

APEL 126A: OVERCURRENT DEVICES, NFPA 70E: ELECTRICAL SAFETY, INTRO TO RELAYS & CONTROLS, PHOTOVOLTAIC SYSTEMS

Foothill College Course Outline of Record

Heading	Value
Effective Term:	Summer 2025
Units:	8.5
Hours:	96 lecture, 24 laboratory per quarter (120 total per quarter)
Prerequisite:	Per California Code of Regulations, this course is limited to students admitted to the Electrical Apprenticeship Program.
Degree & Credit Status:	Degree-Applicable Credit Course
Foothill GE:	Non-GE
Transferable:	None
Grade Type:	Letter Grade (Request for Pass/No Pass)
Repeatability:	Not Repeatable

Student Learning Outcomes

- A student will apply the NEC requirements for overcurrent protection to electrical installations.
- A student will explain photovoltaic system function and installation per the NEC.
- A student will explain how relays function and install them in a circuit.

Description

This course introduces third-year electrical apprentices to the function, operation, installation, and code requirements for overcurrent protection devices such as breakers and fuses, the application of NFPA 70E Electrical Safety standards, the function and wiring of relays and control circuits, and the function and NEC requirements for photovoltaic systems.

Course Objectives

The student will be able to:

- Distinguish between different breaker and fuse classifications.
- Identify the operating principles of fuses and breakers.
- Select appropriate overcurrent protection for an installation, considering load ampacity, electrical system voltage rating, and the system's available fault current.
- Apply NEC requirements for overcurrent protection for electrical installations.
- Explain the importance of NFPA 70E.
- Relate the steps required to create an electrically safe work condition.
- Demonstrate proper lockout tagout procedures.

- Identify relay components and their function.
- Identify motor starter components and their function.
- Distinguish between manual and automatic pilot devices.
- Interpret control circuit ladder diagrams to wire a functional control circuit.
- Design, draw, and wire a functional control circuit.
- Use test instruments to evaluate circuit and component function.
- Demonstrate correct three-phase motor power circuit wiring.
- Use an electrical meter to determine motor winding resistance.
- Use a megohmmeter to determine motor winding insulation integrity.
- Identify the main components of photovoltaic systems and their operational principles.
- Discern the different types of photovoltaic system configurations, such as utility-interactive, stand-alone, and hybrid systems.
- Calculate photovoltaic system component rating requirements based on end-user energy needs.
- Demonstrate knowledge of series and parallel battery connections for the proper voltage and current levels.
- Apply National Electric code rules to battery storage installations for photovoltaic systems.
- Demonstrate knowledge of series and parallel battery connections for the proper voltage and current levels.
- Identify the hazards of working with photovoltaic systems and associated battery backup systems.
- Identify safe work practices to be used when working with photovoltaic systems and associated battery backup systems.
- Apply the National Electric Code and Utility regulations to design a photovoltaic system installation and determine grounding requirements.
- Use test instruments to measure voltage and current generated by a photovoltaic system.

Course Content

- Overcurrent protection
 - Characteristics and classification of different types of fuses and circuit breakers
 - Operating principles of fuses and circuit breakers
 - Sizing fuses and breakers considering amp, voltage, and arc interrupting rating
 - NEC requirements for overcurrent protection
- NFPA 70E
 - Introduction to NFPA 70E and its purpose
 - How to achieve an electrically safe working condition
 - Lockout/tagout principles and procedures
- Introduction to relays and controls
 - Relay characteristics, function, and applications
 - Motor starter characteristics, function, and application
 - Manual and automatic pilot devices
 - Reading and creating control circuit drawings
 - Test instruments as applied to control circuits and equipment
 - Motor installations, metering, and insulation testing
- Photovoltaic systems (PV systems)
 - Photovoltaic operational principles
 - Photovoltaic system components
 - PV system configuration

- d. System sizing
- e. Battery storage for PV systems
- f. National Electric Code and Utility regulations for the installation of PV systems
- g. Test instruments for PV systems

Lab Content

Students will use safety, job management, and material management skills to complete projects in the lab.

1. Wire-pulling techniques using a powered cable-pulling machine.
2. Circuit breaker and circuit wiring installation with lockout tagout procedure practice.
3. Wiring motor control circuits and testing and troubleshooting using test instruments.
4. Three-phase motor installation and testing.
5. Photovoltaic system connections and testing of system components with test instruments.

Special Facilities and/or Equipment

1. Laboratory with electrical tools and equipment.
2. Computer and overhead projector.
3. When taught via Foothill Global Access, on-going access to computer with software and hardware capable of running video conferencing applications (e.g., Zoom).

Method(s) of Evaluation

Methods of Evaluation may include but are not limited to the following:

Results of written quizzes and average of six tests
 Results of hands-on projects and homework
 Results of class participation
 Maintenance of a student's workbook with questions drawn from text

Method(s) of Instruction

Methods of Instruction may include but are not limited to the following:

Lecture
 Lab assignments
 Group discussion
 Demonstration

Representative Text(s) and Other Materials

American Technical Publishers. Test Instruments and Applications. 2019.

Callanan, M.I., and B. Wusinich. Electrical Systems Based on the 2023 NEC. 2023.

Electrical Training Alliance. Code Calculations Based on the 2023 NEC. 2023.

Miller, Charles R.. Illustrated Guide to the National Electric Code Based on the 2023 NEC. 2023.

Miller, Charles R.. Ugly's Electrical References. 2023.

NFPA. NFPA 70: National Electrical Code. 2023.

NFPA. NFPA 70E: Workplace Electrical Safety. 2024.

Although one of these texts is older than the suggested "5 years or newer" standard, it is the most recent version available.

Handouts including manufacturer's instructions, specification sheets, and instructor-developed guides.

Online content from reputable sources such as PG&E.

Types and/or Examples of Required Reading, Writing, and Outside of Class Assignments

Read Chapter 5 in Electrical Systems textbook and answer the review questions.

Discipline(s)

Electricity