COURSE OUTLINE

BENCHMARKING AND ASSESSMENT OF BUILDING ENERGY PERFORMANCE

The course comprises up to ten weekly sessions of in-class instruction, followed by five weeks of field work in commercial buildings. The first ten weeks are designed to provide a foundation for performing a building energy audit and completing an ASHRAE Building EQ In Operation submission. The final five weeks of the course involves students performing the assessment tasks on a real building, either a campus building or a building serving the community (for example, homeless shelter, food bank or public housing). The field work is expected to be mentored by local industry professionals with the credentials to submit a Building EQ rating, either a licensed professional engineer in the project jurisdiction or an ASHRAE BEAP certified professional.

During the first part of the course, while the students are developing an understanding of the methods and processes to be performed in the field, it would be desirable to have a sample building available for instructional examples. Ideally, the entire class could perform a sample building energy audit on this building during the first part of the class, including a preliminary energy use analysis, a walk-through survey, IEQ measurements, analysis of energy efficiency measures, post-audit reporting, and preparation of the Building EQ submittal.

The following outline describes the first ten weeks of the course. For each week, the outline includes weekly learning objectives, the delivery format for the instruction, preparatory reading material, and assignments.

1) Course Introduction
    a) Learning Objectives:
        i) Describe the syllabus for the course, including the course prerequisites and expectations
        ii) Recognize the instructional team, including instructor, professional mentors, and building client, and understand the role of the instructional team members
        iii) Discuss the reason for using the Building EQ program as a course framework
        iv) Describe global energy consumption characteristics and the role of commercial and residential buildings
        v) Explain the building energy end use consumption characteristics
        vi) Recognize the impact of time variations in building energy consumption
    b) Delivery
        i) Lecture slides for course introduction and building energy characteristics
    c) Preparation
        i) Explore websites of the International Energy Agency and U.S. Energy Information Administration
2) Review of building mechanical, electrical, and lighting systems (could be optional for programs without significant exposure to building systems)
    a) Learning Objectives:

i) Describe the anatomy of typical HVAC systems in commercial buildings
ii) Identify typical primary and secondary HVAC equipment and their role in meeting system requirements
iii) Explain the basics of electrical distribution systems and their equipment in commercial buildings
iv) Explain the basics of lighting system in buildings, including performance terminology, lighting technologies, energy performance, and the role of daylighting

b) Delivery
i) Lecture slides on building mechanical, electrical, and lighting systems

c) Preparation
i) TBD

d) Assignments
i) Homework to describe the mechanical and electrical system design of a building, possibly their project building

3) Introduction to building energy benchmarking and assessment

a) Learning Objectives:
i) Discuss the differences between benchmarking, labeling programs, and energy and environmental auditing
ii) Identify and understand the metrics used to benchmark building performance
iii) Explain the role of building type and climate zone on energy use
iv) List the key aspects of ENERGY STAR® Portfolio Manager and other tools for benchmarking
v) Explain the ASHRAE Building EQ As Designed and In Operation ratings
vi) List and explain the differences between Building EQ and Portfolio Manager

b) Delivery:
i) Lecture slides on benchmarking and the Building EQ program
ii) Preliminary field trip to expose students to building features

c) Preparation
i) EPA Portfolio Manager documents
ii) Building EQ case study
iii) Articles about US, European, and other international programs

d) Assignment
i) Homework to explore benchmarking tools, such as Portfolio Manager, Building Peformance Database, City of New York, or local resources

4) Preliminary Energy Use Analysis (PEA)

a) Learning Objectives:
i) Conduct space function analysis
ii) Analyze utility rate schedules and energy billing data
iii) Compare energy performance to similar buildings
iv) Develop appropriate energy target requirements
v) Compare alternative energy targets for same building

b) Delivery
i) Lecture slides on preliminary energy use analysis

ii) Conduct in-class case study by applying PEA to sample building

c) Preparation
   i) Procedures for Commercial Building Energy Audits Part 1 and pp. 26-34

d) Assignment
   i) Perform PEA for sample building
   ii) Compare performance with at least two databases for benchmarking (could be in-class exercise)

5) Measuring and monitoring building performance
   a) Learning Objectives:
      i) Identify instrumentation for measuring indoor environmental quality and building energy flows
      ii) Perform measurements of indoor environmental quality and building energy flows
      iii) Discuss accuracy of building measurements
   b) Delivery
      i) Lecture slides on building measurements and monitoring
      ii) In-class demonstration of instrumentation
   c) Preparation
      i) Performance Measurement Protocols for Commercial Buildings: Best Practices Guide, Ch. 1-2
   d) Assignment
      i) Hands-on exercise of building measurements, including airflow rate, environmental temperature and humidity, electrical power, and lighting levels
6) Walk Through Analysis
   a) Learning Objectives:
      i) Identify the components of an ASHRAE Level 1 walk through survey and the differences between Level 1, 2, and 3 surveys
      ii) Conduct an interview of the building owner/operator
      iii) Validate a space function analysis
      iv) Identify low-cost/no cost opportunities for improvements to the facility or O&M procedures
      v) Identify potential capital improvement projects for further study
   b) Delivery
      i) Lecture slides on walk through analysis
      ii) Preliminary walk through of sample building site with mentors and/or building client
   c) Preparation
      i) Procedures for Commercial Building Energy Audits pp. 34-43
      ii) Case studies of audit processes
   d) Assignment
      i) Develop template for interview with building client
7) Indoor Environment Quality (IEQ)
   a) Learning Objectives:
      i) Describe the role of HVAC systems in maintaining indoor environmental quality
      ii) Apply ASHRAE Standard 55 to evaluate thermal comfort in a commercial building
      iii) Apply ASHRAE Standard 62.1 to evaluate indoor air quality in a commercial building

iv) Explain the role of lighting and acoustic systems in maintaining indoor environmental quality

b) Delivery
   i) Lecture slides on indoor environmental quality
   ii) Field measurements in sample building to evaluate indoor environmental quality

c) Preparation
   i) Performance Measurement Protocols for Commercial Buildings: Best Practices Guide, Ch. 1-2
   ii) Articles about Standard 55 and 62.1

d) Homework
   i) Prepare checklist for site visit

8) Energy Efficiency Measures – Engineering Calculations

a) Learning Objectives:
   i) Explain the process of identifying energy efficiency measures within the ASHRAE commercial building energy audit taxonomy
   ii) Calculate power and energy consumption for simple equipment
   iii) Explain the application of the Degree Day and Bin Methods for energy calculations
   iv) Calculate annual energy consumption using the Bin Method
   v) Explain the use of life cycle cost analysis for evaluating alternative energy retrofit options
   vi) Calculate financial performance indices for energy retrofits, including simple payback, life cycle costs, and internal rate of return.

b) Delivery
   i) Lecture slides on engineering calculations for evaluating energy efficiency measures

c) Preparation
   i) PCBEA pp. 59-72
   ii) Energy Star Building Upgrade Manual

d) Assignment
   i) Homework problems involving energy calculations and life cycle cost calculations

9) Energy Efficiency Measures – Opportunities and Impacts

a) Learning Objectives:
   i) Demonstrate the role of envelope characteristics, HVAC systems, and lighting systems on building energy use
   ii) Identify low-cost and no-cost energy efficiency measures
   iii) Identify common EEM opportunities for envelope systems and explain their impacts
   iv) Identify common EEM opportunities for HVAC systems and their controls and explain their impacts
   v) Identify common EEM opportunities for central plant systems and explain their impacts
   vi) Identify common EEM opportunities for lighting systems and explain their impacts

b) Delivery
   i) Lecture slides on the opportunities and impacts of common energy efficiency measures

c) Preparation
   i) Procedures for Commercial Building Energy Audits pp. 59-72
   ii) Energy Star Building Upgrade Manual
   iii) DOE Advanced Energy Retrofit Guides

d) Homework

i) Homework assignments to calculate energy savings and economic feasibility of EEM retrofits

10) Reporting
    a) Learning Objectives:
        i) Prepare an energy audit report for the building client
        ii) Conduct a post-audit interview with building client
        iii) Submit a Building EQ In Operation rating
        iv) Describe concepts of branding for small building energy assessment firms
    b) Delivery
        i) Lecture slides on reporting for energy analysis and benchmarking
    c) Preparation
        i) PCBEA pp. 78-89
        ii) ASHRAE Building EQ website: http://www.ashrae.org/buildingeq.