SYLLABUS

DESCRIPTION

Proper control of building energy systems is crucial for maintaining occupant comfort with minimal energy consumption. This course treats the design and analysis of building energy control systems from both theoretical and practical perspectives. Consideration of analog and digital control theory and building energy control hardware leads to specific applications for control of building energy systems.

LECTURES
8:00 – 9:15 Tuesday, Thursday
Room ECCR 1B08

INSTRUCTOR
Michael J. Brandemuehl
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Office Hours: 9:30 – 11:00 Tuesday ***(Preliminary)***
1:30 – 3:00 Wednesday

TEXT
Levermore, G.J. 2000. *Buidling Energy Management Systems: Application to Low-Energy HVAC and Natural Ventilation Control.* Longon: Taylor and Francis.

ADDITIONAL READING
Underwood, C.P. 1999. *HVAC Control Systems: Modeling, Analysis, and Design*. London: Taylor and Francis – Routledge .

Haines, R. W., and D.C. Hittle. 1993. *Control Systems for Heating, Ventilating and Air Conditioning, Fifth Edition.* New York: Chapman & Hall.

American Society of Heating, Refrigerating and Air Conditioning Engineers, *ASHRAE Handbooks* - Fundamentals, 2005; HVAC Applications, 2003; HVAC Systems and Equipment, 2004.

WEB PAGE
http://ceae.colorado.edu/~brandem/cven5010/

EVALUATION

Exams	25%
Homework	35%
Project	30%
Participation	10%

Final Presentations: Wednesday, May 7, 10:30 – 1:00 pm

GENERAL COURSE OUTLINE

Topic	*Classes*
HVAC Control Systems	3
a. Basics	
b. Closed loop vs. supervisory control	
c. HVAC processes and control subsystems	
d. System configuration	
Modeling of Dynamic Processes	4
a. Linear system modeling with Laplace transforms	
b. Modeling of building components	
c. Analog control representation	
Control Fundamentals	2
a. Objectives of control systems	
b. Response of dynamic systems	
Stability Considerations	2
a. Feedback control	
b. Stability tests	
c. Tuning of control system parameters	
Discrete System Control	5
a. Modeling with z-transform analysis	
b. Stability issues and sampling rate	
c. Controller design	
Exam	1
Building Control Hardware	4
a. Sensors	
b. Control devices	
c. Pneumatic controllers	
d. Electric/Electronic controllers	
e. Digital controllers	
Supervisory Control	3
a. Ladder diagrams	
b. EMCS structure and hardware	
c. Minimizing energy use/cost through setpoint control	
Advanced Topics	6
a. Optimal supervisory control	
b. Fuzzy logic control	
c. Neural network based control	