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

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;

(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 Manufactures 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;

(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.

(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 selects proper tubbing 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 instillation 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).

- 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: