

Introduction to Instrumentation and Electrical

PEIMS Code: N1303900

Abbreviation: INSTELEC

Grade Level(s): 10–12

Award of Credit: 1.0

State Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
- In accordance with Texas Administrative Code (TAC) §74.27, school districts must provide instruction in all essential knowledge and skills identified in this innovative course.
- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to [TAC §74.13](#) for guidance on endorsements.

Course Description:

Introduction to Instrumentation and Electrical will introduce students to instrumentation professions, including the different career opportunities available and required certification/postsecondary education requirements for each. Introduction to Instrumentation is the first of two courses that provide a pathway for the student to learn core competencies, as identified by industries using process instrumentation and postsecondary institutions such as simple control loops, an introduction to pressure, temperature, level, flow transmitters and the various transducers used in the detection of changes in process variables.

Essential Knowledge and Skills:

- (a) General requirements. This course is recommended for students in grades 10-12. Recommended prerequisite: Integrated Chemistry and Physics (IPC) or Chemistry. Students shall be awarded one credit for successful completion of this course.
- (b) Introduction.
 - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
 - (2) The Energy Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final energy products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
 - (3) Introduction to Instrumentation will introduce students to instrumentation professions, including the different career opportunities available and required certification/postsecondary education requirements for each. Introduction to Instrumentation is the first of two courses that provide a pathway for the student to learn core competencies, as identified by industries using process instrumentation and postsecondary institutions such as simple control loops, an introduction to

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pressure, temperature, level, flow transmitters and the various transducers used in the detection of changes in process

- (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
 - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and skills.
- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
 - (A) demonstrate skills related to health and safety in the workplace as specified by appropriate governmental regulations;
 - (B) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
 - (C) collaborate with others to solve problems;
 - (D) identify employers' work expectations; and
 - (E) research, evaluate and apply various time-management techniques to develop work schedules.
 - (2) The student understands common definitions, terminology, and the basic foundations related to instrumentation. The student is expected to:
 - (A) describe the types of industry using instrumentation, and identify fields related to instrumentation in process technology;
 - (B) describe the career opportunities in instrumentation in process technology, pathways to career development, and certification requirements of industries using process technology, including job responsibilities, typical work schedules, and career opportunities;
 - (C) demonstrate the use of content, such as technical concepts and vocabulary, when analyzing information and following directions;
 - (D) identify currently emerging issues in instrumentation in process technology; and
 - (E) identify principles of instruments and instrument technology used in industrial process technology.
 - (3) The student can identify and discuss process instruments and devices. The student is expected to:
 - (A) discuss process instruments and equipment used in industry, including symbology; and
 - (B) demonstrate the ability to read Process Flow Diagrams (PFD), read & draw Piping & Instrumentation Diagrams (P&ID's) and Loop Drawings, which are the specifications of the instrumentation used.

- (4) The student can identify and discuss the types of control loops applied to the control and detection of pressure, temperature, level, flow, pH, and other applicable processes. The student is expected to:
 - (A) demonstrate the ability to read and interpret the types of industrial drawings, diagrams, charts, and data sheets related to industrial electrical equipment;
 - (B) interpret industry standard circuit schematics, including simple circuits, series circuits, parallel circuits, Ohm's Law, Watt's Law, and the Power Law;
 - (C) identify areas where quality, reliability, and safety can be integrated into a product; and
 - (D) describe applications of electricity in industrial process technology, including alternating current (AC), direct current (DC) 3 phase motor, and variable frequency drives, and where and why they are used in industry.
- (5) The student develops knowledge of measurements and calibration of instrumentation. The student is expected to discuss and demonstrate how precision measuring instruments are used in industrial process technology, including a digital multi-meter (DMM).
- (6) The student develops familiarization of the communicator. The student is expected to:
 - (A) evaluate common communicators, such as an EMERSON 475, and select a communicator appropriate to a specified task; and
 - (B) calibrate microprocessor-based self-monitoring analysis and reporting technology (SMART) instruments and pneumatics such as a 13A Differential Pressure Transmitter (D/P) Transmitter as well as other electronic transmitters.
- (7) The student applies concepts of critical thinking and problem solving. The student is expected to:
 - (A) analyze elements of a problem to develop innovative solutions;
 - (B) critically analyze information to determine value to the problem-solving task;
 - (C) analyze a variety of problem-solving strategies and critical-thinking skills; and
 - (D) conduct technical research to gather information necessary for decision making.
- (8) The student applies comprehensive knowledge in a simulation environment. The student is expected to:
 - (A) represent or simulate a portion of a process system by generating an appropriate drawing, diagram, or data sheet;
 - (B) demonstrate how to achieve a specific goal with the use of a simple mock-up of a "Control Loop";
 - (C) execute a simple mockup of a control loop to achieve a specified goal;
 - (D) use instruments to put together a simple loop;

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- (E) demonstrate appropriate safety equipment selection for use in a variety of assigned tasks;
 - (F) use a Sniffer for confined space entry to be sure of adequate oxygen;
 - (G) identify and apply mathematical operations to complete calculations and specified computations, including temperature unit conversions, for a simulated process system;
 - (H) explain how visual depictions, data readouts, and trends in a computer-based process simulator relate to actual valves, piping, equipment, electrical gear, and instrumentation in a process system;
 - (I) develop critical-thinking skills through simulations to identify and solve problems associated with instrumentation in process technology; and
 - (J) describe how to troubleshoot specific instruments and processes.
- (9) The student presents conclusions, research findings, and designs using a variety of media throughout the course. The student is expected to:
- (A) discuss and critique the validity of conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports; and
 - (B) record, express, and manipulate relationships among data, including the use graphs, charts, and equations.

Recommended Resources and Materials:

Weedon, Thomas A., Philip Kirk, and Franklyn W. Kirk. *Instrumentation and Process Control*.
Orland Park, IL: American Technical Publishers, 2019.

- Industry-level equipment such as Fluke 787 RMS DMM, EMERSON 475 Communicator, Meriam Communicator.
- PIE or ALTEK 4-20 mA driver.
- Fluke 724 Temperature Calibrator.
- Rosemount Instrumentation (SMART).
- Pneumatics, Electronic.
- Ball Valve, Globe, Butterfly, Gate Valve rising stem.
- Swing Check.
- Flowserve BETA &/or LOGIX. 667 EZ Fisher Actuator Pneumatic and digital valve controller 6200 with I/P.

Recommended Course Activities:

- Study-guides by topic
- Project based activities using industry-level equipment such as pipes and valves
- Simulated control loops
- Creating lab reports

Suggested methods for evaluating student outcomes:

- Written papers

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- Written tests
- Oral reports
- Lab reports such as calibration reports, as found, as left, five-point checks. Report written on the work order so there is a history of what was performed to that specific instrument.

Teacher qualifications:

An assignment for Introduction to Instrumentation and Electrical is allowed with one of the following certificates.

- Secondary Industrial Arts (Grades 6-12).
- Secondary Industrial Technology (Grades 6-12).
- Technology Education: Grades 6-12.
- Trade and Industrial Education: Grades 6-12. This assignment requires appropriate work approval.
- Trade and Industrial Education: Grades 8-12. This assignment requires appropriate work approval.
- Vocational Trades and Industry. This assignment requires appropriate work approval.
- Mathematics/Physical Science/Engineering: Grades 8-12.

Additional information:

Advanced Instrument and Electrical

PEIMS Code: N1303901

Abbreviation: ADVINELEC

Grade Level(s): 11-12

Award of Credit: 1.0

State Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
- In accordance with Texas Administrative Code (TAC) §74.27, school districts must provide instruction in all essential knowledge and skills identified in this innovative course.
- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to [TAC §74.13](#) for guidance on endorsements.

Course Description:

Advanced Instrument and Electrical is a course designed for students to develop and build on knowledge and skills from the Introduction to Instrumentation and Electrical course. The learning objectives prepare students with the skills essential for electrical and instrument work environment for construction & maintenance in the petrochemical and manufacturing industry. Students will learn the electrical theories and calculations needed to troubleshoot electrical circuits and the tools and instruments used to fix or replace the electrical components including switches, relays, capacitors, resistors, and motors. Students will also learn how to identify, fabricate, and replace tubing and piping used in refining and chemical processes.

Essential Knowledge and Skills:

- (a) General requirements. This course is recommended for students in grades 11-12. Recommended prerequisites: Algebra I and Introduction to Instrumentation and Electrical. Students shall be awarded one credit for successful completion of this course.
- (b) Introduction.
 - (1) Career and technical education instruction provide content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
 - (2) The Energy Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final energy products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
 - (3) In the Advanced Instrument and Electrical course students will gain advanced knowledge and skills specifically needed to enter the workforce in the refining and chemical processes industry. This course builds on the skills learned in the Introduction to Instrumentation and Electrical course. Students in the Advanced Instrumentation and

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Electrical course will be introduced to the safety regulations in the industry and the agencies that oversee these regulations. Students will learn the electrical theories and calculations needed to troubleshoot electrical circuits and the tools and instruments used to fix or replace the electrical components including switches, relays, capacitors, resistors, and motors. Students will also learn how to identify, fabricate, and replace tubing and piping used in refining and chemical processes.

- (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
 - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.
- (c) Knowledge and Skills.
- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
 - (A) demonstrate skills related to health and safety in the workplace as specified by appropriate governmental regulations;
 - (B) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation;
 - (C) collaborate with others to solve problems;
 - (D) identify employers' work expectations; and
 - (E) research, evaluate and apply various time-management techniques to develop work schedules.
 - (2) The student demonstrates the safety standards, rules, and regulations for Industrial Electrical and Instrument (EI) technicians. The student is expected to:
 - (A) demonstrate safe working procedures in an industrialized workplace;
 - (B) explain the purposes of the Occupational Safety and Health Administration (OSHA) and National Fire Protection Association (NFPA) 70E and how they promote safety on the job;
 - (C) identify electrical/energy hazards and describe how to avoid or minimize them in the work environment;
 - (D) explain safety issues concerning lockout/tag-out procedures, apply personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection systems; and
 - (E) demonstrate dead-live test.
 - (3) The student applies fundamental and advanced concepts of electrical theory, direct-current circuit calculations, and tests, troubleshoots and calculates values in resistive circuit(s) or electrical system(s). The student is expected to:
 - (A) define voltage and identify the ways in which it can be produced;
 - (B) identify the conductors and insulators in electrical circuits;

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- (C) define the units of measurement that are used to measure the properties of electricity;
 - (D) identify meters used to measure voltage, current, and resistance;
 - (E) explain the basic characteristics of and diagram series and parallel circuits;
 - (F) calculate the total unknown currents in a parallel and series-parallel circuits using Kirchhoff's current law;
 - (G) calculate voltage drops in series, parallel and series-parallel circuits using Kirchhoff's voltage law; and
 - (H) calculate voltage, current, and resistance using the formula for Ohm's law.
- (4) The student will apply and use mathematic formulas to analyze alternating current (AC) circuits or electrical system(s). The student is expected to:
- (A) calculate the peak and effective voltage or current values for an AC waveform;
 - (B) calculate the phase relationship between two AC waveforms;
 - (C) measure and differentiate the voltage and current phase relationship in a resistive AC circuit;
 - (D) define inductive reactance and illustrate how it is affected by frequency;
 - (E) compare and contrast the voltage and current transients that occur in a capacitive circuit;
 - (F) define capacitive reactance and illustrate how it is affected by frequency;
 - (G) explain the relationship between voltage and current in AC circuits including resistor-inductor (RL) circuit, inductor-capacitor (LC) circuit, resistor-capacitor (RC) circuit, and resistor-inductor-capacitor (RLC) circuit;
 - (H) explain the following terms as they relate to AC circuits, including true power, reactive power, apparent power, and Power factor; and
 - (I) explain and diagram basic transformer action.
- (5) The student uses and applies the minimum provisions necessary for protecting people and property as published in the National Electric Code®(NEC®). The student is expected to:
- (A) explain the purpose and history of the NEC®;
 - (B) identify and apply code requirements using the NEC®;
 - (C) describe the purpose of the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA); and
 - (D) explain the role of nationally recognized testing laboratories.
- (6) The student understands and interprets electrical and instrument drawings. The student is expected to:
- (A) identify common types of electrical and instrument diagrams and drawings, including isometric and orthographic drawings;
 - (B) interpret and apply electrical diagrams used in instrument work; wiring diagrams, ladder diagrams, one-line diagrams, motor controller diagrams;

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- (C) interpret instrumentation diagrams, including piping and instrumentation diagram (P&ID) diagrams, loop diagrams, flow diagrams and raceway diagrams;
 - (D) design and draw a loop diagram for a given instrumentation loop; and
 - (E) identify types of instrumentation, instrument tags, and specifications for installation in various applications.
- (7) The student uses methods and procedures in selecting components for motor controllers. The student is expected to:
- (A) identify contactors and relays both physically and schematically and describe their operating principles;
 - (B) identify pilot devices both physically and schematically and describe their operating principles;
 - (C) interpret motor control wiring, connection, and wiring diagrams;
 - (D) select and size contactors and relays for specific electrical motor control systems;
 - (E) select and size pilot devices for use in specific electrical motor control systems; and
 - (F) connect motor controllers for specific applications according to National Electrical Code® requirements.
- (8) The student will be able to select the proper electrical and instrumentation test equipment and use common Electrical and Instrument test equipment The student is expected to:
- (A) identify and explain the purposes of test instruments commonly used to test and troubleshoot Electrical and Instrument equipment, including voltage testers, clamp-on ammeters, ohmmeters, multimeters, phase/motor rotation testers, data recording equipment, field communicators, pressure testers and deadweight testers;
 - (B) convert measurements and readings from one scale to another using the test equipment;
 - (C) explain the importance of proper meter polarity;
 - (D) predict and measure wave trends using a frequency meter; and
 - (E) compare and contrast the differences between and applications of digital and analog meters.
- (9) The student identifies measurement devices for the process variables flow, pressure, level, and temperature. The student is expected to:
- (A) identify and describe methods of flow measurement;
 - (B) identify and describe methods of pressure measurement;
 - (C) identify and describe methods of temperature measurement;
 - (D) identify and describe methods of level measurement; and
 - (E) select and use the appropriate measurement device to troubleshoot problems.

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- (10) The student fabricates a variety of tubing and demonstrates proper storage and handling, bending, cutting, deburring, reaming, and flaring of tubing. The student is expected to:
- (A) explain the purpose for tubing standards and specifications;
 - (B) research and identify the different kinds of tubing and describe the properties and common uses for each kind;
 - (C) demonstrate the proper handling and storage of tubing;
 - (D) fabricate (bend) tubing, cut using the proper tools, cutting methods, and safety procedures;
 - (E) identify and select proper tubing fittings for selected instrumentation applications;
 - (F) create a flare on tubing using the proper tools, flaring methods, and safety procedure; and
 - (G) produce and reproduce a compression fitting.

Recommended Resources and Materials:

NCCER, *Industrial Maintenance Electrical and Instrumentation Technician Level 1 Trainee Guide*. 3rd ed. Alachau, FL: Pearson, 2020.

NCCER, *Industrial Maintenance Electrical and Instrumentation Technician Level 2 Trainee Guide*. 3rd ed. Alachau, FL: Pearson, 2020.

NCCER, *Industrial Maintenance Electrical and Instrumentation Technician Level 3 Trainee Guide*. 3rd ed. Alachau, FL: Pearson, 2020.

Weedon, Thomas A., Philip Kirk, and Franklyn W. Kirk. *Instrumentation and Process Control*. Orland Park, IL: American Technical Publishers, 2019.

NFPA, *NFPA 70®: National Electrical Code®*, Chicago, [National Fire Protection Association](#), 2020.

Recommended Course Activities:

- Project based activities using industry-level equipment such as pipes and valves.
- Troubleshoot instrumentation scenarios using simulated control loops to mimic various processes, controller options, disturbances, and control valve issues.
- Create a technical manual using technical drawings and language to install, maintain and troubleshoot a piece of electrical equipment.
- Design wiring schematics using industry recognized software.

Suggested methods for evaluating student outcomes:

- Assess code violations in scenarios using the NEC®.
- Complete installation scenarios using training modules.
- Write work orders for equipment repair.
- Present an oral report on electrical safety.
- Formative assessment quizzes.

Teacher qualifications:

- Secondary Industrial Arts (Grades 6-12).

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- Secondary Industrial Technology (Grades 6-12).
- Technology Education: Grades 6-12.
- Trade and Industrial Education: Grades 6-12. This assignment requires appropriate work approval.
- Trade and Industrial Education: Grades 8-12. This assignment requires appropriate work approval.
- Vocational Trades and Industry. This assignment requires appropriate work approval.
- Mathematics, Physical Science, or Engineering: Grades 8-12.

Additional information:

Practicum in Energy

PEIMS Code: N1303910

Abbreviation: PRACENRG

Grade Level(s): 11-12

Award of Credit: 2.0

State Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
- In accordance with Texas Administrative Code (TAC) §74.27, school districts must provide instruction in all essential knowledge and skills identified in this innovative course.
- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to [TAC §74.13](#) for guidance on endorsements.

Course Description:

The *Practicum in Energy* course gives students the opportunity to apply what they have learned in the classroom in a real-world setting designed to prepare students for occupations in the Oil and Gas, Refinery, and Renewable Natural Resources industries. In this course, students will learn how to communicate in the field and work safely in a variety of situations and environments common in the Energy occupations. Students will also learn about the energy balance, the distribution of power, the technology used in the field, and the regulations and environmental impact of the industry. Practicum experiences occur in a paid or unpaid arrangement and a variety of locations appropriate to the nature and level of the student's need for work-based learning experience. Students implement personal and interpersonal skills to strengthen individual performance in the workplace and in society and to make a successful transition to the workforce or postsecondary education.

Essential Knowledge and Skills:

- (a) General Requirements. This course is recommended for students in grades 11 or 12. Recommended prerequisites: At least one of the following courses *Oil and Gas Production II/Lab, Occupational Safety and Environmental Technology I, Oil and Gas Production III, Occupational Safety and Environmental Technology II, Career Preparation, Oil and Gas Production IV, Introduction to Process Technology, Introduction to Instrumentation and Electrical, Petrochemical Safety, Health, and Environment, Advanced Instrument and Electrical, AC/DC Electronics, Introduction to Renewable Energy, Energy and Natural Resources Technology/Lab, Environmental Sustainability (PLTW), Solid State Electronics, Scientific Research and Design or Digital Electronics*. Students shall be awarded two credits for successful completion of this course.

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(b) Introduction.

- (1) Career and technical education instruction provide content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
- (2) The Practicum of Energy course is in the Energy and Science, Technology, Engineering and Mathematics career cluster and serves as a work-based learning course for the oil and gas exploration and production, refining and chemical processes and/or renewable energy.
- (3) The Practicum in Energy course gives students the opportunity to apply what they have learned in the classroom in a real-world setting designed to prepare students for occupation in the oil and gas, refinery and renewable natural resources industries. In this course, students will learn how to communicate in the field and work safely in a variety of situations and environments common in the energy occupations. Students will also learn about the energy balance, the distribution of power, the technology used in the field and the regulations and environmental impact of the industry.
- (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations, meetings with local chamber of commerce, and with industry specific to the oil and gas exploration and production, refining and chemical production and renewable energy.
- (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and Skills.

- (1) The student demonstrates professional standards/employability skills required by the energy industry. The student is expected to:
 - (A) participate in a paid or unpaid, laboratory or work-based application of previously studied knowledge and skills related to energy;
 - (B) communicate effectively with others using oral and written skills;
 - (C) demonstrate collaboration skills through teamwork;
 - (D) demonstrate professionalism by conducting oneself in a manner appropriate for the profession and workplace;
 - (E) demonstrate a positive, productive work ethic by performing assigned tasks as directed;
 - (F) comply with all applicable rules, laws, and regulations;
 - (G) demonstrate time-management skills by prioritizing tasks, following schedules, and tending to goal-relevant activities in a way that uses time wisely and optimizes efficiency and results; and
 - (H) demonstrate the ability to write and understand Specific, Measurable, Attainable, Relevant and Timely (SMART) goals.
- (2) The student demonstrates leadership and teamwork skills to accomplish goals and objectives. The student is expected to:

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- (A) analyze leadership characteristics in relation to trust, positive attitude, integrity, and willingness to accept key responsibilities in a work situation;
 - (B) demonstrate teamwork skills through working cooperatively with others to achieve tasks;
 - (C) demonstrate teamwork processes that promote team-building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution;
 - (D) demonstrate responsibility for shared group and individual work tasks;
 - (E) establish and maintain effective working relationships in order to accomplish objectives and tasks;
 - (F) demonstrate effective working relationships using interpersonal skills in order to accomplish objectives and tasks;
 - (G) negotiate and work cooperatively with others using positive interpersonal skills; and
 - (H) demonstrate respect for individuals, including those from different cultures, genders, and backgrounds, and value for diversity.
- (3) The student demonstrates safety practices in all areas, in which they are exposed. The student is expected to:
- (A) demonstrate the use of personal protective equipment (PPE);
 - (B) comply with general safety procedures as delineated by the company and industry;
 - (C) demonstrate specific safety practices for each assigned task;
 - (D) identify critical hazards and safety processes using job safety analysis (JSA) worksheet to;
 - (E) describe procedures for reporting safety near misses or event;
 - (F) define emergency response roles and required actions;
 - (G) review and demonstrate Occupational Safety and Health Administration (OSHA) standards for the industry; and
 - (H) describe and demonstrate each phase of the Health Safety and Environment Management System, including the four steps of plan, do, assess, and adjust.
- (4) Demonstrate and explain the procedures of industrial hygiene, such as exposure to toxic or hazardous materials. The student explains the processes of energy balances. The student is expected to:
- (A) investigate and calculate quantities using the work-energy theorem in various situations using the laws of conservation of energy and momentum;
 - (B) investigate examples of kinetic and potential energy and their transformations;
 - (C) calculate the mechanical energy of power generated within, impulse applied to, and momentum of a physical system;
 - (D) demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension; and

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- (E) explain everyday examples that illustrate the four laws of thermodynamics and the processes of thermal energy transfer.
- (5) Investigate and apply the energy-balance principles to given situations such as open system fluid circuit, closed system fluid circuits; heat added or removal systems (thermodynamic processes); and heat cycle efficiency. The student explains the regulations and environmental impact in the energy industry. The student is expected to:
- (A) summarize how OSHA regulates the industry;
 - (B) describe the role of Texas Railroad Commission in the regulation of the industry;
 - (C) explain the role the Texas Commission on Environmental protection and the Quality Texas Commission on Environmental Quality (TCEQ) standards has in the regulation of the industry;
 - (D) analyze the concepts of eminent domain, royalty payments, landowner rights regarding the oil and gas industry; and
 - (E) explain the role of (ERCOT) in the regulation and the distribution of power.
- (6) The student identifies the basic systems and the required components used in the oil and gas, refining and/or renewable energy. The student is expected to:
- (A) identify and explain drilling performance including performance planning;
 - (B) identify and explain gas and oil well site management such as well site logistics management;
 - (C) identify and explain wellbore integrity such as drilling phase;
 - (D) identify and explain shale environments such as unconventional shale operations; and
 - (E) identify and explain mobilization/demobilization such as site preparation for rig move.
- (7) The student explains the distribution of energy, including Upstream, Midstream, and Downstream. The student is expected to:
- (A) define and illustrate the role of the upstream operations in the energy industry;
 - (B) define and illustrate the role of the midstream operations in the energy industry;
 - (C) define and illustrate the role of the downstream operations in the energy industry; and
 - (D) define and illustrate the role of the transportation, distribution, and logistics systems in the energy industry.
- (8) The student develops knowledge of the technology used in the field. The student is expected to:
- (A) demonstrates proficiency in business application platforms, directories, file, management, sorting, and searching;
 - (B) demonstrate computer information technology skills in networking, networking navigation, and programming;

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- (C) identify the basic components of electrical systems and circuits used in the industry;
 - (D) demonstrate knowledge of Ohm's Law and other critical principles of electronics and electricity; and
 - (E) discuss the basics of small engines repair and diesel technology, internal combustion engines, and electrical motors.
- (9) The student explores the careers available in the energy industry. The students are expected to:
- (A) research and report on the employment opportunities in the energy industry that require a high school diploma, an associate's degree, a bachelor's degree or a master's degree; and
 - (B) research and report on the employment opportunities in the upstream, midstream, and downstream energy industry.
- (10) The student explains the business practices and economic principles of the energy industry. The students are expected to:
- (A) demonstrate proficiency in business acumen;
 - (B) demonstrate knowledge of the energy industry market;
 - (C) demonstrate the financial skills related to project management in the energy industry;
 - (D) identify and explain trends in the energy industry market; and
 - (E) create a strategic prospective business plan for a small business in the oil, gas, or natural resource industry.

Recommended Resources and Materials:

- NCCER (2011). Alternative Energy Trainee Guide (1st ed.). Alachua, FL: Pearson.
- NCCER (2017). Introduction to the Pipeline Industry Trainee Guide (3rd ed.). Alachua, FL: Pearson.
- NCCER (2017). Pipeline Maintenance and Mechanical Level 1 Trainee Guide (3rd ed.). Alachua, FL: Pearson.
- NCCER (2011). Power Line Worker Trainee Guide (1st ed.). Alachua, FL: Pearson.
- NCCER (2011). Wind Energy Trainee Guide (1st ed.). Alachua, FL: Pearson.

Recommended Course Activities:

- Visit a refinery or chemical processing plant and report on career opportunities in the industry.
- Create a resume.
- Research the environmental impact of using Renewable Energy resources such as: wind and solar.
- Use regional labor market information to identify careers in oil and gas exploration and production in your region and the state.
- Research the transportation, distribution, and logistics of delivering power across the state and nation.
- Create a Training Plan between the employer, student, and district.

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Suggested methods for evaluating student outcomes:

- Employer evaluations
- Approved training plan
- Career portfolio
- Test/quizzes
- Research projects

Teacher qualifications:

An assignment for the Practicum in Energy course is allowed with one of the following certificates.

- Agriculture, Food, and Natural Resources: Grades 6-12
- Agricultural Science and Technology: Grades 6-12
- Any vocational agriculture certificate
- Trade and Industrial Education: Grades 6-12 This assignment requires appropriate work approval
- Trade and Industrial Education: Grades 8-12. This assignment requires appropriate work approval
- Vocational Trades and Industry This assignment requires appropriate work approval.
- Secondary Industrial Arts: Grades 6-12
- Secondary Industrial Technology: Grades 6-12
- Technology Education: Grades 6-12
- Mathematics/Physical Science/Engineering: Grades 8-12
- Any business or office education certificate.
- Business and Finance: Grades 6-12.
- Business Education: Grades 6-12.

Additional information:

Concepts of Distribution and Logistics Technology

PEIMS Code: N1303800

Abbreviation: DISTLOG

Grade Level(s): 10-12

Award of Credit: 1.0

State Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
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- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to [TAC §74.13](#) for guidance on endorsements.

Course Description:

In *Concepts of Distribution and Logistics Technology*, students will gain knowledge and skills in safe application, design, and assessment of technologies used in the supply chain and logistics industries. The students will apply knowledge and skills in using standard and emerging technologies in the field of logistics. This course allows students to understand, apply, and simulate the new technologies of distribution and logistics. The *Concepts of Distribution and Logistics Technology* course will provide students with a broader basis for understanding the technology of managing, storing, shipping, and receiving different materials. These technologies will include data base tracking and delivering software, equipment, and services used in the field. The course will develop the students' knowledge of distribution, logistics, and the supply chain.

Essential Knowledge and Skills:

- (a) General Requirements. This course is recommended for students in grades 10 and 12. Students shall be awarded one credit for successful completion of the course.
- (b) Introduction.
 - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
 - (2) The Transportation, Distribution, and Logistics (TDL) Career Cluster focuses on careers in planning, management, and movement of people, materials, and goods by road, pipeline, air, rail and water and related professional support services such as transportation infrastructure planning and management, logistics services, mobile equipment and facility maintenance.

- (3) In Concepts of Distribution and Logistics Technology, students will gain knowledge and skills in safe application, design and assessment of technologies used in the supply chain and logistics industries. The students will apply knowledge and skills in using standard and emerging technologies in the field of logistics. This course allows students to understand, apply, and simulate the new technologies of distribution and logistics. The Concepts of Distribution and Logistics Technology course will provide students with a broader basis for understanding the technology of managing, storing, shipping, and receiving different materials. These technologies will include data base tracking and delivering software, equipment, and services used in the field. The course will develop the students' knowledge of distribution, logistics, and the supply chain.
 - (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
 - (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative example.
- (c) Knowledge and Skills.
- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
 - (A) identify policies and procedures of distribution and logistics;
 - (B) research careers in distribution and logistics systems;
 - (C) identify all personal protection equipment required in the workplace;
 - (D) research certification opportunities;
 - (E) investigate response plans to emergency situations; and
 - (F) practice employers' expectations such as appropriate work habits, ethical conduct, legal responsibilities, and good citizenship skills.
 - (2) The student develops a professional portfolio in preparation to enter the workforce. The student is expected to:
 - (A) create a resume;
 - (B) explain what it means to maintain a positive social media account;
 - (C) write and present a 20-30 second elevator speech, including personal attributes and characteristics that employers look for in new hires;
 - (D) research industry-related websites and locate jobs postings online;
 - (E) apply for jobs online and using paper applications;
 - (F) prepare for an interview by researching an employer website, writing possible interview questions, and developing inquiries about the company;
 - (G) write and send a thank-you note or a video thank-you email; and
 - (H) identify and explain networking strategies and research networking opportunities such as professional organizations in the field.
 - (3) The student analyzes the structure of a typical supply chain flow including the distribution and logistics network. The student is expected to:

- (A) explain the flow of products/services from raw material to the customer;
 - (B) describe the flow of information and the importance of communication from customer to supplier and from supplier to customer;
 - (C) describe the flow of finances into the company from product sales as well as from the company to the customer in the form of returns;
 - (D) describe the flow of returns and how it differs from the flow of production; and
 - (E) identify the key components found in a distribution and logistics network.
- (4) The student researches and applies warehouse operational methods. The student is expected to:
- (A) research the pros and cons of the use of automated warehousing;
 - (B) describe the path of a product through a standard warehouse and an automated warehouse;
 - (C) research new ways to secure data used in the distribution and logistics network;
 - (D) prepare business forms used by suppliers to control routing in a distribution and logistics network; and
 - (E) develop a simple warehouse management system with spreadsheet and word processing software.
- (5) The student analyzes the functions of a supplier in distribution and logistics. The student is expected to:
- (A) differentiate between sourcing and strategic sourcing;
 - (B) explain the difference between traditional supplier relationship management and a strategic supplier alliance;
 - (C) research and explain the concept of Business to Business (B2B) commerce; and
 - (D) explain the concept of supplier co-location and research the benefits of co-locating with suppliers.
- (6) The student develops an understanding of the procurement process. The student is expected to:
- (A) explain the difference between procurement and purchasing;
 - (B) research the concept of Total Cost of Ownership (TCO) as it relates to procurement;
 - (C) evaluate the technologies that are used during the procurement process such as analysis software and the benefits that technology brings to procurement; and
 - (D) explain the six key objectives of the procurement process, including identifying customer needs, looking outside your market, prioritizing relationships, collecting and spending data, communicating what you are doing, and knowing your negotiating position.
- (7) The student researches and summarizes the manufacturing processes. The student is expected to:

- (A) analyze manufacturing layouts, including process layout, product layout, cellular layout, and fixed-position layout;
 - (B) compare the four manufacturing environments, including make-to-stock, make-to-order, assembly-to-order, and engineer-to-order;
 - (C) describe the concepts of just-in-time and lean manufacturing;
 - (D) analyze the pros and cons of production offshoring and outsourcing; and
 - (E) evaluate the benefits of technology in manufacturing.
- (8) The student evaluates product design. The student is expected to:
- (A) describe the benefits of collaborative product design versus traditional over-the-wall product design;
 - (B) describe the benefits achieved during the product design process;
 - (C) identify and explain the features of non-price-based product differentiation such as availability, durability, quality and reliability;
 - (D) explain the concept of reverse logistics and its benefits;
 - (E) explain the phases in the product lifecycle such as launch, growth, and maturity and identify the key features of each;
 - (F) research and explain the benefits that technology brings to product or service design; and
 - (G) identify the characteristics of a product and their relationship to customer value.
- (9) The student develops an inventory management system. The student is expected to:
- (A) explain how information can be used to replace physical inventory;
 - (B) define safety stock and safety lead time and explain how they can be used successfully;
 - (C) research the types of supply chain inventory, including cycle, safety stock, anticipation, and pipeline, and the use cases for each;
 - (D) explain the types of inventory costs, including capital, storage, risk, and service, and how those costs are calculated;
 - (E) explain the various inventory policies and controls such as stock keeping units, cycle counting, and alphabetical (ABC) inventory classification and explain how they are used; and
 - (F) develop and present an inventory management system for a company.
- (10) The student applies problem-solving and organizational skills to develop a transportation management system. The student is expected to:
- (A) research the pros and cons of the five primary modes of transportation such as rail, motor, air, water, and pipeline;
 - (B) explain what 'last mile deliveries' are and why consumers are part of the disruption which causes logistics companies to focus on improving the timeliness of direct-to-consumer deliveries;
 - (C) research and compare the types of motor carriers and their limitations;

- (D) compare third party logistics (3PLs) and fourth party logistics (4PLs);
 - (E) research the benefits of transportation management software systems;
 - (F) explain the benefits of technology for the transportation system; and
 - (G) research the benefits of a business partnering with a transportation company to move products from the manufacturing location to the store.
- (11) The student researches and analyzes the distribution network. The student is expected to:
- (A) describe the differences and primary uses of the warehouse classifications, including private, public, and contract;
 - (B) summarize the key warehouse processes, including receiving, put away, storage, picking, packing, and shipping as well as value-added warehousing;
 - (C) research and compare the various mechanized and automated systems for handling warehouse materials;
 - (D) analyze the benefits of technology in distribution including warehouse management systems;
 - (E) explain the concepts of cross-docking and break-bulk operations;
 - (F) explain the concept of inland ports and their importance to today's supply chains;
 - (G) discuss the five basic functions of packaging, including protection, containment, information, utility of use, promotion;
 - (H) explain the concept of free trade zones; and
 - (I) develop a distribution and logistics network for a chosen product.
- (12) The student investigates the customer's role in driving the requirements for distribution and logistics. The student is expected to:
- (A) explain the voice of the customer (VOC) procedure and how it can be used to increase sales and profitability;
 - (B) research and explain how customer needs drive market disruption;
 - (C) identify ways the wants and needs of customers can be discovered;
 - (D) explain how the customer relationship management strategy changes as customers move through the product life cycle;
 - (E) research and explain the benefits technology provides that enables logistics companies to meet customer requirements; and
 - (F) define customer satisfaction and the ways organizations ensure they meet customers' satisfaction.

Recommended Resources and Materials:

Material Handling Institute Website: Video Material

Material Handling Institute (n.d.) *Designing Robotics with the Workforce in Mind*

<https://videos.mhi.org/designing-robotics-with-the-workforce-in-mind>

Course Title

Material Handling Institute (n.d.) *The Emerging Risks of Blockchain Technology*

<https://videos.mhi.org/the-emerging-risks-of-blockchain-technology>

Material Handling Institute (n.d.) *Regulatory Challenges in Healthcare Logistics*

<https://videos.mhi.org/challenges-in-healthcare-logistics>

Material Handling Institute (n.d.) Your Guide to Overhead Lifting Solutions

<https://videos.mhi.org/your-guide-to-overhead-lifting-solutions>

Material Handling Institute: Printed Material

Material Handling Institute (n.d.) Material Handling Institute *Glossary*

<http://www.mhi.org/glossary?q=%22warehouse+management+system%22&pb=1&fq=&sort=score+desc>

Material Handling Institute (n.d.) Automated Storage and Retrieval Systems

<http://www.mhi.org/fundamentals/automated-storage?>

Material Handling Institute (n.d.) Fundamentals of Warehousing & Distribution

<http://www.mhi.org/cte/materials>

Recommended Course Activities:

- The student will develop a professional portfolio with a resume, understanding networking, and social media sites used for job searches and for candidate evaluation.
- The student will develop a presentation on how the lean system can improve a part of the distribution and logistics network.

Suggested methods for evaluating student outcomes:

- Classroom Observation
- Daily Q&A
- Daily Quizzes using Kahoot! or Turning Point
- Rubric on different activities
- Poster of some form of technology used in Distributions and Logistics
- Earn the Certified Logistics Associate Certification
- Exams

Teacher qualifications:

An assignment for this course is allowed with one of the following certificates.

- Technology Education: Grades 6-12.
- Trade and Industrial Education: Grades 6-12. This assignment requires appropriate work approval.
- Trade and Industrial Education: Grades 8-12. This assignment requires appropriate work approval.
- Vocational Trades and Industry. This assignment requires appropriate work approval.

Course Title

Additional information:

Occupational Safety & Environmental Technology I

PEIMS Code: N1303680

Abbreviation: OSET1

Grade Level(s): 9-12

Award of Credit: 1.0

State Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
- In accordance with Texas Administrative Code (TAC) §74.27, school districts must provide instruction in all essential knowledge and skills identified in this innovative course.
- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to TAC §74.13 for guidance on endorsements.

Course Description:

During Occupational Safety & Environmental Technology (OSET) I, students will investigate the field of Occupational Safety and Health Administration and Environmental Technology, which is charged with the tasks of ensuring that business and industry provide a safe workplace, free from hazards and bringing about a reduction in the occurrence of job related injuries and fatalities. Students will use safety resources and discover procedures for collaborating with business and industry regarding ways to increase employee safety and health, reduce workers' compensation insurance costs and medical expenses, decrease payout for return-to-work programs, reduce faulty products, and lower costs for job accommodations for injured workers.

The sequence of OSET courses provides students with the knowledge and skills to enter business and industry under OSET/OSHA. Students will be prepared to investigate hazards and create plans of action to address hazard controls for employers.

Essential Knowledge and Skills:

- (a) General Requirements. Recommended prerequisite: Principles of Transportation Systems, Principles of Distribution and Logistics, or Principles of Manufacturing. This course is recommended for students in Grades 9-12.
- (b) Introduction.
 - (1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
 - (2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.
 - (3) Students investigate the field of Occupational Safety and Health Administration (OSHA), which is charged with the tasks of ensuring that businesses provide a safe workplace that is free from recognized hazards, promoting health and safety in the workplace, and reducing the occurrence of on the job injuries, illnesses, and fatalities. Students will use safety resources and discover

procedures for collaborating with business and industry regarding ways to increase employee safety and health.

- (4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.
- (5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and Skills.

- (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:
 - (A) identify career development and entrepreneurship opportunities in occupational safety and environmental technology;
 - (B) identify careers in occupational safety and environmental technology;
 - (C) apply competencies related to resources, information, interpersonal skills, problem solving, critical thinking, and systems of operation in occupational safety and environmental technology;
 - (D) discuss certification opportunities;
 - (E) identify employers' expectations, appropriate work habits, ethical conduct, legal responsibilities, and good citizenship skills; and
 - (F) explore career goals, objectives, and strategies as part of a plan for future career opportunities.
- (2) The student understands the legal responsibilities of work safety in a hazardous work environment. The student is expected to:
 - (A) apply critical thinking and event analysis from a legal or liability standpoint to make workplace safety decisions inside and outside the classroom;
 - (B) research safety information and convey findings to others;
 - (C) estimate the direct cost of work-related hazard on employees; and
 - (D) investigate the indirect cost of work-related hazards on employers..
- (3) The student identifies hazardous substances that lead to injury and illness on the job. The student is expected to:
 - (A) identifies various hazardous substances that are found in workplace settings;
 - (B) determine short- or long-term cost effects of exposure to hazardous substances; and
 - (C) differentiate between health issues caused by workplace factors and those health issues arising from pre-existing condition(s).
- (4) The student describes the process of adopting safety measures. The student is expected to:
 - (A) explain the importance of controlling workplace hazards at the source whenever possible;
 - (B) develop training programs and promote understanding of health and safety guidelines in the employment setting by improving workplace health and safety program and safety awareness; and
 - (C) recommend safety accessories such as safety glasses, face shields, aprons, and gloves as appropriate.

- (5) The student understands the role of a health and safety representative. In a simulated inspection environment, the student is expected to:
- (A) communicate professionally by
 - (i) adapting language for audience, purpose, situation, and intent;
 - (ii) organizing oral and written information;
 - (iii) interpreting and communicating information, data, and observations;
 - (iv) delivering formal and informal presentations;
 - (v) applying active listening skills;
 - (vi) developing and interpreting tables, charts, and figures;
 - (vii) listening to and speaking with diverse individuals; and
 - (viii) exhibiting public relations skills;
 - (B) conduct surveys and inquiries that lead to plans of action;
 - (C) discuss the processes for reporting a hazard to appropriate parties such as union, supervisor, or advisory committee;
 - (D) examine the relationship between self, community, environment, and consequences of actions; and
 - (E) develop safety and wellness guidelines to improve workplace safety and health program/awareness.
- (6) The student describes the scope of the science of ergonomics. The student is expected to:
- (A) define ergonomics;
 - (B) summarize the history of the science of ergonomics;
 - (C) describe three organizational domains of ergonomics; and
 - (D) apply the science of ergonomics across other fields.
- (7) The student identifies ergonomic problems in a variety of workplace settings. The student is expected to:
- (A) evaluate potential issues related to posture in a workplace setting;
 - (B) apply OSHA's Video Display Terminal (VDT) checklist to a workplace setting; and
 - (C) evaluate elements of a user-friendly computer station.
- (8) The student relates body systems to the study of ergonomics. The student is expected to:
- (A) describe primary body systems analyzed in the study of ergonomics;
 - (B) demonstrate the mechanism of muscular contraction;
 - (C) explain energy transformation for muscular activity;
 - (D) explain the functions of the musculoskeletal system; and
 - (E) describe muscular fatigue, strength, innervation, and reflexive movements.
- (9) The student identifies workplace conditions that lead to types of work-related musculoskeletal disorders (WMSDs). The student is expected to:
- (A) analyze the two classifications, type A and type B, of occupational work;
 - (B) evaluate conditions that can occur due to fatigue in work; and
 - (C) describe in biological terms the fatigue conditions associated with static work
 - (D) compare work-related musculoskeletal disorders (WMSDs) and explain the three stages of WMSDs; and
 - (E) classify occupational factors and risk symptoms for WMSDs.

- (10) The student applies principles of prevention to work-related musculoskeletal disorders. The student is expected to:
- (A) describe principles of arrangement that ensure a functional workplace; and
 - (B) describe environmental factors such as tools and equipment, working conditions, and possible safety hazards.
- (11) The student explains the fundamentals of using professional and regulatory resources. The student is expected to:
- (A) analyze landmark regulatory actions responsible for enforcing public safety;
 - (B) compare four types of product liability classifications from a legal perspective;
 - (C) determine the necessary components of a warning label or signage for a physically intensive job;
 - (D) revise an ergonomic workplace design based on OSHA recommendations; and
 - (E) evaluate professional and regulatory resources such as state and federal laws and rules, safety plans, and emergency plans.
- (12) The student designs workspaces to reduce work related risks. The student is expected to:
- (A) describe personal risk factors that are important in providing training recommendations and administrative controls for WMSDs;
 - (B) propose multiple design solutions with attention to factors such as sophistication, cost, and time to implementation; and
 - (C) produce workplace safety design solutions including immediate, interim, and long-term solutions.
- (13) The student explores successful safety management. The student is expected to:
- (A) examine and evaluate management involvement in ensuring a safe working environment for all employees;
 - (B) identify the responsibilities of management, safety and health professionals, first-line supervisor, and worker regarding safety management; and
 - (C) explain management and supervisory accountability regarding workplace safety.
- (14) The student develops an understanding of elements of a written safety and health program. The student is expected to:
- (A) explain the necessity of a comprehensive safety program;
 - (B) describe the requirements and elements of OSHA guidelines for a safety and health program; and
 - (C) conduct and revise emergency and medical plans through mock emergency and medical drills.
- (15) The student evaluates methods to reduce sources of workplace hazards in order to promote a safe working environment. The student is expected to:
- (A) describe hazard identification steps including inventory, work site inspection, review of the potential dangers associated with various materials and chemicals found in workplaces;
 - (B) perform a root cause analysis and describe the methods associated with the analysis;
 - (C) identify accident types such as those caused by human error, preventable, and life-threatening; and
 - (D) describe the elements of a workplace health program.

- (16) The student demonstrates knowledge of workplace security and violence. The student is expected to:
- (A) describe strategies to enhance workplace security and prevent workplace violence;
 - (B) outline hazard prevention and control;
 - (C) discuss training and education components of a safety program; and
 - (D) identify and discuss types of workplace violence events and prevention strategies.

Recommended Resources and Materials:

Textbooks, instructional materials, and an on-site computer lab will be provided for this course/program.

Oakley, Jeffrey S. *Accident Investigation Techniques*. American Society of Safety Engineers, 2012.
Reese, Charles D. *Occupational Health and Safety Management: A Practical Approach*. CRC Press, 2016.

Suggested methods for evaluating student outcomes:

Measures of success will be determined from daily participation, class work, projects and exams.

Teacher qualifications:

Secondary Industrial Arts: Grades 6-12
Secondary Industrial Technology: Grades 6-12
Technology Education: Grades 6-12
Trade and Industrial Education: Grades 6-12 with appropriate work approval as identified on the certificate
Trade and Industrial Education: Grades 8-12 with appropriate work approval as identified on the certificate
Vocational Trades and Industry. This assignment requires appropriate work approval.

Additional information: