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CE 41400 BUILDING MECHANICAL AND ELECTRICAL SYSTEM DESIGN

Course Description (Include Requisites/Restrictions):
Restriction: Junior status in the College of Engineering;
Prerequisite: CE 31100 or Instructor permission.

This course covers the design of building mechanical and electrical systems. In the first part of the course students learn principles of designing and integrating heating, ventilation, and air conditioning systems into buildings including air delivery systems, mechanical cooling and heating technologies, duct design and layout, blower and pump selection, and hydronic systems. They also learn to design heating, ventilation, and air conditioning systems within the constraint of achieving satisfactory occupant thermal comfort in buildings. The second part of the course covers design concepts related to building electrical systems; including, single and three-phase power systems, motors, transformers, switching, and relays. The course includes a design project related to mechanical and electrical systems for a commercial building.

Course Learning Outcomes:

Upon completion of this course, students will be able to:

- Utilize building thermal load information together with a knowledge of industry standards and numerical methods to design and integrate efficient heating, ventilation, and air conditioning systems into commercial and residential buildings.
- Understand the benefits and drawbacks of conventional and innovative mechanical systems, and identify appropriate opportunities for the selection and integration of both.
- Evaluate the performance and estimate energy consumption of common mechanical systems and components.
- Understand the operating characteristics and appropriately size the components that are integrated into building electrical systems.
TO: The Faculty of the College of Engineering
FROM: The Faculty of the School of Civil Engineering
RE: New Undergraduate Course: CE 41400 Building Mechanical and Electrical System Design

The Faculty of the School of Civil Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

CE 41400 Building Mechanical and Electrical System Design
Sem. 1 or Sem. 2, Lecture 3, Cr. 3.
Restriction: Junior status in the College of Engineering; Pre-requisite: CE 31100 Architectural Engineering or permission from the instructor.

Description: This course covers the design of building mechanical and electrical systems. In the first part of the course students learn principles of designing and integrating heating, ventilation, and air conditioning systems into buildings including air delivery systems, mechanical cooling and heating technologies, duct design and layout, blower and pump selection, and hydronic systems. They also learn to design heating, ventilation, and air conditioning systems within the constraint of achieving satisfactory occupant thermal comfort in buildings. The second part of the course covers design concepts related to building electrical systems; including, single and three-phase power systems, motors, transformers, switching, and relays. The course includes a design project related to mechanical and electrical systems for a commercial building.

Reason: Currently across the United States, buildings account for a large percentage of the total energy that is consumed. Often times as much as half of the energy consumed in a building is attributable to the heating, ventilation, and air conditioning systems that are responsible for maintaining a safe, healthy, and comfortable environment. Additionally, the cost of purchasing and installing these systems in new and existing buildings can represent a significant portion of a project budget. Within the Architectural Engineering emphasis area it is critical that students understand and successfully apply mechanical and electrical system design principles and methods to buildings. This course provides students with a fundamental knowledge of conventional and innovative heating, ventilating, and air conditioning equipment, and building electrical systems. The course was taught as CE 497XX in Spring 2010 and Spring 2011 with enrollments of 25 and 35, respectively.

M.K. Banks
Bowen Engineering Head and Professor
Jack and Kay Hockema Professor of Civil Engineering

APPROVED FOR THE FACULTY OF THE SCHOOLS OF ENGINEERING BY THE ENGINEERING CURRICULUM COMMITTEE

ECC Minutes #9
Date 1-17-2012
Chairman ECC K. Cyra
CE 41400 BUILDING MECHANICAL AND ELECTRICAL SYSTEM DESIGN

Course Instructor: Travis Horton

Level: Undergraduate Level

Restriction: Junior status in the College of Engineering.
Pre-requisite: CE31100 Architectural Engineering or instructor permission.

Course Outcomes: Upon completion of this course students will be able to:

- Utilize building thermal load information together with a knowledge of industry standards and numerical methods to design and integrate efficient heating, ventilation, and air conditioning systems into commercial and residential buildings.
- Understand the benefits and drawbacks of conventional and innovative mechanical systems, and identify appropriate opportunities for the selection and integration of both.
- Evaluate the performance and estimate energy consumption of common mechanical systems and components.
- Understand the operating characteristics and appropriately size the components that are integrated into building electrical systems.

Course Outline:

- **Introduction and Concept Review.** Define the design scope for building mechanical and electrical systems; Review of fundamental engineering principles, including thermodynamic properties and processes, and fluid dynamics. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 55. Introduce computer programming and basic numerical methods. [2 weeks]
- **Air Distribution System Design.** Introduction to air delivery system configurations. Constant and variable volume air delivery systems. Duct sizing methods, including equal friction, static regain, equal velocity, and optimization-based techniques. Air system components, including air handling units, grilles, and diffusers. [4 weeks]
- **Building Ventilation Design.** Indoor air quality. Requirements for building ventilation systems and building ventilation standards. ASHRAE Standard 62. Energy recovery devices used in ventilation systems. [1 week]
- **Heating and Air Conditioning Systems.** Analysis of components and systems, including air conditioners, heat pumps, heat exchangers, boilers, furnaces, and combined heat and power systems. [4 weeks]
- **Building Electrical Systems.** Electrical system fundamentals, including single and three-phase power, voltage drop in conductors, and over-current protection systems. Building electrical system components; motors, transformers, switching, and relays. [3 weeks]

Total = 15 weeks
Course website: Purdue Blackboard


Grading: Final course grade will be based on the following breakdown: 90.0% and up = A; 80.0% to 89.9% = B; 70.0% to 79.9% = C; 60.0% to 69.9% = D; 59.9% and below is an F.

Final grades will be based on the following breakdown:
Homework: 15%,
Projects: 30%,
Quizzes: 25%,
Exams: 30%

A typical course syllabus is appended on the following pages.
CE 49700  BUILDING MECHANICAL AND ELECTRICAL SYSTEM DESIGN

Instructor: Dr. W. Travis Horton
Office: CIVL G219
Phone: 494-6098
Time: MWF 12:30 p.m. - 1:20 p.m.
Location: CIVL 3153
Office Hours: M 2:30 p.m. – 3:30 p.m.
W 1:30 p.m. – 2:30 p.m.
F 11:30 a.m. – 12:30 p.m.


Prerequisites: CE 31100 Architectural Engineering

Course Objectives:
This course covers various aspects related to the design of building mechanical and electrical systems. In the first part of the course students learn principles of designing and integrating heating, ventilation, and air conditioning systems into a building; including, air delivery systems, mechanical cooling and heating technologies, duct design and layout, blower and pump selection, and hydronic systems. They also learn to design heating, ventilation, and air conditioning systems within the constraint of achieving satisfactory occupant thermal comfort in buildings. The second part of the course covers design concepts related to building electrical systems; including, single and three-phase power systems, motors, transformers, switching, and relays. The course includes a design project related to mechanical and electrical systems for a commercial building.

Homework and Projects:
Homework and projects will be assigned regularly. Assignments should be done neatly and submitted with final solutions clearly summarized and marked. Assignments are to be submitted before the beginning of the lecture period on the due date. Assignments turned in late will lose a minimum of 50% of the points. Assignments that are more than a week late will not be accepted unless a specific arrangement has been made with the instructor prior to the due date.

Quizzes and Exams:
Quizzes and exams will be administered during the semester. Quizzes and exams must be taken on the scheduled day and at the scheduled time. Students with conflicts must make arrangements to take a make-up exam or quiz with the instructor at least one week prior to the scheduled quiz or exam.
Grading:
Your final course grade will be based on the following breakdown: 90.0% and up = A; 80.0% to 89.9% = B; 70.0% to 79.9% = C; 60.0% to 69.9% = D; 59.9% and below is an F. Final grades will be based on the following breakdown:

Homework: 15%
Projects: 30%
Quizzes: 25%
Exams: 30%

Grade challenge policy:
Any challenges to a grade received on an assignment, quiz, or exam must be submitted to the instructor in writing within one week of receiving the grade.

Special Accommodations:
If you require special accommodations because of a disability, please inform the instructor of your needs by the end of the first week.

Emergencies:
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Any changes will be posted to the course blackboard site.

Academic Integrity:
Academic dishonesty will not be tolerated. Please refer to the section, “Definition of Academic Dishonesty,” on the following web page: http://www.purdue.edu/odos/osrr/integrity.htm. Any incidents of academic dishonesty will, at the very least, result in zero credit for the associated assignment, quiz, or exam. Further penalties, such as immediate failure of the course and/or referral to the Dean of Students, are at the discretion of the instructor.