ENRG 55B - HVAC Systems and Efficiencies

COURSE DESCRIPTION: Configured HVAC systems types, system controls and identification of energy efficiency or conservation measures.

52 Hours (34 lecture, 18 lab)

LEARNING OUTCOMES:

- Describe and compare various types of air side systems such as single duct, dual duct, multi-zone, psychrometrics, terminal units, etc.
- Describe and compare various types of water side systems such as steam, condenser water, hydronic, cooling and heating sources
- Describe the fundamentals of various controls of HVAC systems
- Evaluate energy conservation or efficiency measures of HVAC systems
- Calculate the energy efficiency or conservation coefficients such COP, EER and/or SEER
- Examine and evaluate various energy efficiency or conservation measures as applied to HVAC systems
- Calculate the amount of energy saved by implementing energy efficiency measures on both air side and water side systems

COURSE TOPICS:

I. Brief review of components, equipment and terminology from ENRG 55A, HVAC Fundamentals & Components

II. HVAC system types
   - A. Air-side systems
     1. Air-handling-unit (AHU) system arrangement
        - a. Package AHU
        - b. Built-up (field assembled) AHU
        - c. Individual room AHU
     2. Single-duct systems
        - a. Constant volume
          - 1.) Single zone system
          - 2.) Multiple zone reheat system
        - b. Variable-air-volume (VAV)
          - 1.) Dual conduit
          - 2.) Variable diffuser
     3. Dual-duct systems
        - a. Constant volume (Single fan with or without reheat)
        - b. Variable-air-volume (VAV)
          - 1.) Single fan, dual duct system
          - 2.) Dual fan, dual duct system
     4. Multi-zone systems
        - a. Three-deck systems
        - b. Texas multi-zone systems
     5. Special systems
        - a. Primary/secondary
        - b. Dedicated outdoor air
        - c. Air distribution
     6. Terminal units
        - a. Constant volume reheat
        - b. Variable-air-volume (VAV)
        - c. Terminal and filters
     7. Psychrometrics of HVAC systems

a. Psychrometrics for supply ducts and plenums
b. Psychrometrics for reheat systems
c. Variable volume systems
d. Multi-zone and dual duct systems
e. Evaporative cooling

B. Water-side systems
1. Steam systems
a. Steam source
b. Steam distribution
c. Boiler connections
d. Combined steam & water systems
2. Condenser water systems
a. Open cooling tower systems
b. Low-temperature (water economizer) systems
c. Closed-circuit evaporative coolers
3. Variable refrigerant flow (VRF) system
a. Cooling-only
b. Heat pump
c. Heat recovery
4. Hydronic systems
a. Water distribution systems
b. Principles of water flow
c. Circulating pumps configuration
d. Piping systems
e. Refrigerant distribution
f. Pumps
5. HVAC system types
a. Cooling source
1.) DX-coils
2.) Chilled water coils
3.) Evaporative coolers
b. Heating source
1.) Electric resistance
2.) DX coils (Heat pump)
3.) Hot water coils

III. HVAC system controls
A. Introduction to fundamentals and symbols of controls
B. Typical control systems
1. Electrical interfaces
2. Computer-based controls
C. Closed-loop (Feedback) and open-loop control systems
D. HVAC energy conservation controls
1. Install time clocks or setback-programmable thermostats to minimize the run-time of equipment
2. Use energy management system to control all equipment
3. Install intermittent ignition devices on gas furnaces to save gas
4. Use occupancy sensors or twist timers to control equipment in areas with limited occupancy
5. Use carbon monoxide (CO) sensors to control ventilation fans in garages
6. Use demand ventilation controls (CO_2) in areas with high ventilation requirements to limit the outside air entering the building
7. Keep vents closed in unoccupied areas to prevent heating or cooling of storage areas and closets
8. Install locking covers on thermostats to prevent employee tempering with temperature settings

IV. Energy efficiency and/or conservation measures (EEMs or ECMs)
A. Identifying energy efficiency opportunities and measures

1. O&M (operations and maintenance)
   a. Routine maintenance to assure optimal performance
   b. Repair to restore equipment to specifications
2. Add economizers to air handlers
3. Scheduling

B. Coefficient of performance (COP)
C. Energy Efficiency Ratio (EER) and Seasonal EER (SEER)
D. Calculating the energy reductions of common EEMs
1. Convert constant volume air handlers to variable air volume (VAV) systems
2. Install fans, or other re-circulating systems to create air movement when temperature stratification is undesirable
3. Install un-loaders on compressors or other staged loads
4. Install variable frequency drives (VFDs) for HVAC fans and chilled water pumps
5. Evaporatively cool the air entering condensers
6. Trim pump impellers on over-sized pumps
7. Re-sheave fans on oversized fans
8. Insulate water heaters, supply pipes and ducts
9. Replace electric resistance heating systems with heat pumps
10. Modify flue dampers on gas furnaces to increase burner efficiency

TYPES OF ASSIGNMENTS:

I. In-class
A. Class demonstrations and discussions
B. Demonstrations and discussions of various system and control types
C. Calculations from sample data, such as operating energy use, energy savings from suggested EEMs, etc.
D. Small group projects such as identifying all operational components of a system, identifying possible EEMs, and making a team presentation of findings to the class
E. Field trips such as to the Pacific Energy Center, or site visits to various campus facilities to observe systems

II. Out-of-class
A. Readings from texts, websites and instructor handouts
B. Research manufacturer websites to find EER, SEER and specifications for various equipment from nameplate data
C. Brief written paper (2-3 pages) on topics such as the most common energy efficiency opportunities in HVAC systems

TEXTBOOKS & RESOURCES:

- Instructor handouts on topics such as EER and SEER, economizers, COP

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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Building Efficiency for a Sustainable Tomorrow

NSF National Science Foundation