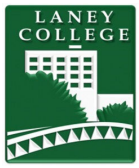
ECT 25 COURSE

LANEY COLLEGE
ENVIRONMENTAL CONTROL TECHNOLOGY
Commercial HVAC Systems Program

ECT 25 Introduction to Building Commissioning Course Development

National Science Foundation - National Center for Building Technician Education



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INTRODUCTION TO BUILDING COMMISSIONING

Course Documentation

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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Catalog description

Introduction to fundamentals of commissioning, re-commissioning, and retro-commissioning related to mechanical and electrical building systems; review of building equipment and building control systems.

After completing this course, the students will be able to develop a commissioning plan for new and existing facilities, understand the use of data collection instrumentation and protocols, and analyze data to identify and solve issues on building systems, specifically HVAC systems. The student will learn how to write a commissioning report and calculate cost and benefits from commissioning existing buildings.

Class hours

Lecture 26.25 Hours Lab 26.25 Hours

Units

Lecture 1.5 semester units Lab 0.5 semester units

Entry skills needed

- Reading level: College-level English technical reading. Ability to decode new technical terminology with reference help.
- Writing level: Ability to express complex technical concepts in English.
- Math level: college technical math
    1. Perform mathematical operations using real numbers, fractions, decimals and percentages.
    2. Solve simple linear equations.
    3. Demonstrate knowledge converting fractions to decimals and decimals to fractions.
    4. Solve basic math and geometry problems on area, angles, volume and percentages.
    5. Use algebraic equations to solve heating and cooling load calculation problems.
    6. Solve problems involving ratio and proportions.
    7. Interpret data in graphs in rectangular coordinate systems.
    8. Use and apply Imperial and Metric systems of measurement.
    9. Solve problems involving area and perimeter.

Suggested co-requisite skills development

- Commercial HVAC systems skills:
    1. Describe and explain the functions of all the HVAC system components.
    2. Explain the principles of thermodynamics as they apply to HVAC systems.
    3. Use the psychrometric chart to evaluate thermal comfort conditions.
    4. Demonstrate proficiency in the electrical and mechanical aspects of HVAC systems.
    5. Demonstrate proper use of instrumentation.
    6. Use different software tools to measure and analyze HVAC systems.
    7. Demonstrate a good understanding of mechanical, electrical and electronic controls.
    8. Demonstrate proficiency on hydronics systems.

Syllabus

See Appendix A for sample Syllabus, course schedule, and policies. For Lesson Topics to include in course, see Exit Skills.

Student learning outcomes

The exit skills listed in the next section support these 3 outcomes:

Fundamentals

Describe the building system fundamentals and building equipment.

The commissioning process

Explain the process and terminologies of commissioning, re-commissioning and retro-commissioning.

Commissioning implementation

Utilize building controls and energy management systems for commissioning.

Exit skills

Course content to achieve 3 outcomes listed above:

Concept

1. Explain the process of building commissioning, with distinctions between new and existing buildings.

   Course Content for this objective:

   a. Identify key components of the commissioning process.
   b. Identify cost and benefits of the commissioning process.

Process

2. Explain the processes of commissioning, re-commissioning and retro-commissioning.

   Course Content for this objective:

   a. Develop commissioning plans for new and existing buildings.
   b. Develop test procedures and data collection protocols.

      Lesson Topics:

      - Planning phase
      - Design phase
      - Construction phase
      - Investigation phase
      - Implementation phase

Building systems

3. Describe the building system fundamentals.

Building equipment

4. Describe building equipment such as boilers, chillers, air-handlers, pumps and motors.

Terminologies

5. Explain commissioning terminologies.

   Course Content for this objective:

   a. Owner's program
   b. Commissioning plan
   c. Construction documents
   d. O&M and manual
   e. Testing, adjusting, and balancing
   f. Functional test
   g. Acceptance procedure
   h. Construction checklist
   i. As-operated
   j. EBCx (existing building commissioning) plan and report
   k. Utility analysis
   l. Benchmarking
   m. Data collection
   n. Data analysis

o. Recommendations
p. Systems manual

Implementation

6. Utilize controls and energy management systems for commissioning.

Course Content for this objective:

a. Demonstrate proficiency in data analysis
b. Develop training protocols for building operators
c. Field methods of commissioning, re-commissioning and retro-commissioning
d. Proper use of instrumentation
e. Safety practices and equipment review
f. Software use for data analysis

Course materials

Principal text

Reading materials provided, listed under handouts.

Lecture materials and handouts

- Reading: Commissioning checklist for major building components. (01813_PREFUNCTIONALCHECKLISTS.pdf) 37pp
- Reading: Hydronic system as built schematics, HVAC symbols, electrical symbols. (As_Operated_Samples.pdf) 11pp
- Presentation: States of the commissioning process. (Class 01_Commissioning Process Overview.pdf) 37slides.
- Presentation: Process and tool list for existing building commissioning. (Class 02_New VS Existing.pdf) 11slides.
- Presentation: Initial or construction checklist phase of commissioning, and details of pump technology, application, and performance. (SCOPING_PHASE_PFT.pdf) 36 slides.

Other reference materials

- Complete proprietary fan application guide with fan performance curves. (Greenheck_Fan_Fundamentals_D299.pdf) 24pp.

Software needed

None required for this course.

Lab materials

- General tool kit for plumbing and electrical servicing including wrenches and screwdrivers
- Hand-held digital pressure gauge (or alternative pump installation with built-in pressure gauges
- Strobe tachometer
- Amprobe

Lab equipment & instruments required

FIGURE 1 - Economizer on build-up AHU in lab. Controls fully accessible for adjustment, setting up faults, or commissioning activities.

FIGURE 2 - Variable Frequency Drive, 3 are connected to water circulation pumps in lab. Can be programmed by students, faults can be set up by instructor.

Generally, hands-on implementation of concepts is key to successful learning of equipment function and relationships. Laney ECT department's lab has a fully functional commercial building central plant system for demonstration purposes. All components of the system are accessible to students for operation, measurement, diagnosis, servicing, and commissioning. See Laney College - Commercial HVAC Systems program documentation for lab layout and more detailed information on equipment and instruments.

A connected and functional commercial HVAC system should include a boiler, chiller, water pumps, air handling units, terminal units, cooling towers, control systems(pneumatic and/or DDC), sensors, and actuators. Monitoring access point computers accompanied by one or more control system trainer boards (with equivalent connected controls and actuators) will allow students maximum access.

For the project listed below, a pump and associated throttling valves, pressure gauges, VFD and accessible wiring are required.

Economizers need to be set up to demonstrate response to any outdoor conditions regardless of the time of day or year the lab class is meeting. A furnace/AC unit has been installed to supply "outside air" to the economizers at a selected temperature between 55°F and 120°F.

Project

- Complete performance test write-up of an installed pump including analysis of energy efficiency, performance in relation to demand, and improvement strategies (Class Project_No.3_Pump_Performance.docx). 10pp.

- Procedure and data sheet for testing pump function on site. (Use with Class Project_No.3_Pump_Performance.docx) (1009-HotWaterSystemPumpTest.pdf) 5pp.

Problem-based learning (PBL) - Commissioning as a topic provides many opportunities to frame a PBL project. The PBL could be based on investigation of an actual building, or based on a case study. ECT 25 is part of the 3rd semester of the Commercial HVACR Systems program, which contains 2 other courses with PBL projects.

Assessment

Methods

- Tests
- Peer-evaluated presentations
- Instructor verified hands-on lab work

See Appendix B – Sample project rubric for project assessment.

Sample test questions

See future update.

Adaptability to on-line format

The lecture portion can be delivered and assessed on-line with traditional methods. The laboratory portion requires hands-on experience with equipment, so on-line delivery needs to be supported by real world access. Adaptation of laboratory equipment for video presentation might support on-line demonstrations. Refer to "PNNL Retuning Commercial Buildings" for examples of web-based interactive problem scenarios.

Appendix A – Sample syllabus

(See Exit Skills section for lesson topics.)

LANEY COLLEGE
ENVIRONMENTAL CONTROL TECHNOLOGY

Course: Introduction to Building Commissioning

Course No. /Code: ECT 025

Units: 2 Units

Date/Time: Monday & Wednesday 5:30 – 6:50 PM

Instructor: **Email:**

Course Description: After completing this course, the students will be able to develop a commissioning plan for new and existing facilities, understand the use of data collection instrumentation and protocols, and analyze data to identify and solve issues on building systems specifically on HVAC systems. The student will learn how to write a commissioning report and calculate cost and benefits from commissioning existing buildings.

Outcomes:

- Identify key components of the commissioning process.
- Develop commissioning plans for new and existing buildings.
- Identify cost and benefits of the commissioning process.
- Develop test procedures and data collection protocols.
- Demonstrate proficiency in data analysis.
- Develop training protocols for building operators.

Prerequisites: NONE

Text: None, handouts provided

Supplies Needed: Three ring binder, "thumb" drive.

Special Notes: The following are recommended but not required to take this course:

- Email account to receive electronic files
- Laptop computer
- Knowledge of spreadsheets (Excel)

Class Schedule:

Description
Commissioning process review _ Part 1
Commissioning process review _ Part 2
• Assign class projects: 1. Small office building with LEED rating • Planning Phase
Planning Phase Lab
Planning Phase: Owner's Program
Planning Phase: Owner's Program (continued)
NO CLASS
Planning Phase: Commissioning Plan
Planning Phase: Basis of Design
Design Phase: Bldg systems description
Design Phase: Refine Commissioning Plan Specifications
Construction Phase: Construction Documents O&M TAB Functional Test
Development of Functional Test
Construction Checklist
Acceptance procedure
Class Project 1 Due Date **Existing Building Commissioning**
Existing VS New building commissioning
Planning Phase: As – Operated
Planning Phase: EBCx Commissioning plan
Investigation Phase: Utility Analysis
Investigation Phase: Benchmarking
Investigation Phase: Data Collection
Investigation Phase: Lab _ Data Collection
Investigation Phase: Data Analysis
Investigation Phase: Lab _ Data Analysis
Investigation Phase: Recommendations
Investigation Phase: Savings and cost analysis
Implementation Phase: Checklist
Implementation Phase: O&M Manual
Implementation Phase: Systems Manual I
Implementation Phase: Systems Manual II
Implementation Phase: Systems Manual III
EBCx Report
Class Project 2 Due Date
Class review
FINAL EXAM

Evaluation: The final grade will be assigned based on the following components:

1. Attendance and participation 30 points
2. Class Project No. 1 20 points
3. Class Project No. 2 20 points
4. Final Exam 30 points

TOTAL: 100 points

Safety: Some lab exercises will be conducted on a real life setting; students are expected to follow safety practices and recommendation from instructor.

Attendance: Students may be dropped from this course if the number of unjustifiable absences exceeds four weeks of class meetings.

Class Behavior: Students are encouraged to observe respectful behavior during class, no cell phones or iPods are allowed in class.

Appendix B – Sample project rubric

See future update.

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