Course Number and Title: ELC 101 Introduction to Instrumentation

Campus Location:
Stanton

Effective Date:
2018-51

Prerequisite:
MAT 020, ENG 090 or ENG 091 or concurrent, SSC 100 or concurrent

Co-Requisites:
none

Course Credits and Hours:
3.00 credits
2.00 lecture hours/week
2.00 lab hours/week

Course Description:
This course provides the student with instrumentation fundamentals required to understand the measurement and control aspects of plant operations.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
Calculator

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Identify the major process variables and terminology used in the process industry. (CCC 6; PGC 1)
2. Apply the fundamentals of electricity concepts to circuits and instrumentation. (CCC 6; PGC 2)
3. Explain how to sense and measure pressure in industrial processes. (CCC 3, 6; PGC 1, 3)
4. Explain how to sense and measure temperature in industrial processes. (CCC 3, 6; PGC 1, 3)
5. Explain how to sense and measure levels in industrial processes. (CCC 3, 6; PGC 1, 3)
6. Explain how to sense and measure flow in industrial processes. (CCC 3, 6 PGC 1, 3)
7. Explain the process methods used to analyze products in industrial processes. (CCC 6; PGC 1)
8. Describe the fundamentals of process control. (CCC 3, 6; PGC 1, 3)
9. Explain primary sensors, transmitters, and transducers used in control loops in industrial processes. (CCC 3, 6; PGC 1, 3)
10. Explain controllers and final control elements used in industrial processes. (CCC 3, 6; PGC 1, 3)
11. Explain control valves, actuators, and final control elements used in industrial processes. (CCC 3, 6; PGC 1, 3)
12. Identify and describe the instruments, lettering, and numbering standards in different types of instrumentation drawings. (CCC 6; PGC 1)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Identify the major process variables and terminology used in the process industry.
    1. Describe the following major process variables: pressure, temperature, flow, level, and composition.
    2. Explain how major process variables are related.
    3. Explain how major process variables can be measured or regulated.
    4. Define process industry terminology: *local, remote, indicating, transmitting, recording, controlling, control loop pneumatic, electronics, analog, digital,* and *distributive control system*.
2. Apply the fundamentals of electricity concepts to circuits and instrumentation.
    1. Define electrical units: *voltage*, *current*, *resistance*, *power*, and *energy*.
    2. Predict voltage, current, resistance, and power in simple direct current (DC) circuits.
    3. Use a digital multimeter to properly measure DC voltage, current, and resistance.

3. Explain how to sense and measure pressure in industrial processes.
    1. Define *pressure*.
    2. Predict process pressure using different types of measurement techniques.
    3. Define terms associated with pressure and pressure instruments.
    4. Identify and describe the purpose and operation of pressure-sensing/measuring instruments used in a lab or industrial setting.
    5. Convert between pounds per square inch gauge (Psig) and pounds square inch absolute (psia).
    6. Convert between in mercury (Hg) and in water (H_20).
    7. Use pressure gauges to measure pressure.
4. Explain how to sense and measure temperature in industrial processes.
    1. Define *temperature*.
    2. Define temperature and temperature instruments terminology: *differential temperature*, *Fahrenheit*, *Celsius/centigrade*, *Rankin*, and *Kelvin*.
    3. Identify and describe the operation of temperature sensing/measurement devices such as thermowell, thermometer, bimetallic strip, resistance temperature detector (RTD), thermistors, thermocouple, and temperature gauge.
    4. Convert between Fahrenheit, Celsius, and Kelvin temperature scales.
    5. Assemble, test, and measure temperature using acceptable industry standards.
5. Explain how to sense and measure levels in industrial processes.
    1. Define level and level instrument terminology such as *level, direct/indirect measurement, interface level, meniscus, density,* and *hydrostatic head pressure.*
    2. Identify and describe the purpose and operation of the following types of level-sensing devices used in the process industry: gauge/sight glass, float, tape gauge, differential pressure cell, bubbler, displacer, ultrasonic device, and nuclear device.
    3. Predict head pressure given the height and density of a liquid.
    4. Use direct and indirect level instruments to determine the level in a tank.
6. Explain how to sense and measure flow in industrial processes.
    1. Define flow and flow measurements terminology such as *laminar, turbulent, direct and indirect flow measurement, positive displacement flow measurement, percent flow rate,* and *volumetric flow units*.
    2. Identify and describe the purpose and operation of the following types of flow sensing/measuring devices used in the process industry: orifice plate, venturi tube, flow nozzle, pitot tube, annubar tube, rotameter, electromagnetic meter, turbine meter, mass flow meter, and totalizer.
7. Explain the process methods used to analyze products in industrial processes.
    1. Define terms associated with analytical instruments: *pH (acid/base) and oxidation reduction potential (ORP), conductivity, optical measurements, chromatography, excess oxygen,* and *environmental*.
    2. Identify and describe the purpose and operation of analytical instruments used in the process industry: optical analyzer, color analyzer, conductivity meter, pH/ORP meter, gas chromatograph (GC), and GC mass spectrometer, spectrophotometer, total carbon analyzer, and explosimeter.
    3. Use a pH meter to measure pH.
8. Describe the fundamentals of process control.
    1. Explain the function of a control loop.
    2. Identify the common components of a control loop such as sensor, transmitter, controller, transducer, and final control element.
    3. Sketch a function block diagram of both a closed and an open control loop.
    4. Explain various types of signal transmission: pneumatic, electronic (4-20 mA), digital (0-5V), and mechanical signals.
9. Explain primary sensors, transmitters, and transducers used in control loops in industrial processes.
    1. Describe the purpose and operation of a transmitter in a control loop.
    2. Discuss differential pressure in relation to the process input to the transmitter.
    3. Discuss 3-15 psig instrument signals.
    4. Describe the function of a current-to-pneumatic transducer.
10. Explain controllers and final control elements used in industrial processes.
    1. Define terms associated with controllers: *auto/manual/cascade switch, local/remote switch, set point, tuning, direct acting, reverse acting, proportional band/gain, integral/reset, derivative/rate,* and *tuning*.
    2. Identify and describe the purpose and operation of various controllers.
    3. Identify whether a control loop is in or out of control, and describe the information used to make the decision.
11. Explain control valves, actuators, and final control elements used in industrial processes.
    1. Identify and describe the purpose, operation, and terms associated with control valves and regulators.
    2. Identify and explain the main components of a control valve: body, bonnet, disc, actuator, stem, seat, spring, valve positioner, handwheel, and current/power current to pressure (I/P) transducer.
    3. Describe operating scenarios in which fail open, fail closed, and fail last positions are desirable.
    4. Discuss the purpose of diaphragm valve actuators and piston valve actuators.
    5. Explain the three uses of a valve positioner.
    6. Explain the function of each of the three gauges located on a pneumatic valve positioner.
    7. Explain the purpose and operation of control, three-way, and butterfly valves.
    8. Identify and describe pressure regulators and solenoid valves on a process flow diagram and/or piping and instrumentation diagram (P&ID).
12. Identify and describe the instruments, lettering, and numbering standards in different types of instrumentation drawings.
    1. Describe the lettering and numbering standards based on the International Society of Automation (ISA) instrumentation symbols.
    2. Describe how to determine the instrument type from the symbol information.
    3. Describe the standards for line symbols.

4. Identify instrumentation on a drawing using a legend.
5. Trace a control loop on a P&ID.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	–	100	=	A
83	–	91	=	B
75	–	82	=	C
0	–	74	=	F

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):

1. Perform the duties of an entry-level technician using the skills, modern tools, theory, and techniques of the electronics engineering technology.
2. Apply a knowledge of mathematics, science, engineering, and technology to electronics engineering technology problems that require limited application of principles but extensive practical knowledge.
3. Conduct, analyze, and interpret experiments using analysis tools and troubleshooting methods.
4. Identify, analyze, and solve narrowly defined electronics engineering technology problems.
5. Explain the importance of engaging in self-directed continuing professional development.
6. Demonstrate basic management, organizational, and leadership skills which commit to quality, timeliness, and continuous improvement.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.