UNIVERSITY OF CALGARY
SCHOOL OF ARCHITECTURE, PLANNING AND LANDSCAPE

Instructor: Dr. C. Hachem-Vermette **Winter 2020**
carolinehachem@ucalgary.ca,
PF 3170, office hours by appointment

EVDS 683.60: Solar Building Envelope Design

Dr. Caroline Hachem-Vermette
e: caroline.hachem@ucalgary.ca
Office hours: by appointment

Target audience: MArch, MEDes, PhD

Course Description

Buildings are responsible for 30% of Canada's total energy consumption. Reduction of energy use in buildings, and transforming them into energy producers, is a high priority objective in attaining sustainable communities.

A building envelope constitutes the interface between the interior and the environment and is thus largely responsible for heat transfer from/to the indoor environment. Energy efficient building envelope can significantly reduce energy required for heating. On the other hand the envelope offers exposed surface that can be exploited for energy generation (heat and electricity).

This course consists of two main parts. The first part is analytical in nature, aiming at the study and characterisation of the energy performance (energy consumption versus energy generation potential) of existing and prospective envelope /curtain wall systems. In the second part, guidelines and tools are applied in a creative approach to the design of energy efficient and energy generating envelopes.

The course will review building envelope/curtain wall components as well as existing and new technologies, including building integrated photovoltaic (PV), semi transparent PV systems and hybrid PV/thermal systems. The concept of solar communities, and performance of buildings within them will be introduced as well. Effect of envelope geometrical design and the integration of advanced technologies on capturing solar energy and on the energy performance of a building will be analysed. Issues of integration of PV and semi transparent PV with the envelope and building systems will be discussed. Simple modeling of the envelope system will support the analysis, using Scketchup/OpenStudio Plugin (as interface to EnergyPlus). Students will be encouraged to create new building envelopes that combine aesthetic, function and advanced technologies.

Learning Outcomes:

This course will enhance the understanding of the integrated design process and will highlight the effect of building design on sizing building systems. By the end of this course students will be able to:

- Assess the main effect of building envelope on heat transfer, heating and cooling loads and therefore on building systems (e.g. HVAC and lighting).
- Demonstrate knowledge of available state of the art of curtain wall technologies, including window design, glazing types, insulation and photovoltaic technologies (e.g. semitransparent PV, hybrid PV/thermal systems).
- Perform simple calculations of electricity by different type of photovoltaic systems.

- Model and analyze quantitatively building envelope design effect on heating, cooling and electricity and heat generation.
- Develop creative design methodologies for building envelope that integrate building technologies together with aesthetical and functional aspects.

Teaching Approach

The course will be presented in lecture and workshop modes. The weekly meetings will comprise lectures, group work/discussion and active learning components. The workshops will cover development and modeling of building envelope designs employing computer-based design aids.

Content: Topic Areas and preliminary schedule

W1: 13, 15 Jan	L1, L2	• Introduction to building envelope, examples of various building skin technologies (intelligent, adaptable, passive, etc.); overview of expected work in the course. Introducing first assignment.	
W2: 20, 22 Jan	L3,L4	• Building envelope design; Review of heat transfer through building envelope, thermal properties of building envelope components, thermal capacity, passive heat gains.	
W3: 27, 29 Jan	L5,L6	• Solar capture and solar control: Main factors that affect the potential of buildings to capture and utilize solar radiation; Shading devices and heat gain control	
W4: 3, 5 Feb	L7,L8	• Curtain wall systems and high performance facades- Review of main components and their properties, discussion on windows and advancement in window design and window materials. Introducing the design project.	
W5: 10, 12 Feb		• Students' presentation: Assignment 1	

W6: 16-22 Feb	• Block week		
W7: 24, 26 Feb	L9,L10	• Energy simulation package tutorial, brief introduction to EnergyPlus, learning to perform basic simulations of building envelope, employing Energyplus in conjunction with Scketchup/Openstudio plugin	
W8 : 2, 4 Mar	L11,L12	• Energy simulation (EnergyPlus (contd))	
W9: 9-13 Mar	• Block week		
W10: 16,18 Mar	L13,L14	• PV technologies 1 – Introduction to PV technologies, state of the art in the world, and presentation of successful design of building integrated PV systems.	Presentations uploaded on D2L with annotations
W11: 23, 25 Mar	L15,L16	• PV technologies 2 – Overview of the technical aspects of PV systems, simple calculation of electricity generation, Hybrid PV/thermal systems. Energy generation using simulation tool.	
W12: 30, 1 Apr	L17,L18	• Integration issues of PV technologies within the building envelope, and of building envelope with the building systems (HVAC, lighting systems) • Introduction to solar communities – Main principles in the design of solar communities, effect of various community designs on the shape and performance of the building envelope, case studies of solar communities.	

W13: 6, 8 Apr	M Apr 8 W Apr 10	• ~~Student's Final presentation~~	

Student work

The student work will be conducted in teams of two students. It contains two assignments:

1) Assignment and presentations (50%).
2) Project: Development of new building envelope design (50%). The project will account for the grade that was dedicated to the slide presentation.

Grading Scheme

Grading will be based on the following scale:

Grade	Grade Point Value	4-Point Range	Percent	Description
A+	4.00	4.00	95-100	Outstanding - as evaluated by
A	4.00	3.85-4.00	90-94.99	Excellent - superior performance showing comprehensive understanding of the subject matter
A-	3.70	3.50-3.84	85-89.99	Very good performance
B+	3.30	3.15-3.49	80-84.99	Good performance
B	3.00	2.85-3.14	75-79.99	Satisfactory performance
B-	2.70	2.50-2.84	70-74.99	Minimum pass for students in the Faculty of Graduate Studies
C+	2.30	2.15-2.49	65-69.99	All final grades below B- are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements.
C	2.00	1.85-2.14	60-64.99	
C-	1.70	1.50-1.84	55-59.99	
D+	1.30	1.15-1.49	50-54.99	
D	1.00	0.50-1.14	45-49.99	
F	0.00	0-0.49	0-44.99	

Notes:
A student who receives a "C+" or lower in any one course will be required to withdraw regardless of their grade point average (GPA) unless the program recommends otherwise. If the program permits the student to retake a failed course, the second grade will replace the initial grade in the calculation of the GPA, and both grades will appear on the transcript.

Readings

A list of readings related to each topic will be posted regularly on D2L.

Important Notes

1. Written work, term assignments and other course related work may only be submitted by e-mail if prior permission to do so has been obtained from the course instructor. Submissions must come from an official University of Calgary (ucalgary) email account.
2. Academic Accommodations. Students who require an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to their Instructor or the designated contact person in EVDS, Jennifer Taillefer (jtaillef@ucalgary.ca). Students who require an accommodation unrelated to their coursework or the requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Vice-Provost (Student Experience). For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/
3. Plagiarism - Plagiarism involves submitting or presenting work in a course as if it were the student's own work done expressly for that particular course when, in fact, it is not. Most commonly plagiarism exists when:(a) the work submitted or presented was done, in whole or in part, by an individual other than the one submitting or presenting the work (this includes having another impersonate the student or otherwise substituting the work of another for one's own in an examination or test),(b) parts of the work are taken from another source without reference to the original author,(c) the whole work (e.g., an essay) is copied from another source, and/or,(d) a student submits or presents work in one course which has also been submitted in another course(although it may be completely original with that student) without the knowledge of or prior agreement of the instructor involved. While it is recognized that scholarly work often involves reference to the ideas, data and conclusions of other scholars, intellectual honesty requires that such references be explicitly and clearly noted. Plagiarism is an extremely serious academic offence. It is recognized that clause (d) does not prevent a graduate student incorporating work previously done by him or her in a thesis. Any suspicion of plagiarism will be reported to the Dean, and dealt with as per the regulations in the University of Calgary Graduate Calendar.
4. Appeals: If a student has a concern about the course, academic matter, or a grade that they have been assigned, they must first communicate this concern with the instructor. If the concern cannot be resolved with the instructor, the student can proceed with an academic appeal, which normally begins with the Faculty: http://www.ucalgary.ca/provost/students/ombuds/appeals
5. Information regarding the Freedom of Information and Protection of Privacy Act (https://www.ucalgary.ca/legalservices/foip)
6. Emergency Evacuation/Assembly Points (http://www.ucalgary.ca/emergencyplan/assemblypoints)
7. Safewalk information (http://www.ucalgary.ca/security/safewalk)
8. Contact Info for: Student Union (https://www.su.ucalgary.ca/contact/); Graduate Student representativehttps://gsa.ucalgary.ca/about-the-gsa/gsa-executive-board/) Student Union Wellness Centre: https://www.ucalgary.ca/wellnesscentre/; Library Resources: http://library.ucalgary.ca/ and Student Ombudsman's Office (http://www.ucalgary.ca/ombuds

CACB Student Performance Criteria:

The following CACB Student Performance Criteria will be covered in this course at a primary level (other criteria will be covered at a secondary level): A1. Critical Thinking Skills; A6. Human Behaviour, B3. Site Design, and B4. Sustainable Design. *(see CACB SPC matrix for further details)*

Contact & Office Information

Dr. C. Hachem-Vermette | PF Room # 3170 | caroline.hachem@ucalgary.ca

Please contact instructor and teaching assistants with any questions or concerns. Meetings by appointment.