CAE 331/513: Building Science — Fall 2015

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
Life Sciences Building, Room 121
Tuesdays and Thursdays, 1:50 PM – 3:05 PM

Course Website
http://built-envi.com/courses/cae-331513-building-science-fall-2015/

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.
Assistant Professor CAEE
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Website: www.built-envi.com

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 and construction.
3. Describe and quantify fundamental heat and mass transfer processes in buildings, including conduction, convection, radiation, thermodynamics, fluid flow, and mass balances.
4. Calculate heating and cooling loads in buildings.
5. Understand types of HVAC equipment for residential and commercial construction.
6. Understand basic ventilation and indoor air quality concepts.
7. Describe basic building diagnostic field tests (e.g., blower door tests).
8. Critically analyze claims about building components and environmental systems from product manufacturers, contractors, and building designers.

Textbook
I strongly 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. There is also a free PDF version floating around the Internet as well.

Teaching Assistant
Your teaching assistant (TA) this semester will be Akram Ali, a PhD student in my Built Environment Research Group. Feel free to contact Akram via email (aali21@hawk.iit.edu) to schedule an appointment if you would like to seek help on homework problems or other issues.

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 10% reduction in the total score per day 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
Course grades will be determined by the total number of points accumulated through HW assignments and exams. 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. This is a mixed undergraduate and graduate course; higher expectations will also be placed upon deliverables from graduate students.

Grading	HW	Exam 1	Exam 2	Final exam	Total
UG and G	300	250	250	300	1100

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 25	Introduction to building science		Wang Ch. 1
	Aug 27	Pre-requisite review, energy concepts, and units		
2	Sep 1	Heat transfer in buildings		Wang Ch. 3
	Sep 3	Heat transfer in buildings	HW1	
3	Sep 8	Heat transfer in buildings		
	Sep 10	Heat transfer in buildings		
4	Sep 15	Review problems w/ TA Akram Ali (Stephens traveling)		
	Sep 17	Human thermal comfort	HW2	Wang Ch. 4
5	Sep 22	Psychrometrics: Chart		Wang Ch. 2 & 8 ASHRAE Ch. 1
	Sep 24	Psychrometrics: Equations		
6	Sep 29	Psychrometrics: Equations Introduction to mechanical systems		
	Oct 1	Mechanical systems and psychrometric processes	HW3	
7	Oct 6	Mechanical systems and psychrometric processes		
	Oct 8	Review for Exam 1		
8	Oct 13	*No class* (Stephens traveling)		
	Oct 15	**Exam 1**		
9	Oct 20	*Guest lecture* (Stephens traveling)		
	Oct 22	Refrigeration cycles		Wang Ch. 9
10	Oct 27	Air and water distribution systems		Wang Ch. 7, 15
	Oct 29	Air and water distribution systems		
11	Nov 3	Ventilation and indoor air quality		Wang Ch. 24
	Nov 5	Ventilation and indoor air quality		
12	Nov 10	Heating load calculations	HW4	Wang Ch. 6
	Nov 12	Cooling load calculations		
13	Nov 17	Cooling load calculations	HW5	
	Nov 19	**Exam 2**		
14	Nov 24	[Mechanical systems site visit on campus]		
	Nov 26	*No class – Thanksgiving Day*		
15	Dec 1	Energy estimation methods, energy efficiency, exergy, and sustainable buildings		Wang Ch. 5 & 25
	Dec 3	Building performance diagnostics	HW6	Wang Ch. 35
Final	Dec 9	**Final exam (comprehensive): 2-4 pm** (Wednesday)		