City College of San Francisco
Course Outline of Record

I. GENERAL DESCRIPTION

A. Approval Date	May 2012
B. Department	Engineering
C. Course Number	ENRG 55A
D. Course Title	HVAC Fundamentals and Components
E. Course Outline Preparer(s)	Lawrence Tachie
F. Department Chairperson	Hitesh Soneji
G. Dean	David Yee

II. COURSE SPECIFICS

A. Hours	Lecture: 34 total Laboratory: 18 total
B. Units	3
C. Prerequisites	ENRG 52
Corequisites	None
Advisories	ET 108B, CNIT 100, ENRG 51
D. Course Justification	Commercial buildings are very energy intensive, and are therefore the most cost effective to assess. California has set aggressive energy efficiency and greenhouse gas reduction goals. In February 2011 San Francisco passed the Existing Commercial Buildings Energy Performance Ordinance, requiring all commercial buildings over 10,000 square feet to benchmark their energy use annually, and be audited every five years. This class is part of a comprehensive training program developed with grant funds from the CCCCOEWD. HVAC and refrigeration systems represent over 40% of energy use in commercial buildings. Auditors need to understand the fundamentals and concepts of how HVAC systems work, how to identify various types of equipment in the field, understand the basic concepts of equipment operations, calculate heating and cooling loads, and understand equipment energy use. It prepares students for "ENRG 55B HVAC Systems and Efficiencies."
E. Field Trips	Yes
F. Method of Grading	Letter, Pass/No Pass
G. Repeatability	0

III. CATALOG DESCRIPTION

Fundamentals and concepts of HVAC with emphasis on types of equipment and conveyance. Principles of work, power and energy. Refrigeration cycle, pschrometric chart, load calculations, nameplate identification, media.

IV. MAJOR LEARNING OUTCOMES

Upon completion of this course a student will be able to:

A. Describe the principles and concepts of work, power, and energy.
B. Describe the basic principles of thermodynamics and heat transfer.
C. Measure and calculate conversion of units, such as temperature, pressure, power, British Thermal Units (BTU), etc.
D. Analyze and interpret room conditions using the psychrometric chart and software such as Trace 700 or e-Quest.
E. Estimate various types of heating and cooling loads as applied to buildings, rooms, and mechanical systems.
F. Define the purpose of various heating, cooling, and conveyance equipment.
G. Identify various heating, cooling, and conveyance equipment in the field.
H. Interpret name plate data of various heating, cooling, and conveyance equipment.

V. CONTENTS

A. Introduction to physical principles of HVAC & systems
    1. Conversion of units
        a. Temperature
        b. Pressure
        c. Horse power
        d. Power (kWh)
        e. British Thermal Units/hr (BTU/hr)
        f. Tons
    2. Concept of work, power, and energy
    3. Overview of psychrometric analysis of the air conditioning system
        a. Psychrometric processes and calculations
            1. Sensible or latent processes
            2. Air side equations
            3. Air side mixing
            4. Summary of process line calculations
        b. Room sensible heat ratio (RSHR) and room CFM (cubic feet per minute)
            1. Room sensible heat ratio
            2. Room sensible heat ratio line
            3. Design CFM (Room)
            4. Multiple room sensible heat ratios
        c. The coil sensible heat ratio (CSHR)
            1. Coil sensible heat ratio without ventilation
            2. Coil sensible heat ratio with ventilation
            3. Construction of the RSHR and CSHR lines
            4. Coil By-pass factor
    4. Thermodynamic laws and heat transfer principles

5. Estimate of sensible and latent heat changes
6. Analysis of thermal comfort

B. Load calculations
   1. Heating loads
      a. Building net heating load
      b. System heat losses
      c. Heating coil load
   2. Cooling loads
      a. Room and building peak cooling load
      b. Cooling load calculations for lighting, people, equipment & appliances
      c. Infiltration and ventilation
      d. Cooling coil load
   3. Use of psychrometric tables and various software packages for heating and cooling estimates

C. Conveyance systems
   1. Principles of conveyance systems
   2. Types of conveyance equipment and components
      a. Open and closed loops
      b. Media
         1. Air
         2. Water
         3. Refrigerant
         4. Steam
         5. Others
      c. Mechanisms
         1. Pumps
         2. Fans
         3. Motors
      d. Distribution systems
         1. Pipes
         2. Ducts
         3. Dampers
         4. Valves
         5. Filters
      e. Heat exchangers
         1. Coils
         2. Radiators
         3. Others
   3. Name plate interpretation

D. Principles of heating systems
   1. Types of heating equipment & components
      a. Boilers
      b. Furnaces
      c. Combustion processes and fuel
      d. Fuel-Burning equipment
      e. Boiler feed water and systems

f. Direct-and Indirect-Fired heating equipment
g. Unit heater and duct heaters
h. Terminal heating equipment
i. Heat pumps
j. Heat recovery and reclaim

2. Name plate interpretation

E. Cooling systems
1. Principles of the refrigeration cycle
2. Types of equipment & components
a. Compressors
b. Chillers
c. Condensers
d. Cooling towers
e. Cooling coils
f. Radiant cooling
g. Evaporative cooling
h. Evaporators
3. Name plate interpretation

F. Air-handling systems
1. Diffusers, , and registers
2. Dampers, louvers, filters, fans

VI. INSTRUCTIONAL METHODOLOGY

A. Assignments
1. In class
a. Class discussions and demonstrations of various equipment types.
b. Simple and rule-of-thumb load calculations.
c. Field simulation exercises such as name plate interpretation of various HVAC equipment and components.
d. Describe or draw refrigeration cycle.
e. Describe or draw two or four loops distribution systems.
f. Pyschrometric chart analysis and calculations.
g. Field trips such as to the Pacific Energy Center, or site visits to various campus facilities to observe equipment.
2. Out of class
a. Load calculations.
b. Research codes and service or safety factors of various types of equipment, and prepare a brief (1-2 page) report.
c. Pyschrometric chart analysis and calculations.
d. Research and interpret name plate data from equipment.

B. Evaluation
1. Participation in class discussions, demonstration, field simulation exercises and field trips.
2. In-class and out-of-class problem sets and calculations.
3. Sample name plate interpretation and verification assignments.
4. Brief written report.

5. Tests or quizzes on topics covered in lectures and texts.
6. Final exam.

C. Textbooks and other instructional materials
   1. Websites such as FILL IN HERE.
   2. Instructor handouts on topics such as the refrigeration cycle, or illustrations of various types of equipment.

VII. TITLE 5 CLASSIFICATION
CREDIT/DEGREE APPLICABLE (meets all standards of Title 5. Section 55002(a)).

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

BEST
Building Efficiency for a Sustainable Tomorrow

NSF National Science Foundation