenges of interconnecting increasing numbers of Distributed Energy Resources (DERs) to the Electric Power System (EPS). Topics include: challenges to distribution and transmission system protection; local voltage control; ride through; optimal interconnection transformer configurations; and practical engineering approaches to maintain system reliability and protection. The current and evolving interconnection standard (IEEE 1547) is included. *(Prerequisites: ECE 5500 Power System Analysis plus either ECE 5520 Power System Protection and Control or ECE 5521 Protective Relaying. ECE 5530 Power Distribution highly recommended.)*

Power Transmission – ECE 5540
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 transient's 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.)*

Choose 4 of the following School of Business Courses:

Project Management – MIS 576 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.

Group and Interpersonal Dynamics in Complex Organizations – OBC 500

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.

Operations Risk Management – OIE 541

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.)

Optimization Methods For Business Analytics – OIE 598

This course covers mathematical optimization in greater detail beyond the foundational concepts of linear programming. A variety of optimization problem classes will be addressed, likely including integer programming, nonlinear programming, stochastic programming and global optimization. While ensuring an appropriate level of theory, the main emphasis will be the methodological and computational aspects of solving such problems arising in the operational, manufacturing, and service sectors. Recommended background: Previous course(s) in linear algebra, basic knowledge about optimization and linear programming, or consent of the instructor.

Special Topics in Energy Management – BUS 598

The student and faculty work together to develop a course focused on energy management from a business perspective.

Clemson University

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING (BSEE)

Course Requirements:
The Electrical Engineering (BSEE) Degree Completion program enables students to enroll in the Clemson University online electrical engineering degree completion program after completing required prerequire courses. Clemson University offers the CORE engineering courses required for the BSEE degree online. Prerequisite courses can be taken elsewhere and transferred to Clemson University with proper pre-approval.

All courses required for the traditional BSEE degree at Clemson University are required. For the most up to date information and curriculum requirements, please visit Clemson University's website at **www.clemson.edu/ece**.

For more information on applying, tuition costs, or to contact an advisor please visit **http://epceonline.org/bs-electricalengineering** and **www.clemson.edu/ece**.

Required and Prerequisite Courses

The following courses must be completed prior to consideration/acceptance into the BSEE Online Completion program. Candidates must have also met these prerequisite courses with an average GPA of 3.0.

- CH 1010 - Chemistry I (4)
- CH 1020 - Chemistry II (4)
- CPSC 1110 – Introduction to Programming in C (3)
- ENGL 1030 – Composition and Rhetoric (3)
- MTHSC 1060 - Calculus of One Variable I (4)
- MTHSC 1080 - Calculus of One Variable II (4)
- PHYS 1220 - Physics with Calculus I (3)
- PHYS 2210 - Physics with Calculus II (3)

The following courses are strongly recommended to be completed prior to applying:

- MTHSC 2060 - Calculus of Several Variables (4)
- MTHSC 2080 - Introduction to Ordinary Differential Equations (4)

ENGR and ECE Course Descriptions:

Engineering Disciplines and Skills - ENGR 1020 - 2 Credits (1 Contact Hours)

Provides foundational engineering problem solving skills. Students demonstrate problem solving techniques with an emphasis on dimensions and units, create and utilize spreadsheets for analysis, employ modeling techniques, and interpret the validity of experimental results. Includes exploration of various engineering disciplines. Introduces professional issues appropriate to engineering. Various forms of technical communication are emphasized. Includes Honors sections. Preq: MATH 1050 with a C or better; or preq or concurrent enrollment in MATH 1040 or MATH 1060 with a C or better; or a score of 65 or better on the Clemson Mathematics Placement Test (CMPT). Coreq: ENGR 1021.

Programming and Problem Solving - ENGR 1410 - 3 Credits (2 Contact Hours)

Students formulate and solve engineering problems individually and on teams using MATLAB and other computer applications; estimate answers for comparison to computed solutions; read, interpret and write programs, instructions and formatted output; create and interpret plots and trendlines; evaluate and compose conditional statements and looping structures; and debug. Various forms of technical communication are emphasized. Includes Honors sections. Preq: ENGR 1020 with a C or better; or preq or concurrent enrollment: ENGR 1060 with a C or better. Coreq: ENGR 1411.

Logic and Computing Devices - ECE 2010 - 3 Credits (3 Contact Hours)

Introduction to Boolean algebra and digital logic. Topics include number systems and representation of information; Boolean operators and algebra; expression minimization; combinational circuits, including adders, comparators, decoders and multiplexors; sequential logic, including flip-flops, shift registers, counters and memory. Includes Honors sections. Preq: MATH 1080 and PHYS 1220, each with a C or better.

Electric Circuits I - ECE 2020 - 3 Credits (3 Contact Hours)

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. Includes Honors sections. Preq: MATH 1080 and PHYS 1220, each with a C or better. Preq or concurrent enrollment: PHYS 2210 with a C or better.

Logic and Computing Devices Laboratory - ECE 2090 - 1 Credits (2 Contact Hours)
Introduction to designing, building, simulating and testing digital logic circuits. Topics include SSI and MSI ICs; general combinational circuits; adders, decoders and multiplexors; general sequential circuits; shift registers, counters and memory. Includes Honors sections. Preq or concurrent enrollment: ECE 2010 with a C or better.

Electrical Engineering Laboratory I - ECE 2110 - 1 Credits (2 Contact Hours)
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. Preq or concurrent enrollment: ECE 2020 with a C or better.

Electrical Engineering Laboratory II - ECE 2120 - 1 Credits (2 Contact Hours)
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. Preq: ECE 2020 and ECE 2110, each with a C or better. Preq or concurrent enrollment: ECE 2620 with a C or better.

Electric Circuits II - ECE 2620 - 3 Credits (3 Contact Hours)
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 ideal op amps. Includes Honors sections. Preq: ECE 2020 and MATH 2060 and PHYS 2210, each with a C or better. Preq or concurrent enrollment: MATH 2080 with a C or better.

Computer Organization - ECE 2720 - 3 Credits (3 Contact Hours)
Introductory course in computer organization and architecture. Topics include CPUs, memory, I/O, processor families, buses, peripherals, microarchitectures, and instruction sets. Includes Honors sections. Preq: CPSC 1110 and ECE 2010, each with a C or better.

Computer Organization Laboratory - ECE 2730 - 1 Credits (2 Contact Hours)
Laboratory enhances students' understanding of computer organization via assignments involving assembly language programming. Topics include basic syntax, branching and loops, addressing modes, arrays and pointers, subroutines and stacks. Includes Honors sections. Preq or concurrent enrollment: ECE 2720 with a C or better.

Electrical Engineering Laboratory III - ECE 3110 - 1 Credits (2 Contact Hours)
Measurements and characteristics of electronic devices and circuits; use of manual and automated instruments to acquire data; oral and written engineering reports. Preq: ECE 2120 and ECE 2620 and MATH 2080 and PHYS 2210, each with a C or better. Preq or concurrent enrollment: ECE 3200 with a C or better.

Electronics I - ECE 3200 - 3 Credits (3 Contact Hours)
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. Includes Honors sections. Preq: ECE 2620 and MATH 2080 and PHYS 2210, each with a C or better.

Signals, Systems, and Transforms - ECE 3300 - 3 Credits (3 Contact Hours)
Study of systems models, analysis of signals, Fourier series and transforms, sampling and Z transforms, discrete Fourier transforms. Includes Honors sections. Preq: ECE 2620 and MATH 2080, each with a C or better.

Electric Power Engineering - ECE 3600 - 3 Credits (3 Contact Hours)
Presents the basic principles of power systems, energy conversion, electromagnetic induction and developed forces. Topics include power and energy concepts and analysis; the basics of electric power generation, transmission, and distribution; synchronous machines, induction motors, and DC motors. Preq: ECE 2620 and PHYS 2210, each with a C or better.

Electromagnetics - ECE 3800 - 3 Credits (3 Contact Hours)
Topics in electrostatics include static electric charge, force, field (Coulomb's and Gauss's laws), flux, potential, energy, dielectrics, boundary conditions, and capacitance. Topics in magnetostatics include steady electric current, magnetic field (Biot-Savart and Ampere's law), force, flux, energy, boundary conditions, and inductance. Preq: ECE 2620 and MATH 2060 and PHYS 2210, each with a C or better.

Electrical Engineering Laboratory IV - ECE 3120 - 1 Credits (2 Contact Hours)
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. Preq: ECE 3110 and ECE 3200, each with a C or better. Preq or concurrent enrollment: ECE 3210 with a C or better.

Random Signal Analysis - ECE 3170 - 3 Credits (3 Contact Hours)
Introduction to engineering problems of a probabilistic nature. Systems transformations, statistical averages, simulation, and estimation of system parameters. Includes Honors sections. Preq: ECE 2620 and MATH 2080, each with a C or better. Preq or concurrent enrollment: ECE 3300 with a C or better.

Electronics II - ECE 3210 - 3 Credits (3 Contact Hours)
Analysis and design of discrete amplifier circuits at low and high frequencies; operational amplifiers, frequency response, feedback, stability, and applications of analog integrated circuits. Preq: ECE 3200 with a C or better.

Microcontroller Interfacing - ECE 3710 - 3 Credits (3 Contact Hours)
Discusses the programming and interfacing of microcontrollers in order to control their integrated devices and external peripherals. Topics include memory and I/O; interupts, counters and timers; ADCs and DACs; PWMs; and parallel and serial communication. Preq: ECE 2620 and ECE 2720, each with a C or better. Preq or concurrent enrollment: ECE 3200 with a C or better.

Microcontroller Interfacing Laboratory - ECE 3720 - 1 Credits (3 Contact Hours)
Emphasizes microcontroller programming and interfacing for controlling various types of hardware. Topics include reading and writing to RAM, applications of a digital latch, keypad interfacing, interrupts, clock pulse generation, pulse width modulation, serial interfaces, and A-to-D and D-to-A conversion. Preq or concurrent enrollment: ECE 3710 with a C or better.

Fields, Waves, and Circuits - ECE 3810 - 3 Credits (3 Contact Hours)
Covers foundation of circuit theory, transmission lines and circuits, plane-wave propagation, radiation, and antennas. Preq: ECE 3800 and MATH 2080, each with a C or better.

Introduction to Linear Control Systems - ECE 4090 - 3 Credits (3 Contact Hours)
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. Preq: ECE 3300 with a C or better.

Communication Systems - ECE 4270 - 3 Credits (3 Contact Hours)
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. Preq: ECE 3170 and ECE 3300, each with a C or better.

Integrated System Design I - ECE 4950 - 2 Credits (1 Contact Hours)
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. Preq: Electrical Engineering major and ECE 3200 and ECE 3300 and ECE 3600 and ECE 3800, each with a C or better; or Computer Engineering major and ECE 3200 and ECE 3220 and ECE 3300 and ECE 3520 and ECE 3710, each with a C or better. Preq or concurrent enrollment: ECE 4090 with a C or better. Coreq: ECE 4951.

Integrated System Design II - ECE 4960 - 2 Credits (6 Contact Hours)
Project-oriented course which brings together electrical and computer engineering students of dissimilar training in teams or project groups. Group assignments are designed to develop an appreciation for individual and creative thinking, as well as team effort. Preq: Electrical Engineering major and ECE 3210 and ECE 3710 and ECE 3810 and ECE 4090 and ECE 4950, each with a C or better; or Computer Engineering major and ECE 3270 and ECE 4090 and ECE 4950, each with a C or better.

Technical Electives
9 credit hours (3 courses) from an approved technical elective listing are also required by all candidates for the BSEE degree. Many of these courses are offered online. An updated list is found on the Clemson University website at www.clemson.edu/ece

POWER SYSTEMS ENGINEERING CERTIFICATE

This certificate is for individuals who do not wish to pursue a BSEE degree and are not currently enrolled at another institution. There are three courses required to complete the certificate.

Note: Some candidates may also need to complete prerequisite courses.

For more information on applying, tuition, or to contact an advisor, please visit the following websites **http://epceonline.org/renewableenergy-certificate** & **www.clemson.edu/ece**

Electric Power Engineering - ECE 3600 - 3 Credits (3 Contact Hours)

Presents the basic principles of power systems, energy conversion, electromagnetic induction and developed forces. Topics include power and energy concepts and analysis; the basics of electric power generation, transmission, and distribution; synchronous machines, induction motors, and DC motors. Preq: ECE 2620 and PHYS 2210, each with a C or better.
ECE 4180 - Power System Analysis
3 Credits (3 Contact Hours)

Power System Analysis - ECE 4180 - 3 Credits (3 Contact Hours)

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 3600 and ECE 3800, each with a C or better.

Electric Machines and Drives - ECE 4190 - 3 Credits (3 Contact Hours)

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 3210 and ECE 3600 and ECE 3800, each with a C or better. Preq or concurrent enrollment: MATH 4340 with a C or better.

RENEWABLE ENERGY CERTIFICATE

This certificate is for individuals who do not wish to pursue the BSEE degree and are not currently enrolled at another institution. There are three courses required to complete the certificate.

Note: Some candidates may need to complete prerequisite courses.

For more information on applying, tuition, or to contact an advisor, please visit the following websites **http://epceonline.org/renewable-energy-certificate** & **www.clemson.edu/ece**

Fundamentals of Wind Power - ECE (ME) 4570 - 3 Credits (3 Contact Hours)

Introduces 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. May also be offered as ME 4570. Preq: ECE 2070 or ECE 3200 with a C or better.

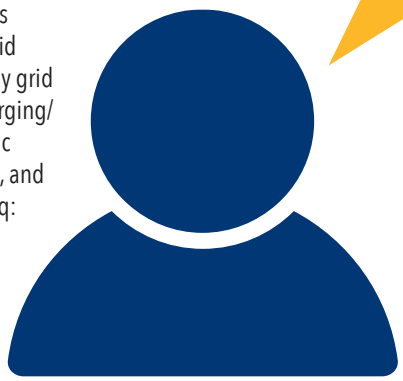
Fundamentals of Solar Energy - ECE 4610 - 3 Credits (3 Contact Hours)

Introduces 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 3200 with a C or better.

Renewable Energy Penetration on the Power Grid - ECE 4200 - 3 Credits (3 Contact Hours)

Introduces the basic definition 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 2070 or ECE 3200, each with a C or better.

Ask an Educational Consultant at: **epceonline.org/educational-consultant**



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