

**Course Description****ETP2040C | Electric Power Distribution | 4.00 credits**

This is a required course for all students pursuing a certificate in solar photovoltaic energy generation. The student will acquire an understanding of multi-phase power transmission, how to connect to the electric grid and the major components used in electric power distribution including: power transformers, circuit breakers, transmission lines, reclosures, relay coordination, fuses, motors and generators. The student will learn about the maintenance, troubleshooting and protection of these devices against lightning and other abnormal conditions through hands-on laboratory experiments utilizing modern testing and simulation equipment. Prerequisite: EET1033C.

**Course Competencies**

**Competency 1:** The student will demonstrate an understanding of electrical power distribution systems and operation by:

1. Identifying the components of electrical distribution systems
2. Discussing the role of generators and transformers in the electrical distribution process
3. Identifying transmission lines at various voltage levels
4. Describing the factors and variables that affect power transmission

**Competency 2:** The student will demonstrate an understanding of components and systems used to protect the major elements of power distribution systems by:

1. Identifying protective devices used in power distribution systems and describing their functions
2. Describing the role of silicon control rectifiers (SCR) in protecting power distribution systems
3. Explaining how ground fault interrupters (GFI) function and protect power distribution systems
4. Discussing safety procedures for replacing protection devices

**Competency 3:** The student will demonstrate an understanding of power distribution by:

1. Explaining the following terms and concepts as they apply to electrical distribution systems: single-phase, two-phase, and three-phase, diesel power, backup system/redundant power system, neutral grounding,
2. Describing the necessary components and wiring to provide a safe electrical distribution system when given the functional characteristics of an AC power source and the intended load
3. Discussing the reasons that three-phase power systems are used in industry
4. Defining the following terms relative to the power triangle (include symbols and units): apparent power, true power, reactive power, power factor
5. Calculating the following power components for an AC circuit when given the values for voltage (E), resistance (R), reactance (X), impedance (Z), and/or current (I): apparent power, true power, reactive power, power factor
6. Explaining the differences between a wye-connected and delta-connected AC generator, including the advantages of each type
7. Stating the indications of an unbalanced load in a three-phase power system
8. Describing the application and use of inverters and battery chargers and how they operate
9. Connecting renewable power generators to the grid

**Competency 4:** The student will demonstrate an understanding of transformers by:

1. Explaining the general theory, function, and operation of transformers
2. Identifying different types of transformers and discussing their similarities, differences, and respective applications
3. Explaining how single phase and three phase transformers work
4. Defining the following terms as they pertain to transformers: mutual induction, turns ratio, impedance ratio, and efficiency
5. Identifying and explaining the key specifications when selecting electrical transformers, including:

maximum secondary voltage rating, maximum secondary current rating, maximum power rating, and output type

6. Describing the differences between a wye-connected and delta-connected transformer
7. Calculating voltage, current, and power of each of the following types of transformers when given the type of connection and turns ratios for the primary and secondary windings of a transformer: Delta – Delta, Delta – Wye, Wye – Delta, Wye – Wye, Open Delta
8. Describing how to de-energize and ground transformers
9. Explaining how and why combustible gases are sampled for in transformer operation
10. Explaining how winding resistance is tested

**Competency 5:** The student will demonstrate an understanding of protective devices by:

1. Listing the components within the electrical power distribution system that are used to protect power systems against lightning and other abnormal conditions
2. Describing the function and operation of various protective devices, including fuses, breaker circuits, reclosures, and relays
3. Troubleshooting component and system failures and identifying corrective measures
4. Selecting the correct type of relay based on voltage and current calculations
5. Selecting the correct type of fuse based on voltage and current calculations

**Competency 6:** The student will demonstrate how to troubleshoot and resolve equipment problems/failures using schematics by:

1. Interpreting circuit schematics to identify malfunctions
2. Calculating single phase and three phase voltages and currents
3. Connecting components using schematics

**Competency 7:** The student will demonstrate an understanding of the maintenance procedures for transformer protective devices by:

1. Discussing the causes of transformer failures
2. Explaining the function and operation of the transformer differential protection as a major protective element for transformer protective relays
3. Identifying transformer failures and describing corrective measures
4. Demonstrating the ability to use schematics, computer simulations, and lab experiments to set, install, configure, and test transformer management relays
5. Identifying system problems caused by: percent differential protection element, instantaneous differential protection, phase overcurrent, under/over frequency, over excitation

**Competency 8:** The student will demonstrate ability to identify regulatory requirements for connecting/disconnecting intermittent renewable energy sources to the grid by:

1. Determining the local, state, and federal regulations requirements
2. Describing the procedures to obtain permits
3. Describing the commissioning of new generating power plants

**Learning Outcomes:**

- Communicate effectively using listening, speaking, reading, and writing skills
- Solve problems using critical and creative thinking and scientific reasoning