

Energy Simulation in Building Design

ARE 383, CE 397, ARE 371 Spring 2009

The University of Texas at Austin

Department of Civil, Architectural, and Environmental Engineering

Course Unique Numbers: 14870 (ARE 383), 15475 (CE 397), 14835 (ARE 371) 3 hrs

Course Website: <http://www.ce.utexas.edu/prof/Novoselac/classes/ARE383/>

Classroom and Time: ECJ 7.202, Tuesday and Thursday 11:00 AM - 12:30 PM

Prerequisites: Graduate student. For undergraduate students: ARE 346N or consent of instructor.

Professor: Dr. Atila Novoselac

Office: ECJ 5.422

e-mail: atila@mail.utexas.edu

<http://www.ce.utexas.edu/prof/Novoselac>

Office Hours: Tuesday and Thursday 1:00 PM - 2:00 PM or by appointment. I have an open door policy – if my office door is open, I will see students without an appointment. If I am busy, we will schedule a convenient time for both of us.

Course Catalog Description: Fundamentals of building energy simulations including basic analytical models for heat and mass transfer in building elements and general numerical methods for solving system of equations, use of energy simulations tools for building design analysis including parametric study of various design features and operational parameters considering energy consumption.

Course Objectives:

1. Identify basic building elements which affect building energy consumption and analyze the performance of these elements using energy conservation models.
2. Analyze the physics behind various numerical tools used for solving different heat transfer problems in building elements.
3. Use basic numerical methods for solving systems of linear and nonlinear equations.
4. Conduct building energy and mass transfer analysis using comprehensive computer simulation tools.
5. Evaluate the performance of building envelope and environmental systems considering energy consumption in buildings.
6. Perform parametric analysis to evaluate the effects of design choices and operational strategies of building systems on building energy use.
7. Use energy simulations in life-cycle cost analyses for selection of energy-efficient building components.

Textbook:

There are no required textbooks for this class. Students are required to read provided papers and handouts. Some textbooks that you might find useful are in the reference list below:

References: (optional – on 2 hour reserve at Engineering Library)

J A Clarke, 2002, *Energy Simulation in Building Design (2nd Edn)*, Butterworth-Heinemann, ISBN 0 7506 5082.

2001 ASHRAE Handbook: *Fundamentals*. IP or SI edition, hard copy or CD.

S V Patankar, 1980, *Numerical Heat Transfer and Fluid Flow*, ISBN: 0891165223.

John A. Duffie, William A. Beckman, 1991, *Solar Engineering of Thermal Processes*, ISBN: 0471510564.

Topics:

1. Course Introduction and Background	0.5 wk
2. Fundamentals of energy mass transfer	1.5 wks
3. Thermal analysis of building components	2 wk
4. Numerical methods	2 wks
5. Energy simulation tools	1 wk
6. Introduction to DOE2(eQUEST) software	1 wk
7. Building envelope analyses	2 wks
8. HVAC System analyses	2 wks
9. Parametric Analyses	<u>2 wks</u>
	14 wks

<u>Grading:</u>	Test	25%
	Classroom Participation	5%
	Homework Assignments	30%
	Midterm Project	10%
	Final Project & Presentation	<u>30%</u>
		100%

Course Letter Grades:

90-100	A-, A
80-90	B-, B, B+
70-80	C-, C, C+
60-70	D-, D, D+
< 60	F

Personal Problems:

If you have illness or personal problems that will affect your performance during the course of the semester, please let me know as soon as possible. “After the fact” provides little protection unless there are extreme circumstances. I have an answering machine and an e-mail address if you need to get in touch with me after hours. Do not hesitate to use them.

Academic Honesty:

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. For further information, visit the Student Judicial Services web site <http://www.utexas.edu/depts/dos/sjs/>.

Privacy – Web Based Class Sites:

Web-based, password-protected class sites may be associated with all academic courses taught at the University. Syllabi, handouts, assignments and other resources are types of information that may be available within these sites. Site activities could include exchanging email, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1. For information on restricting directory information, see: <http://www.utexas.edu/student/registrar/catalogs/gi00-01/app/appc09.html> .

Students with Disabilities:

The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. Any student with a documented disability (physical or cognitive) who requires academic accommodations should contact the Services for Students with Disabilities area of the Office of the Dean of Students at 471-6259 as soon as possible to request an official letter outlining authorized accommodations. For more information, contact that Office, or TTY at 471-4641, or the College of Engineering Director of Students with Disabilities at 471-4321.

Dropping the Course:

Undergraduate Students: From the 1st through the 12th class day, an undergraduate student can drop a course via the web and receive a refund. From the 13th through the 20th class day, an automatic Q is assigned, no refund; approval from the Dean and departmental advisor is required. From the 21st class day through the mid-semester deadline, approval is required from the Dean, instructor of the course and departmental advisor.

Graduate Students: From the 1st through the 4th class day, graduate students can drop a course via the web and receive a refund. During the 5th through 12th class day, graduate students must initiate drops in the department that offers the course and receive a refund. After the 12th class day, no refund is given. No class can be added after the 12th class day. From the 13th through the 20th class day, an automatic Q is assigned with approval from the graduate advisor and the Graduate Dean. From the 21st class day through the last class day, graduate students can drop a class with permission from the instructor, graduate advisor, and the Graduate Dean.

Course Evaluations:

Each student will be given the opportunity to evaluate the course using the standard course/instructor evaluation form at the end of semester.

Computer Usage:

Basic knowledge of any programming language (Fortran, C, Matlab, etc.) or use of equation solver tools (MathCAD, Mathematica, EES, etc.) is beneficial. Some homework assignments and the term projects will require extensive use of computers. The students will use the energy simulation software eQUEST and other energy simulation tools for projects and homework assignments.

Projects:

There will be two projects assigned. The midterm projects will count for 10% and final for 30% of your final grade. The final project will include the project presentation.

Important Dates:

Test: March 26 (will be confirmed)

Midterm Project Due: April 7

Final Project Due: May 7

TENTATIVE COURSE SCHEDULE

Date	Topics	Due date for
01/20	Course introduction and terminology	
01/22	Heat transfer review	HW0
01/27	No class -ASHRAE meeting	
01/29	Heat transfer review	
02/03	Solar radiation	
02/05	Thermal processes in building elements	
02/10	Thermal modeling of basic building elements	HW1
02/12	Unsteady-state heat transfer	
02/17	System of equations for the building systems	
02/19	Numerical methods for solving system of equations	
02/24	Internal and external heating/cooling load	HW2
02/26	Design condition vs. typical weather conditions – TMY data	
03/03	Simplified and detailed simulation techniques and programs	
03/05	Building simulation software	
03/10	Example of building energy simulation using eQuest	HW3
03/12	Introduction to parametric analysis	
03/24	Midterm project assignment	
03/26	Review for Midterm Test	
03/31	Building environmental systems	Test
04/02	Primary and secondary HVAC systems	
04/07	Midterm project analysis	Midterm project
04/09	Heating ventilation and air-conditioning (HVAC)	
04/14	Modeling the HVAC systems and equation solving	
04/16	Final project assignment	
04/21	Interaction of building envelope and HVAC system	
04/23	Control systems	
04/28	Building simulation as requirement for the LEED certification	
04/30	Detailed energy/mass transport simulation – TRANSYS, Energy Plus	
05/05	Energy modeling and life cycle cost analysis	
05/07	Final project report and analysis	Final project