APED 220.11 Course Outline as of Fall 2022

CATALOG INFORMATION

Dept and Nbr: APED 220.11 Title: CALCTP
Full Title: California Advanced Lighting Controls Training Program
Last Reviewed: 1/24/2022

Units		Course Hours per Week		Nbr of Weeks	Course Hours Total	
Maximum	0.50	Lecture Scheduled	0	10	Lecture Scheduled	0
Minimum	0.50	Lab Scheduled	4.00	1	Lab Scheduled	40.00
		Contact DHR	0		Contact DHR	0
		Contact Total	4.00		Contact Total	40.00
		Non-contact DHR	0		Non-contact DHR	0

Total Out of Class Hours: 0.00 Total Student Learning Hours: 40.00

Title 5 Category:	AA Degree Applicable
Grading:	Grade Only
Repeatability:	00 - Two Repeats if Grade was D, F, NC, or NP
Also Listed As:	
Formerly:	

Catalog Description:
This course provides students a step-by-step approach to understand, apply and install commercial lighting control systems. Students will learn lighting terminology, lighting control strategies, Light Emitting Diode (LED) light sources and drivers, line and low voltage controls, dimming systems, occupancy sensors, photosensors, networked lighting control systems, common codes and standards, and associated installation/wiring requirements. This course is for students who have completed the 5th year Electrical Apprenticeship program or California State Certified general electricians or electrical contractors.

Prerequisites/Corequisites:

Recommended Preparation:

Limits on Enrollment:
Indentured apprentice - apply and be accepted by the Redwood Empire Joint Apprenticeship & Training Committee (REJATC)

Schedule of Classes Information:
Description: This course provides students a step-by-step approach to understand, apply and

install commercial lighting control systems. Students will learn lighting terminology, lighting control strategies, Light Emitting Diode (LED) light sources and drivers, line and low voltage controls, dimming systems, occupancy sensors, photosensors, networked lighting control systems, common codes and standards, and associated installation/wiring requirements. This course is for students who have completed the 5th year Electrical Apprenticeship program or California State Certified general electricians or electrical contractors. (Grade Only)
Prerequisites/Corequisites:
Recommended:
Limits on Enrollment: Indentured apprentice - apply and be accepted by the Redwood Empire Joint Apprenticeship & Training Committee (REJATC)
Transfer Credit:
Repeatability: Two Repeats if Grade was D, F, NC, or NP

ARTICULATION, MAJOR, and CERTIFICATION INFORMATION:

AS Degree:	**Area**	Effective:	Inactive:
CSU GE:	**Transfer Area**	Effective:	Inactive:
IGETC:	**Transfer Area**	Effective:	Inactive:

CSU Transfer:	Effective:	Inactive:
UC Transfer:	Effective:	Inactive:

CID:

Certificate/Major Applicable:
Certificate Applicable Course

COURSE CONTENT

Student Learning Outcomes:
At the conclusion of this course, the student should be able to:
1. Identify lighting controls and how they function
2. Describe how lighting controls are installed

Objectives:
At the conclusion of this course, the student should be able to:
1. Define and explore common terminology used in the lighting industry
2. Identify lighting control strategies used in commercial spaces
3. Explore how and where these strategies are used
4. Identify and explore the latest generation of energy efficient LED sources and power equipment
5. Identify and understand which LED sources are compatible with fluorescent ballasts
6. Identify and understand which sources are compatible with various control technologies
7. Understand various power platforms for lighting control systems
8. Examine centralized and distributed topologies
9. Examine wireless communication and networking
10. Understand general area control strategies and code requirements
11. Identify and describe various types of switching
12. Identify and understand emergency lighting / switching

13. Practice the installation of common switching controls
14. Examine the reasons for dimming
15. Define the types of dimming controls commonly used with LED systems
16. Explain dimming controls operation
17. Explore where dimming controls are used
18. Identify and describe scheduling and demand response controls
19. Understand the application and wiring requirements
20. Practice installing scheduling and demand response controls
21. Define and describe the types of occupant sensor technologies explain their operation and coverage
22. Identify the applications for each type of occupant sensor technology
23. Practice the installation and commissioning of the occupant sensors
24. Define and describe daylight harvesting control strategies
25. Explain photosensor and controller technology
26. Explain photosensor operation
27. Identify the applications for each photosensor type
28. Practice the installation and startup of photosensors

Topics and Scope:

Module 1 – Lighting Concepts and Control Strategies

I. Lighting Terminology
  A. Lighting system defined
  B. Lighting metrics and units of measurements
    1. Luminous flux
    2. Luminous intensity
    3. Illuminance
    4. Luminance
    5. Correlated color temperature
    6. Color rendering index
  C. Illuminance measurement demonstration
II. Lighting Control Strategies
  A. Controls and Strategies
    1. Switching, dimming and scene control
    2. Time scheduling
    3. Demand Response
    4. Tuning
    5. Lumen maintenance
    6. Adaptation compensation
    7. Occupancy sensing
    8. Daylight harvesting
  B. Energy savings potential
  C. Cost of lighting controls
III. Applications
  A. Commercial applications
  B. Industrial applications
  C. System-level application within a building
IV. Codes and Standards
  A. California Building Energy Efficiency Standards
  B. California Appliance Efficiency Regulations
  C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

/Illuminating Engineering Society of North America (IESNA) 90.1 2016
Module 2 – LED Light Sources

I. LED Lighting Systems
- A. LED System Overview
  1. LEDs
  2. LED System Components
  3. LED Characteristics
  4. LED Optics
  5. Heat Management
  6. Physical Forms
  7. LED Drivers
- B. System Characteristics and Performance
  1. Average Rated Life
  2. Light Output
  3. Color Rendering Index
  4. Correlated Color Temperature (CCT)
  5. Temperature Sensitivity
  6. Storage & Handling
- C. Commercial Products Overview
  1. Screw-base Lamps
  2. Linear LED Lamps
  3. Dedicated Luminaires
  4. Zhaga Books
- D. Linear LED Solutions
  1. UL Ratings
     a. Type A
     b. Type B
     c. Type C
  2. Fluorescent Ballast Review
  3. Fluorescent dimming ballast types
  4. Controls compatibility
- E. Fluorescent System Applications - Common Ballast Type
  1. Instant Start
  2. Rapid Start
  3. Programmed Start
  4. Dimming
- F. LED Dimming and Controls
  1. How LED Dimming Works
  2. LED Dimming Methods
  3. LED Lighting and Dimming Controls

II. LED System Applications
- A. Indoor Applications
  1. Office
  2. Retail
- B. Outdoor Applications
  1. Parking & Area
  2. Architectural Lighting

Module 3 – Power and Communication

I. Power Infrastructure - Power Environments

- A. Line voltage
  - 1. General overview
  - 2. Line voltage controls overview
- B. Low voltage
  - 1. General overview
  - 2. Low voltage controls overview
  - 3. Power classifications
  - 4. Transformer loading - exercise
- C. Power of Ethernet
  - 1. Power
  - 2. Controls
  - 3. Module System – example
- D. Self-powered Wireless Devices
  - 1. Flea power
  - 2. Battery power

II. Centralized and Distributed Control Architecture
- A. Overview
- B. Applications
- C. Centralized Control Systems
  - 1. PC controlled networks
  - 2. Centralized relay panel
    - a. Features
    - b. Example
    - c. Block diagram
    - d. Override features
  - 3. Remote control circuit breaker system
    - a. Construction
    - b. Panel board
    - c. Programming
    - d. Networked panels
    - e. Applications
- D. Distributed Control Systems
  - 1. Distributed relay panels
    - a. Examples
    - b. Applications
  - 2. Modular systems
    - a. Overview
    - b. Example
    - c. Applications

III. Communication and Networking
- A. Communication protocols
- B. Serial and parallel communication
- C. Digital and analog communication
- D. Network terminology
- E. Networked lighting control systems
  - 1. Control panels
  - 2. Wired protocols used with lighting
  - 3. Power line carrier systems
  - 4. Wireless systems
    - a. Overview
    - b. Topologies
    - c. Mesh networks

d. RF protocols
e. Devices
f. Applications

Module 4 – General Area Controls: Switching

I. General Area Controls
A. Overview
B. Building applications
C. Interlocked lighting systems
D. Common code requirements
II. Line Voltage Switching
A. Device types overview
B. Wall box devices
1. Single pole switch
2. 3-way switch
3. 4-way switch
4. Demonstration of 3 and 4-way switches
II. Low Voltage Switching
A. Components
B. Examples
C. Switching relays
1. Electrically held relays
2. Mechanically held / latching relays
D. Power over Ethernet
1. Overview
2. Wiring diagram
IV. Wireless Switching
A. Overview
B. Power technology
C. Product examples
D. Wiring example
V. Emergency Lighting
A. Overview
B. National Fire Protection Association (NFPA) -101 Life Safety Code
C. NFPA-70 NEC Art.700
D. UL 924 shunt relay
1. Applications for shunt relay
2. UL1008 Automatic Transfer Switch (ATS)
3. Shunt relay vs. ATS
4. Shunt relay demonstration
5. ATS demonstration
E. Safety labeling
VI. Line Voltage Switching Control Installation Laboratory

Module 5 – Dimming and Scene Controls

I. Overview
A. Why dim?
1. Energy savings and code compliance
2. Flexibility and functionality
3. Productivity

4. Aesthetics
B. Applications
1. Building-level placement
2. Indoor applications
3. Outdoor applications

II. Dimming Control Technology
A. Terminology
B. Visual Perception
C. Dimming Load Types
D. How LED Dimming Works
1. Constant current reduction
2. Pulse width modulation
E. Dimming control signals commonly used with LED sources
F. Dimming issues with LEDs
G. Phase Control Dimming
1. Forward phase control
2. Reverse phase control
3. 2-Wire phase control
4. 3-Wire phase control
H. 0-10V Dimming Control
I. Control by Digital Signals
J. Dimming control systems
1. Wall box dimmers - basic
2. Wall box dimmers - characteristics
a. Diagrams
b. Derating and example
c. Derating for use with LED systems and example
d. NEMA SSL-7A
3. Multi-zone, multi-scene preset controls
a. Characteristics
b. Integrated devices
c. Modular devices
4. Panel systems
a. Overview
b. Devices
c. Control stations
d. Installation requirements

III. Dimming and Scene Control Installation Laboratory

Module 6 – Scheduling and Deman Response

I. Scheduling Controls
A. Overview
B. Mounting
C. Wall box devices
1. Interval time switch – mechanical
2. Interval time switch – electronic, wiring diagram
D. Cabinet devices - automatic time switch
1. Overview
2. Features
3. Wiring diagram
E. Centralized, Software-based Scheduling Control

F. Energy Management System
II. Lighting Controls and Demand Response (DR)
A. What is demand response?
B. Manual and automated DR
C. Open ADR
D. Auto-DR Network
1. Direct enrollment architecture
2. Managed services architecture
3. Customer Accounts
E. ADR Client Software
1. Client Software
2. Device Firmware
3. Cloud Services
F. DR for Lighting Systems - Wiring Diagram / Example
III. Applications
A. Building-level applications
B. Indoor applications
C. Outdoor applications
IV. Scheduling and DR Installation Laboratory

MODULE 7 – OCCUPANCY CONTROLS (Lecture 60 Minutes; Lab 420 Minutes)

I. Occupancy Sensor Overview
A. What they are, what they do
B. Energy savings potential
C. Control configurations
1. Partial-ON
2. Partial-OFF
3. Vacancy sensors
D. Commissioning and acceptance
II. Occupancy Sensor Characteristics
A. Sensor components and operation
B. Occupancy sensor variables
C. Occupancy sensor parameters
D. False triggering
E. Occupancy sensor features
F. Sensor with self-adapting technology
G. Power - block diagrams
1. Low voltage
2. Line voltage
3. Self-powered
H. Auxiliary equipment
1. Power pack diagram
2. Power pack application
I. Occupancy sensor mounting
J. Detection coverage
III. Occupancy Sensor Technology
A. Passive Infrared (PIR)
1. Operation
2. Considerations
3. Coverage & placement
4. Coverage zone

5. Lens masking
B. Ultrasonic (US)
1. Operation
2. Considerations
3. Coverage zone
4. Comparison to PIR
C. Microwave
1. Operation
2. Considerations
3. Coverage zone
D. Microphonics
1. Operation
2. Considerations
3. Coverage zone
E. Dual technology (DT)
1. Operation
2. Considerations
3. Coverage zone

IV. Applications
A. Commercial applications
B. Building-level applications
C. Exercise
D. Mounting
1. Wall-mounted applications
2. Ceiling-mounted applications
3. Exterior
E. Multiple-sensor applications

V. Occupancy Sensor Installation Laboratory

Module 8 – Daylight Harvesting

I. Overview
A. What is daylight harvesting?
B. Photosensors
C. Energy savings potential
D. Daylit zones
E. Codes & Standards

II. Photosensor Characteristics
A. Sensor & eye comparison (location, orientation, view, color, intensity)
B. Spatial response (field of view)
C. Spectral response
D. Range of response (light sensitivity)
E. Sensor system components
F. Control adjustments
G. Power supply

III. Photosensor Control Technology
A. Control methods
B. Open loop
C. Closed loop
D. Sensor mounting location (ceiling, window, skywell, luminaire)
E. Sensor placement (no direct daylight, no direct electric light)
F. Set points, deadbands & time delay

G. Switching vs. dimming
H. Switching option
I. Dimming option

IV. Photosensor Applications
A. Building-level application
B. Space-type Applications

VI. Daylight Harvesting Installation Laboratory

Assignment:

GRADING POLICY: Passing grade for the written Final Exam is 70% (correct answers). A participant who does not pass the exam must repeat the exam. All participants must install the lighting control equipment in the lab exercises correctly (100%). They may not proceed to the next module until they do so. The trainer must verify and document (sign off) the correct installation of all devices. The average of the two grades for both the lecture and lab (70% and 100%) equals the California Advanced Lighting Controls Training Program (CALCTP) passing score of 85%.

Methods of Evaluation/Basis of Grade:

Writing: Assessment tools that demonstrate writing skills and/or require students to select, organize and explain ideas in writing.

None, This is a degree applicable course but assessment tools based on writing are not included because skill demonstrations are more appropriate for this course.	Writing 0 - 0%

Problem Solving: Assessment tools, other than exams, that demonstrate competence in computational or non-computational problem solving skills.

None	Problem solving 0 - 0%

Skill Demonstrations: All skill-based and physical demonstrations used for assessment purposes including skill performance exams.

Lab exercises	Skill Demonstrations 50 - 50%

Exams: All forms of formal testing, other than skill performance exams.

Final exam	Exams 50 - 50%

Other: Includes any assessment tools that do not logically fit into the above categories.

None	Other Category 0 - 0%

Representative Textbooks and Materials:

NJATC online Learning Management System for the California Advanced Lighting Controls Training Program - Training materials and tests