

**CARLETON UNIVERSITY**  
**DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**  
**CIVE 5707 – FALL 2020**  
**ENERGY MODELLING FOR EXISTING BUILDINGS**

**Instructor:** Burak Gunay, PhD, PEng

**Virtual meeting room:** Zoom link

**Office Hour:** Email to make an appointment for a one-on-one meeting. I will keep the following timeslots available: Monday 5 pm to 6 pm and Wednesday 5 pm to 6 pm.

**Email:** burak.gunay@carleton.ca

**Recorded software tutorial videos will be posted on cuLearn. The class will meet on Mondays at 6:05 pm via Zoom. Lecture will be recorded and posted on cuLearn. After the lecture, there will be time allocated to answer your questions.**

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**Learning Objectives:**

1. Learn about the heat and mass transfer processes in buildings
2. Understand models representing the heat and mass transfer processes in buildings
3. Learn about the indoor climate control systems
4. Learn about common control sequences for building energy systems
5. Perform scripting to incorporate control sequences in building energy models
6. Calibrate energy models with hourly meter data
7. Understand common energy efficiency measures for existing buildings
8. Apply optimization in retrofit decision making

**Supplementary text:**

ASHRAE Guideline 14 and Standard 90.1

ASHRAE Energy Efficiency Guides for Existing Commercial Buildings

**Software:**

SketchUp Make 2017

Euclid

EnergyPlus

Matlab

**Course Plan:**

**Introduction**

*Lesson 1:* Course overview

*Lesson 2:* Background on building energy modelling in existing buildings

**Weather and climate**

*Lesson 3:* Weather data for energy modelling

*Assignment 1:* Weather data analysis

*Tutorial 1:* Installation of EnergyPlus and Sketchup

## **Geometry and zoning**

*Lesson 4:* Geometry and thermal zoning

*Tutorial 2:* Representing the geometry of a building

## **Constructions**

*Lesson 5:* Thermal properties walls, roofs, and windows

*Assignment 2:* Thermal properties of walls and windows

*Tutorial 3:* Defining envelope properties

## **Infiltration**

*Lesson 6:* Air infiltration

*Assignment 3:* Air infiltration

*Tutorial 4:* Modelling infiltration in EnergyPlus

## **Schedules and internal gains**

*Lesson 7:* Casual gains

*Tutorial 5:* Constant schedules and use of EMS environment to define custom schedules

## **Basics of HVAC systems in buildings**

*Lesson 8:* Common HVAC configurations

*Tutorial 6:* HVAC templates in EnergyPlus

## **Advanced control sequences**

*Lesson 9:* Sequences of operation for AHUs and VAVs

*Tutorial 7:* Economizer settings and demand control ventilation in EnergyPlus

## **Energy efficiency measures for existing buildings**

*Lesson 10:* Review of common energy efficiency measures

*Assignment 4:* Operational energy efficiency measures

*Tutorial 8:* Parametric analysis by coupling EnergyPlus with Matlab

## **Calibration and optimization**

*Lesson 11:* Calibration and optimization

*Assignment 5:* Model calibration process

*Tutorial 9:* EnergyPlus and Matlab coupling with Genetic Algorithm for model calibration

*Tutorial 10:* Use of calibrated energy models in decision making

## Grade Distribution:

- Assignments 40% - Five assignments (each 8%)
- Final report 60% - Develop an ASHRAE Guideline 14 compliant calibrated energy model and assess model parameters.

## Letter Grade Distribution:

>= 90.00	A+
85.00 - 89.99	A
80.00 - 84.99	A-
77.00 - 79.99	B+
73.00 - 76.99	B
70.00 - 72.99	B-
67.00 - 69.99	C+
63.00 - 66.99	C
60.00 - 62.99	C-
57.00 - 59.99	D+
53.00 - 56.99	D
50.00 - 52.99	D-
<= 49.99	F

**Academic Regulations, Accommodations, Plagiarism** 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.

**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](mailto: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 here.). 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.

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