CAE 331/513: Building Science

Fall 2016

Illinois Institute of Technology
3 credit hours
Department of Civil, Architectural and Environmental Engineering

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Course Unique Number(s)
CAE 331 Section 01: 10405 (undergraduate)
CAE 513 Section 01: 15258 (graduate in-class); CAE 513 Section 02: 17668 (graduate online)

Classroom and Meeting Time
Stuart Building, Room 212, Tuesdays and Thursdays, 1:50 PM – 3:05 PM

Course Website
http://built-envi.com/courses/cae-331513-building-science-fall-2016/

Prerequisites
CAE 209 Thermal Fluids Engineering II, MMAE 322 Heat and Mass Transfer, or CHE 302 Heat and Mass Transfer Operations

Instructor
Brent Stephens, Ph.D., Associate Professor, Architectural Engineering
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Office Hours
Office hours are by appointment only. Please email me to schedule an appointment.

Course Catalog Description
Study of the physical interaction of climate (humidity, temperature, wind, sun, rain, snow, etc.) and buildings. Topics include psychrometrics, indoor air quality, indoor thermal comfort, heat transfer, air infiltration, solar insolation, and heating and cooling load calculation.

Instructor's Course Objectives and Learning Outcomes
To introduce students to physical phenomena that affect building design and performance. By taking this course students will be able to:

1. Describe the role of building components and building environmental systems in energy consumption, peak electricity demand, thermal comfort, and human exposures to pollutants.
2. Describe the role of buildings and environmental systems in building design, construction, and operation.
3. Describe and quantify fundamental heat and mass transfer properties and processes in buildings, including conduction, convection, radiation, psychrometrics, thermodynamics of refrigeration systems, fluid flow, and mass balances.
4. Calculate peak heating and cooling loads for buildings.
5. Understand types of HVAC equipment for residential and commercial construction and how they operate.
6. Understand basic ventilation and indoor air quality concepts.
7. Understand basic concepts of building diagnostic tests, acoustics, and lighting.
8. Critically analyze claims about building components and environmental systems from product manufacturers, contractors, and building designers.

Textbook

I recommend this book as an excellent resource for general building science topics:

Wang, S.K. 2000. *Handbook of air conditioning and refrigeration* (2nd edition). McGraw-Hill. ISBN: 0-07-068167-8.

You can find inexpensive used copies online.

References (optional; will be given handouts when necessary)

In addition to the aforementioned textbook, I will also rely on several other materials in this course. These materials are optional for the student; handouts will be given when necessary so that no one is required to purchase these items.

ASHRAE 2013. *Handbook of Fundamentals.* American Society of Heating, Refrigerating, and Air-Conditioning Engineers. (**Highly recommended; can be purchased for $50 or less for students**)

ASHRAE 90.1-2010. *Energy Standard for Buildings Except Low-Rise Residential Buildings.*

Janis, R.R. and Tao, W.K.Y. 2009. *Mechanical and Electrical Systems in Buildings*. Pearson Prentice Hall. ISBN: 978-0-13-513013-1.

Kreider, J.F., Curtiss, P.S., and Rabl, A. *Heating and Cooling of Buildings: Design for Efficiency* (2nd Edition), CRC Press, Taylor & Francis Group. ISBN: 978-1-4398-1151-1.

Kuehn, T.H., Ramsey, J.W., and Threlkeld, J.L. 1998. *Thermal Environmental Engineering*. Prentice Hall. ISBN: 0-13-917220-3.

McQuiston, F.C., Parker, J.D., and Spitler, J.D. 2005. *Heating, ventilating, and air conditioning: analysis and design*. John Wiley & Sons, Inc. ISBN: 0-471-47015-5.

Mitchell, J.W. and Braun, J.E. 2013. *Principles of Heating, Ventilation, and Air Conditioning in Buildings*. John Wiley & Sons, Inc. ISBN: 978-0-470-62457-9.

Moss, K.J. 2007. *Heat and Mass Transfer in Buildings* (Second Edition). Taylor & Francis. ISBN: 978-0-415-40908-7.

Straube, J. and Burnett, E. 2005. *Building Science for Building Enclosures*. Building Science Press. ISBN: 0-9755127-4-9.

Homework Assignments

There will be several homework assignments during the course that will involve hand calculations, development of spreadsheets, and/or learning the basics of some software packages typically used in industry. Some general rules for homework assignments are as follows:

- HW assignments will be posted online on Blackboard (BB) and will typically be due 1 week after they are assigned.
- Undergraduate and graduate students enrolled in the in-class sections should submit hardcopies of their HW at the beginning of class.
- Hardcopy HW assignments should be neatly printed, preferably on **engineering paper**.
- Multiple page submissions of any hardcopies must have all pages stapled together.
- Graduate students enrolled in the online section can submit HW via electronic PDF either directly to the instructor or uploaded via Blackboard (BB). Your file should be in PDF format and the filename should be in the format of **hw1_lastname_firstname.pdf**. Handwritten HW must be scanned and converted to PDF by online students. Multiple pages must be converted to a single PDF for submission.

Late Homework Policy

Homework is due at the beginning of class on the day that it is due. Do not work on HW during the lecture. Late HW will receive a 5-point deduction for every day that it is late, excluding weekends. For example, a HW due on a Tuesday turned in the following Tuesday will have its grade reduced by 50%.

Exams
Three in-class exams will be given in this course: two exams during the semester on topics covered in the course in the period between each exam and one final exam (the final is comprehensive). Both undergraduate and graduate students will take the same exams.

Grading
This is a mixed undergraduate and graduate course; there is an additional deliverable for graduate students and higher expectations be placed upon all deliverables from graduate students. Graduate students will be required to complete an advanced research project in addition to the regular HW and exam requirements. The project will involve researching and writing a literature review on a particular aspect of building science. For all students, course grades will be determined by the total number of points accumulated through HW assignments, exams, and for graduate students, their final project deliverables. The total number of points available in each category is listed in the table below. The percentage of total points required for various letter grades is also given below.

Grading	HW	Exam 1	Exam 2	Final exam	Final project	Total
Undergraduate	300	250	250	300	n/a	1100
Graduate	300	250	250	300	300	1400

Grading scale	A	B	C	D	F
UG and G	90% and up	80.0-89.9%	70.0-79.9%	60.0-69.9%	<60.0%

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. Contact me by phone or e-mail at any time.

Students with Disabilities
Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources. The Center for Disability Resources (CDR) is located in Life Sciences Room 218, telephone (312) 567-5744 or email: disabilities@iit.edu.

Academic Honesty
It is your responsibility to be familiar with IIT's Code of Academic Honesty. The Code of Academic Honesty can be found online:
http://www.iit.edu/student_affairs/handbook/information_and_regulations/code_of_academic_honesty.shtml

You must submit your own work for homework. You are encouraged to discuss and even work with other students on homework (unless explicitly told otherwise), but material that is submitted must be your own work. For group project assignments, each group is to submit their own work. For a first violation of the IIT Code of Academic Honesty for a homework or project, the homework will receive a grade of zero for all involved students and the students will be reported to the Designated Dean for Academic Discipline (DDAD). For a first violation of the Code of Academic Honesty for a major project or an examination, the student will receive a failing grade for the course and the student will be reported to the DDAD. For a second violation, the student will receive also failing grade for the course and be reported to the DDAD.

Course Topics and Tentative Schedule

Week	Date	Lecture Topics	HW Due	Reading
1	Aug 23	Introduction to building science		Wang Ch. 1
	Aug 25	Pre-requisite review, energy concepts, and units		
2	Aug 30	Heat transfer in buildings: conduction	HW1	Wang Ch. 3
	Sep 1	Heat transfer in buildings: convection		
3	Sep 6	Heat transfer in buildings: radiation		
	Sep 8	Heat transfer in buildings: solar radiation/windows		
4	Sep 13	Heat transfer in buildings: energy balances		
	Sep 15	Human thermal comfort	HW2	Wang Ch. 4
5	Sep 20	Exam review: example problems		
	Sep 22	**Exam 1**		
6	Sep 27	Psychrometrics: Chart		Wang Ch. 2 & 8 ASHRAE Handbook Ch. 1
	Sep 29	Psychrometrics: Equations		
7	Oct 4	Psychrometrics: Processes	HW3	
	Oct 6	*In lieu of class, attend my talk at Tremco seminar, 1:45 pm in the MTCC*		
8	Oct 11	Mechanical systems and psychrometric processes		
	Oct 13	Introduction to HVAC systems		Wang Ch. 7, 15
9	Oct 18	Refrigeration cycles	HW4	Wang Ch. 9
	Oct 20	Refrigeration cycles		Wang Ch. 9
10	Oct 25	Air and water distribution systems		Wang Ch. 7, 15
	Oct 27	**Exam 2**		
11	Nov 1	*Class cancelled*		
	Nov 3	*Campus HVAC tour with Brian Bozell*		
12	Nov 8	Ventilation and indoor air quality		Wang Ch. 24
	Nov 10	Ventilation and indoor air quality		Wang Ch. 24
13	Nov 15	Heating load calculations	HW5	Wang Ch. 6
	Nov 17	Cooling load calculations		Wang Ch. 5 & 25
14	Nov 22	Cooling load calculations		
	Nov 24	*No class – Thanksgiving Day*		
15	Nov 29	Energy estimation and design for efficiency	HW6	
	Dec 1	Standards and guidelines for energy efficiency	Final projects (grads)	
Final	Dec 8	**Final exam – 2 to 4 pm**		