**Course Description:**

Students will apply basic principles of energy accounting, thermodynamics and heat transfer, energy conversion and efficiency to heating, power generation and transportation. Students will apply the principles and practices needed for managing renewable and non-renewable energy resources. Throughout this course, future energy systems and energy use scenarios are investigated, with a focus on promoting the use of renewable energy resources and technologies.

**Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome: 1.1. Employability Skills**

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

**Competencies**

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.

1.1.3. Develop a career plan that reflects career interests, pathways and secondary and postsecondary options.

1.1.4. Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships.

1.1.5. Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate associated behaviors in fulfilling personal, community and workplace roles.

1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.

1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism.

1.1.9. Give and receive constructive feedback to improve work habits.

1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

**Outcome: 1.2. Leadership and Communications**

Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.

**Competencies**

1.2.1. Extract relevant, valid information from materials and cite sources of information.

1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.

1.2.4. Use negotiation and conflict-resolution skills to reach solutions.

1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.

1.2.6. Use proper grammar and expression in all aspects of communication.

1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.

1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence internal and external workplace relationships.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).

1.2.10. Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.

1.2.11. Write professional correspondence, documents, job applications and resumés.

1.2.12. Use technical writing skills to complete forms and create reports.

1.2.13. Identify stakeholders and solicit their opinions.

1.2.14. Use motivational strategies to accomplish goals.

**Outcome: 1.3. Business Ethics and Law**

Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies**

1.3.1. Analyze how regulatory compliance (e.g., United States Department of Agriculture [USDA], Food and Drug Administration [FDA], United States Department of Interior [USDI], Ohio Livestock Care Standards, water quality standards, local water regulations, building codes) affects business operations and organizational performance.

1.3.4. Identify how federal and state consumer protection laws affect products and services.

**Outcome: 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3. Verify compliance with security rules, regulations and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.

1.4.4. Use system hardware to support software applications.

**Outcome: 1.6. Business Literacy**

Develop foundational skills and knowledge in entrepreneurship, financial literacy and business operations.

**Competencies**

1.6.7.  Identify the effect of supply and demand on products and services.

1.6.10. Describe the impact of globalization on an enterprise or organization.

**Outcome: 1.10. Sales and Marketing**

Manage pricing, place, promotion, packaging, positioning and public relations to improve quality customer service.

**Competencies**

1.10.6. Discuss the importance of correct pricing to support a product’s or service’s positioning in the marketing mix.

**Outcome: 1.11. Principles of Business Economics**

Examine and employ economic principles, concepts and policies to accomplish organizational goals and objectives.

**Competencies**

1.11.2. Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior.

1.11.4. Determine how the quality, quantity and pricing of goods and services are affected by domestic and international competition in a market economy.

1.11.8. Identify the relationships between economy, society and environment that lead to sustainability.

**Outcome: 1.12. Site and Personal Safety Procedures**

Follow site and personal safety procedures in specific situations with specialized tools and equipment, evaluate the situation and take corrective action.

**Competencies**

1.12.1. Use Occupational Safety and Health Administration (OSHA) defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries and labeling.

1.12.2. Interpret safety signs and symbols.

1.12.5. Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.

1.12.6. Identify procedures for the handling, storage and disposal of hazardous materials.

1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.

1.12.8. Identify safety hazards and take corrective measures.

1.12.9. Identify, inspect and use safety equipment appropriate for the task.

1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.

1.12.14. Identify the source of electrical hazards and use shutdown and established lock-out/tag-out procedures.

1.12.15. Select and operate fire extinguishers based on the class of fire.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | |  | Does not apply | | |

**Strand 3. Biotechnology**

Learners apply the skills and knowledge of interpreting laboratory requests, using protective clothing and hazardous material containment, specimen collection procedures, a variety of laboratory testing and techniques, and maintenance of laboratory equipment and supplies.

**Outcome: 3.8. Research and Experiments**

Conduct a problem-based study, applying scientific methodology and using descriptive statistics to communicate and support predictions and conclusions.

**Competencies**

3.8.1. Identify research problems and structure a statistical experiment, simulation or study related to the problem.

3.8.12. Prepare and present findings using scientific reports.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | |  | Does not apply | | |

**Strand 4. Power Systems**

Learners apply principles of tool use, power transmission, hydraulics, two- and four-stroke cycle combustion, heating and cooling, exhaust, ignition, starting and charging, steering and lubrication systems to operate, to maintain or repair equipment.

**Outcome: 4.1. Tool, Stationary and Mobile Equipment Maintenance**

Inspect, clean, maintain and perform planned preventative maintenance on tools, machinery, implements and equipment.

**Competencies**

4.1.1. Identify the types of hand tools, power tools and stationary equipment and describe their functions.

4.1.2. Ensure the presence and functionality of safety systems and hardware.

4.1.3. Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment.

4.1.4. Maintain machinery, equipment, instrument and facility cleanliness, appearance and safety.

4.1.5. Inspect and service the electrical connections and lamps.

4.1.6. Inspect for fluid leakage, fluid levels and the condition of fluids.

4.1.7. Clean, lubricate and adjust machinery and equipment.

4.1.8. Select fluids, maintain fluid levels and replace system filters.

4.1.9. Inspect and maintain fluid conveyance and storage components (e.g., hoses and lines, valves, nozzles).

4.1.10. Inspect and replace drive belts.

4.1.11. Calibrate metering, monitoring and sensing equipment.

4.1.12. Compare alternative sources of power for equipment.

**Outcome: 4.2. Equipment Operations**

Operate and maintain mechanical equipment and power systems.

**Competencies**

4.2.1. Follow manufacturer’s recommended operating procedures and adjustment specifications.

4.2.2. Differentiate among the functions, limitations and proper use of equipment, equipment controls and instrumentation.

4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.

4.2.4. Perform appropriate start-up, operating and shut-down procedures.

4.2.5. Select and operate the equipment and attachments needed to complete the task including levers, pedals or valves.

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |

**Strand 5. Structural Engineering**

Learners apply the principles of engineering related to electricity, structural repair and design, use of brick, block and concrete, water distribution, and metal working to design, construct, manage and maintain structures and biological systems used in agriculture, food and natural resources.

**Outcome: 5.1. Electrical Theory**

Interpret and apply electrical and electronic principles and theories.

**Competencies**

5.1.1. Interpret symbols and wiring diagrams.

5.1.2. Describe the features, benefits and applications of electrical and electronic systems.

5.1.3. Explain atomic structure and its relationship to electricity.

5.1.4. Describe the relationship between electrical effect and electromagnetic effect.

5.1.5. Explain methods of producing electrical current.

5.1.6. Describe the differences between alternating current (AC) and direct current (DC).

5.1.7. Compare and contrast conductors and insulators.

5.1.8. Differentiate the relationships among voltage, current, resistance and power in circuits.

5.1.9. Measure the amperage of AC and DC electrical systems and system components.

5.1.10. Calculate voltage, current, resistance, impedance and power in circuits using Ohm’s Law, Kirchhoff’s Law and Watt’s Law.

5.1.11. Describe the purpose of grounding and common methods used for grounding.

5.1.12. Describe the uses of series, parallel and series-parallel circuits.

5.1.13. Use a digital multimeter to determine voltage, current, frequency and phase.

**Outcome: 5.2. Structural Electrical Circuits**

Describe features of an electrical schematic that illustrates a wiring system and interpret and install the design.

**Competencies**

5.2.1. Describe over-current protective devices and their functions.

5.2.2. Identify the types of motors and uses for each.

5.2.3. Map circuits and label the service panel directory to reflect devices installed on each circuit.

5.2.4. Calculate service requirements for an electrical installation and evaluate for safe capacity.

5.2.5. Identify types of cable, conduit, boxes, switches, outlets and other common wiring devices.

5.2.6. Identify fasteners, anchors and fire stop systems.

5.2.7. Select materials and lay out rough-in wiring runs according to specifications, drawings and code requirements.

5.2.8. Select and install lighting technologies (e.g., Halogen, light-emitting diode [LED], incandescent, fluorescent, high-intensity discharge [HID]).

5.2.9. Install and service low-voltage lighting and control systems.

**Outcome: 5.3. Design and Estimate**

Plan and design a basic site plan for a desired outcome.

**Competencies**

5.3.1. Identify, interpret and use symbols, lines, dimensions, views, sections, site plans, floor plans, specifications, common scales, detail drawings and abbreviations on drawings and prints.

5.3.2. Apply proportional reasoning and indirect measurement techniques.

5.3.3. Complete a site inventory and analysis, including physical conditions, code and utilities requirements and the environmental impact.

5.3.4. Develop a program list, including intended use, budget, economics, customer wants and needs and maintenance.

5.3.8. Calculate the space requirements and compute various attributes, including length, angle measurement, surface area and volume.

5.3.9. Prepare sketches, drawings, prints, specifications and construction details.

5.3.11. Identify construction documents, common scales, specifications and materials used in construction or fabrication.

5.3.12. Estimate material, construction and equipment needs, availability and costs.

5.3.13. Establish the sequential steps of construction and installation.

**Outcome: 5.4. Surveying and Mapping**

Perform surveying procedures to construct a site plan.

**Competencies**

5.4.1. Identify civil drafting symbols and abbreviations.

5.4.2. Interpret maps, topographic site plans, deeds and aerial or satellite imagery for site planning.

5.4.3. Perform site measurements.

5.4.4. Integrate map and surveying data into geographic information system (GIS) or computer aided design (CAD) software.

5.4.5. Identify topographical and existing features of areas, including property lines, benchmarks, utilities, streets and setbacks, on survey maps, parcel maps and plats.

**Outcome: 5.8. Water Distribution Systems**

Calculate the demand for specific water applications and design and install water supply and drainage components.

**Competencies**

5.8.2. Compare the types, applications and operating principles of pumps and controls.

5.8.4. Identify components of supply and drainage systems and describe their functions.

5.8.9. Select supply and drainage components based on their application for a given purpose.

5.8.11. Join pipe, pipefittings and valves of similar and dissimilar materials using solder, brazing, solvents and mechanical means of joining.

5.8.12. Connect plumbing fixtures and appliances to a supply and drainage system.

5.8.13. Compare and contrast sources of contamination in water supplies and methods of filtering and disinfecting water.

5.8.14. Prevent freezing and mechanical damage to pipes.

5.8.15. Describe how water moves from the source through the water distribution system to the fixture.

5.8.16. Test a water supply and drainage system for leaks and pressure using soap, inert gas, electronic sensors and fluorescent dye.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |

**Strand 6. Environmental Science**

Learners apply earth, life, and physical sciences to the production, extraction, processing, protection, use, and renewal of both renewable and non-renewable resources.

**Outcome: 6.10. Ecosystems**

Evaluate biotic and abiotic components and relationships in ecosystems to apply restoration and conservation practices that maintain functionality.

**Competencies**

6.10.1. Describe ecological levels, including population, community, ecosystem and biosphere.

6.10.2. Distinguish the flow of energy through ecosystems.

6.10.3. Identify and classify interactions among organisms, including predation, symbiosis and competition, to determine species interdependent relationships.

6.10.4. Describe the process of succession and its impact on ecosystems.

6.10.5. Connect biotic interactions with the abiotic environment.

6.10.6. Describe biogeochemical cycles (e.g., carbon, nitrogen, phosphorous, hydrological) and their roles in maintaining equilibrium in an ecosystem.

6.10.7. Identify interactions of ecosystems to differentiate biomes.

6.10.8. Select and implement restoration ecology practices to repair damaged ecosystems.

6.10.9. Determine the impact of native and non-native invasive species on ecosystems.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |

**Strand 9. Energy**

Learners apply principles of physics, chemistry, the earth sciences and mathematics to energy sources, transformations, acquisition, and application.

**Outcome: 9.1. Energy**

Identify energy sources according to their economic viability, sustainability and environmental impact.

**Competencies**

9.1.1. Identify, compare and contrast fossil fuel sources and the technology used to generate energy.

9.1.2. Identify, compare and contrast renewable energy sources and the technology used to generate energy.

9.1.3. Identify, compare and contrast alternative energy sources and technology used to generate energy (e.g., fuel cells, hydrogen, nuclear).

9.1.4. Identify the social, economic and environmental drivers and barriers that influence the development and use of energy sources.

9.1.5. Calculate fuel equivalents among energy sources.

9.1.6. Trace the transformations of energy within a system (e.g., mechanical to electrical, chemical to mechanical).

9.1.7. Determine best management practices (e.g., carbon sequestration, conservation, animal safety, efficiency) that lessen environmental impact.

9.1.8. Perform an energy evaluation to determine the best social, economic and environmental solution.

**Outcome: 9.2. Crude Oil and Natural Gas**

Describe the processes for exploring, drilling, producing, transporting, marketing and refining crude oil and natural gas.

**Competencies**

9.2.2. Assess how crude oil and natural gas wells are sited, designed and installed.

9.2.6. Identify the different processes for producing, treating, compressing, transporting, processing and storing crude oil and natural gas.

**Outcome: 9.3. Biomass**

Describe and manage processes required to extract energy from biomass.

**Competencies**

9.3.1. Identify applications for biomass energy.

9.3.2. Describe the thermal, chemical and biochemical methods of converting biomass into energy.

9.3.3. Identify feedstock materials (e.g., plants, algae, municipal waste) used to produce energy and compare the energy potential of each.

9.3.4. Identify and differentiate the aerobic and anaerobic digestion of biomass.

9.3.5. Test source materials and final products and compare the results to industry standards.

9.3.6. Process source materials for energy conversion.

9.3.7. Identify and describe technical standards and regulations for residential, agricultural and commercial biofuel operations.

9.3.8. Identify the byproducts generated in the production of biofuels and apply methods for their extraction, use and disposal.

9.3.9. Manage storage and distribution systems for biofuels.

**Outcome: 9.4. Solar Energy**

Plan, install and maintain a solar array that can collect, store and distribute solar energy.

**Competencies**

9.4.1. Identify the different types of solar energy devices (e.g., photovoltaic [PV], solar thermal, concentrating solar power [CSP]) and how they produce energy.

9.4.2. Conduct a site evaluation to identify an appropriate solar panel installation.

9.4.3. Select the appropriate solar energy application for commercial and residential solar power.

9.4.4. Design a layout of solar arrays and associated equipment.

9.4.5. Identify and describe technical standards and regulations for a solar energy installation.

9.4.6. Interpret an electric schematic for a solar energy installation.

9.4.7. Install, test and maintain a solar energy installation.

9.4.8. Compare and contrast equipment disposal methods.

**Outcome: 9.5. Wind Energy**

Plan and maintain a wind energy installation that captures, stores and distributes electrical energy.

**Competencies**

9.5.1. Describe the internal and external components of wind energy installation.

9.5.2. Conduct a site evaluation to identify an appropriate wind turbine installation.

9.5.3. Identify and describe technical standards and regulations for wind turbines.

9.5.4. Describe and differentiate the manufacturing processes for producing wind turbines.

9.5.5. Select and design an appropriate wind energy installation for commercial and residential applications.

9.5.6. Interpret an electric schematic for a wind energy installation.

9.5.7. Test and maintain wind energy components.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |