Energy Simulation in Building Design
ARE 371, CE 397  Fall 2015
The University of Texas at Austin
Department of Civil, Architectural, and Environmental Engineering

Course Unique Numbers: 15105 (ARE 371) 15800 (CE 397)

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

Classroom and Time: ECJ 9.236, Tuesday and Thursday 9:30 AM - 11:00 AM

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

Instructor: Dr. Atila Novoselac
Office: ECJ 5.430
Phone: Office 475-8175
e-mail: atila@mail.utexas.edu
http://www.ce.utexas.edu/prof/Novoselac

Office Hours: Tuesday and Thursday 11:00 AM - 12:00 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 & mass transfer in building elements and general numerical methods for solving system of equations. Use of energy simulations tools for building design analyses including parametric studies of various design solutions for different operational and environmental parameters.

Course Objectives:
1. Identify basic building elements which affect building energy consumption and analyze the performance of these elements using energy and mass conservation models.
2. Understand the physics behind various numerical tools used for solving different heat and moisture 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 analyses using comprehensive computer simulation tools.
5. Evaluate the performance of building envelope and environmental systems considering energy consumption in buildings.
6. Perform parametric analyses 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 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)

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  1 wk
5. Fundamentals of moisture transfer  1 wk
6. Energy and moisture simulation tools  1 wk
7. Introduction to modeling software  1 wk
8. Building envelope analyses  2 wks
9. HVAC system analyses  2 wks
10. Parametric analyses  2 wks
    14 wks

Grading:  
Test  30%
Homework Assignments  25%
Midterm Project  10%
Final Project & Presentation  30%
Classroom Participation (attendance)  5%
    100%

Course Letter Grades (for graduate and undergraduate students):
  90-93,  >93  A-, A
  80-83, >83-86, >86-90  B-, B, B+
  70-73, >73-76, >76-80  C-, C, C+
  60-63, >63-66, >66-70  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.

Honor Code:
The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, thrust, fairness, and respect towards peers and community.

Policy of Scholastic Dishonesty:
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://deanofstudents.utexas.edu/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.

Accommodations (Disability Statement):
The University of Texas at Austin provides, upon request, appropriate academic accommodations for qualified students with disabilities. For more information, contact the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259 (voice) or 232-2937 (video phone) or http://www.utexas.edu/diversity/ddce/ssl.

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, if eligible. From the 13th through the university’s academic drop deadline, a student may Q drop a course with approval from the Dean, 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.

Attendance Policy:
Regular attendance and participation are essential and expected. Random attendance will be taken throughout the semester by various means and it can affect your grade up to 5% (participation grade). "A student who is absent from a class or examination for the observance of a religious holy day may complete the work issued within a reasonable time after the absence, if proper notice has been given". The deadline for notification of such an absence is 14 days prior to the class absence.

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

Quantitative Reasoning:
This course carries the Quantitative Reasoning flag. Quantitative Reasoning courses are designed to equip you with skills that are necessary for understanding the types of quantitative arguments you will regularly encounter in your adult and professional life. You should therefore expect a substantial portion of your grade to come from your use of quantitative skills to analyze real-world problems.

Computer Usage:
Some homework assignments and the term projects will require extensive use of computers. The students will use the energy and moisture simulation software eQUEST, EnergyPlus, WUFI, etc. for projects and homework assignments. The software will be installed on computers in ECJ building, but the eQUEST and EnergyPlus software can be downloaded to personal computers for
free at: http://www.doe2.com/equest/ and http://apps1.eere.energy.gov/buildings/energyplus/. Also, basic knowledge of any programming language (Matlab, Fortran, C, etc.) is beneficial.

**Final Exam:**
This course will not have a final exam. The final project and the final project presentation will replace the final exam.

**Projects:**
There will be two projects assigned. The midterm projects will count for 10% and final for 30% of your final grade. Midterm project will be an individual project.

**Final Project Description:**
It will be a group project where students have a choice to select their project topic in the area of building energy analysis. Each group will prepare a two page proposal to define the project objectives, scope, methodology, and deliverables. Students are welcome to propose problems from their current research or future career. Based on these proposals the course instructor will refine the final project scope and deliverables for each group, so that each student will have the same final project work load. Each group member will have the same project grade.

**Due Dates Policy:**
All assignments are due at the end of the day and those turned in late will count off 10% per day.

**TENTATIVE COURSE SCHEDULE**

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<th>Class</th>
<th>Topics</th>
<th>Due date for</th>
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<tbody>
<tr>
<td>08/26</td>
<td>Course introduction and terminology</td>
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<tr>
<td>09/01</td>
<td>Heat transfer review</td>
<td>HW0</td>
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<tr>
<td>09/03</td>
<td>Heat transfer review</td>
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<tr>
<td>09/08</td>
<td>Heat transfer review</td>
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<tr>
<td>09/10</td>
<td>Solar radiation</td>
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<tr>
<td>09/15</td>
<td>Weather boundary conditions</td>
<td>HW1a</td>
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<td>09/17</td>
<td>Thermal processes in building elements</td>
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<td>09/22</td>
<td>Thermal modeling of basic building elements</td>
<td>HW1b</td>
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<td>09/24</td>
<td>Unsteady-state heat transfer</td>
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<td>09/29</td>
<td>System of equations for the building systems</td>
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<td>10/01</td>
<td>Numerical methods for solving system of equations</td>
<td>HW2</td>
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<td>10/06</td>
<td>Internal and external heating/cooling load</td>
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<td>10/08</td>
<td>Design condition vs. typical weather conditions – TMY data</td>
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<td>10/13</td>
<td>Simplified and detailed simulation techniques and programs</td>
<td>HW3</td>
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<td>Moisture transfer - fundamentals</td>
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<td>Control of moisture transfer</td>
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<td>Midterm project assignment</td>
<td>HW4</td>
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<td>Review, for midterm test</td>
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<td><strong>10/29</strong></td>
<td><strong>Test</strong></td>
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<td>Introduction to parametric analysis</td>
<td>Midterm project</td>
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<td>Final project assignment</td>
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<td>11/10</td>
<td>Primary and secondary HVAC systems</td>
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<td>11/12</td>
<td>HVAC and automatic control</td>
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<tr>
<td>11/17</td>
<td>Modeling the HVAC systems and equation solving</td>
<td>Final project - prel. results</td>
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<td>11/19</td>
<td>Interaction of building envelope and HVAC system</td>
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<td>11/24</td>
<td>Building simulation as requirement for the LEED certification</td>
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<td>12/01</td>
<td>Detailed energy simulations - TRANSYS, Energy Plus</td>
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<tr>
<td>12/03</td>
<td>Energy modeling and life cycle cost analysis</td>
<td>Final project</td>
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