

## **ENRG 54 - Introduction to Lighting Systems and Controls**

**COURSE DESCRIPTION:** Fundamentals of lighting systems and controls for energy auditors. Concepts of lighting, terminology, measurement tools, identifying energy efficiency opportunities, codes, standards.

**30 Hours (20 lecture, 10 lab)**

### **LEARNING OUTCOMES:**

- Summarize terminology, physics and principles of lighting
- Identify and compare various types of lighting systems, including field identification and interpretation of nameplate data
- Measure illuminance and lighting intensity
- Describe the theory and operations of various lighting control systems
- Evaluate energy use by various types of lighting systems and identify opportunities for energy efficiency measures
- Calculate energy savings of energy efficiency measures and estimate their financial impact
- Apply relevant local, state and national codes, standards and regulations relevant to lighting system recommendations

### **COURSE TOPICS:**

- I. Introduction to fundamentals of lighting
  - A. Lighting terminology
    1. Luminous flux
    2. Illuminance
    3. Reflectance
    4. Power
    5. Efficacy
    6. Lighting power density
    7. Lamp life
    8. Lumen depreciation
    9. Correlated color temperature
    10. Color rendering index (CRI)
    11. Ballast factor
  - B. Physics and principles of lighting
    1. Spectral power distribution
    2. Inverse square law
  - C. Units of measurement
    1. Lumen
    2. Foot-candle
    3. Power (wattage)
    4. kWh
  - D. Vision and colors
  - E. Ambient, directional and task lighting
  - F. Over-and under-illuminance
- II. Lighting systems
  - A. Components
    1. Luminaire
    2. Lamp
    3. Ballast
    4. Reflector
    5. Diffuser, lens or louver

- B. Types of lamps
  - 1. Incandescent
  - 2. Halogen
  - 3. Fluorescent
  - 4. High intensity discharge
    - a. Metal halide
    - b. Mercury vapor
    - c. High pressure sodium
    - d. Low pressure sodium
  - 5. Induction lamps
  - 6. Light emitting diodes (LED)
  - 7. Neon
- C. Ballasts
  - 1. Electro-magnetic (magnetic) ballast
  - 2. Electronic ballast
  - 3. Ballast factor
- D. Lamp comparison matrix
- E. Types of lighting luminaires and intensities
- F. Energy efficiency measures (EEMs)
  - 1. Lamp replacement
  - 2. Ballast replacement
- III. Lighting controls
  - A. Basic concepts of effectiveness of lighting control
  - B. Types and appropriate applications of lighting controls
    - 1. Manual switches
    - 2. Schedule controls or sweeps (building automation systems)
    - 3. Timers and time clocks
    - 4. Infrared and ultrasonic occupancy sensors
    - 5. Manual dimmers
    - 6. Daylight controls or photo sensors
    - 7. Bi-level switching
  - C. Lighting control equations
  - D. Energy efficiency measures (EEMs)
- IV. Additional EEMs
  - A. De-lamping
  - B. Scotopic lighting
  - C. Task and ambient light levels
  - D. Circadian rhythms
- V. Lighting measurements
  - A. Tools
    - 1. Flicker checker
    - 2. Illuminance meter
    - 3. Luminance meter
    - 4. Lighting measurement devices
    - 5. Spectrophotometer
    - 6. Goniophotometer
    - 7. Circuit tracer
  - B. Data loggers and applications
    - 1. Occupancy
    - 2. Hours of use
- VI. Lighting calculations
  - A. Equation and method of calculating lumens (zonal cavity formula)
  - B. Equation and method of calculating energy savings

- ## TYPES OF ASSIGNMENTS:

- ### TEXTBOOKS & RESOURCES:

- Instructor handouts on such topics as comparison of qualities of various lamp types
- Lighting wattage tables

# BEST Center Curricula, Resources & Recordings

## Academic Programs

Georgia Piedmont Technical College - Building Automation Systems

Milwaukee Area Technical College - Sustainable Facilities Operations

Laney College - Commercial HVAC Systems

City College San Francisco - Commercial Building Energy Analysis & Audits

## Professional Development Materials, Presentations & Videos

National Institutes

Building Automation Systems Instructor Workshops

Webinars (e.g., BEST Talks)

## Faculty Profile Videos

## Reports & Case Studies

## Marketing Resources

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