Instructor: Burak Gunay, Ph.D.
Office: CB 5206
Office Hours: Monday 9:00 to 10:00 am and Thursday 4:30 to 5:30 pm (or by appointment)
Email: Burak.Gunay@carleton.ca

PA Session (on alternating weeks)

Course meets: Wednesday 8:35 am to 11:25 am

Learning Objectives:
1. Analysis of heat, air, and moisture transfer in buildings
2. Understanding of engineering methods in building science
3. Design for control of heat, air, and moisture in a severe climate

Reading (s)/Textbook (s):
1. Lecture notes on cuLearn
2. Worked examples in class

Additional reference books:
1. Building Science for a Cold Climate by Hutcheon and Handegord
2. ASHRAE Fundamentals Handbook
4. Building Science for Building Enclosures by Straube and Burnett

Course Plan
Lecture 1: Background
• Definition and importance of building science
• A brief history of building science

Lecture 2: Climate and weather
• Climate data for building performance analysis
• Heating and cooling degree-day
• Solar geometry and radiation

Lecture 3: Heat transfer and storage in buildings
• Steady-state 1D conduction (U-value, R-value)
• Steady-state 2D conduction (thermal bridging)
• Boundary conditions (film coefficients, sol-air temperature)
• Transient 1D conduction (thermal mass)
• Thermal properties of envelope materials and windows
• Thermal analysis of walls, ceilings, attics, and roofs
• Measuring thermal properties

Lecture 4: Properties of air
• Psychrometry
• Mixing, heating / cooling, de-humidifying and humidifying air
Lecture 5: Airflow in buildings
- Driving mechanisms for infiltration
- Air transfer in open-porous materials
- Airflow across permeable layers, apertures, joints, leaks and cavities
- Control of infiltration in buildings
- Airflow across large intentional openings (natural ventilation)
- Measuring air leakage
- Mechanical and mixed-mode ventilation
- Heat recovery and economizers
- Energy cost of infiltration and ventilation

Lecture 6: Moisture transport and storage in buildings
- Vapour diffusion and convection
- Analysis of condensation potential
- 1D steady-state vapour transfer in materials and assemblies
- Condensation & drying rates
- Rain control
- Safe storage of moisture in envelope materials
- Strategies to mitigate moisture damage in cold climates

Lecture 7: Thermal loads and integration with renewable energy sources
- Steady-state peak heating and cooling load calculations
- Charging / discharging the building fabric and the thermal storage media

Lecture 8: Methods in building science
- Building energy and comfort codes, standards, and guidelines
- Lab-scale and field investigation methods
- Building performance simulation

Lecture 9: Exam practice

Course Requirements & Methods of Evaluation:
30% MIDTERM
20% QUIZZES DURING PA SESSIONS
50% FINAL

In accordance with the Carleton University Undergraduate Calendar (p 34), the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100   B+ = 77-79   C+ = 67-69   D+ = 57-59
A  = 85-89   B   = 73-76   C   = 63-66   D   = 53-56
A - = 80-84   B - = 70-72   C - = 60-62   D - = 50-52
F   = Below 50   WDN = Withdrawn from the course
ABS = Student absent from final exam
DEF = Deferred (See above)
FND = (Failed, no Deferred) = Student could not pass the course even with 100% on final exam

Academic Regulations, Accommodations, Plagiarism, Etc.
University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university’s website, here:
http://www.carleton.ca/calendars/ugrad/current/regulations/acadregsuniv.html
Academic Accommodations for Students with Disabilities
The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

**For Religious Obligations:**
Students requesting academic accommodation on the basis of religious obligation should make a formal, written request to their instructors for alternate dates and/or means of satisfying academic requirements. Such requests should be made during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist, but no later than two weeks before the compulsory event.
Accommodation is to be worked out directly and on an individual basis between the student and the instructor(s) involved. Instructors will make accommodations in a way that avoids academic disadvantage to the student.
Students or instructors who have questions or want to confirm accommodation eligibility of a religious event or practice may refer to the Equity Services website for a list of holy days and Carleton's Academic Accommodation policies or may contact an Equity Services Advisor in the Equity Services Department for assistance.

**For Pregnancy:**
Pregnant students requiring academic accommodations are encouraged to contact an Equity Advisor in Equity Services to complete a letter of accommodation. The student must then make an appointment to discuss her needs with the instructor at least two weeks prior to the first academic event in which it is anticipated the accommodation will be required.

**Plagiarism**
Plagiarism is the passing off of someone else's work as your own and is a serious academic offence. For the details of what constitutes plagiarism, the potential penalties and the procedures refer to the section on Instructional Offences in the Undergraduate Calendar.

**What are the Penalties for Plagiarism?**
A student found to have plagiarized an assignment may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; and/or a reprimand; a refusal of permission to continue or to register in a specific degree program; academic probation; award of an FNS, Fail, or an ABS.

**What are the Procedures?**
All allegations of plagiarism are reported to the faculty of Dean of FASS and Management. Documentation is prepared by instructors and/or departmental chairs.
The Dean writes to the student and the University Ombudsperson about the alleged plagiarism.
The Dean reviews the allegation. If it is not resolved at this level then it is referred to a tribunal appointed by the Senate.

**Plagiarism and cheating at the graduate level are viewed as being particularly serious and the sanctions imposed are accordingly severe.** Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy (See http://www2.carleton.ca/sasc/advisingcentre/academic-integrity/). The Policy is strictly enforced and is binding on all students. Plagiarism and cheating – presenting another’s ideas, arguments, words or images as your own, using unauthorized material, misrepresentation, fabricating or misrepresenting research data, unauthorized co-operation or collaboration or completing work for
another student – weaken the quality of the graduate degree. Academic dishonesty in any form will not be tolerated. Students who infringe the Policy may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; a refusal of permission to continue or to register in a specific degree program; academic probation; or a grade of Failure in the course.

**Intellectual Property Statement:**
Student or professor materials created for this course (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the author(s). They are intended for personal use and may not be reproduced or redistributed without prior written consent of the author(s).