Solar Building Envelope Design, (H (3-0)- Winter 2016)

EVDS 683.60

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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.

Objectives:

This course will enhance the understanding of the integrated design process and will highlight the effect of building design on sizing building systems. The main objectives are as follows:

- Understanding of the main effect of building envelope on heat transfer, heating and cooling loads and therefore on building systems (e.g. HVAC and lighting).
- Acquiring knowledge of available state of the art curtain wall technologies, including window design, glazing types, insulation and photovoltaic technologies (e.g. semitransparent PV, hybrid PV/thermal systems).

- Acquiring awareness of the integrated design of building envelope with the design of building systems (such as HVAC and lighting) and technologies.
- Ability to perform simple calculations of electricity and heat generation by different type of photovoltaic systems.
- Ability to model and analyze quantitatively building envelope design effect on heating, cooling and electricity and heat generation.
- Developing 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

M Jan 11	• Introduction to building envelope, examples of various building skin technologies (intelligent, adaptable, passive, etc.); overview of expected work in the course. Introducing first assignment.
M Jan 18	• Building envelope design; Review of heat transfer through building envelope, thermal properties of building envelope components, thermal capacity, passive heat gains.
M Jan 25	• Solar capture and solar control: Main factors that affect the potential of buildings (isolated and in neighbourhoods) to capture and utilize solar radiation; Shading devices and heat gain control; Solar Access: Legislations in Canada.
M Feb 1	• Students' presentation: Assignment 1
M Feb 8	• 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.
Feb 15 - 19	**Block week**
M Feb 22	• Energy simulation package tutorial, brief introduction to EnergyPlus, learning to perform basic simulations of building envelope, employing Energyplus in conjunction with Scketchup/Openstudio plugin
M Feb 29	• Student- presentations- Legal issues

M Mar 7	IEA task- no class
M Mar 14	• Energy simulation (EnergyPlus (contd))
M Mar 21	• PV technologies 1 – Introduction to PV technologies, state of the art in the world, and presentation of successful design of building integrated PV systems.
M Mar 28	• 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.
M Apr 4	• 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.
M Apr 11	Student's Final presentation

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Student work

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

1) Assignments and presentations (40%).
2) Project: Development of new building envelope design (60%).

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.

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. The Academic Accommodations Policy can be found at: http://www.ucalgary.ca/access/accommodations/policy. It is the students' responsibility to request academic accommodations. If you are a student with a documented disability who may require academic accommodations and have not registered with Student Accessibility Services, please contact them at 403.220.6019. Students who have not registered with Student Accessibility

Services are not eligible for formal academic accommodations. More information about academic accommodations can be found at www.ucalgary.ca/access. You are also required to discuss your needs with your instructor no later than fourteen (14) days after the start of this course.

3. The instructor may reduce grades for assignments and components thereof when submitted after deadlines.

4. 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.

5. Information regarding the Freedom of Information and Protection of Privacy Act (http://www.ucalgary.ca/secretariat/privacy) and how this impacts the receipt and delivery of course material

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 (http://www.su.ucalgary.ca/page/affordability-accessibility/contact); Graduate Student representative(http://www.ucalgary.ca/gsa/) and Student Ombudsman's Office (http://www.su.ucalgary.ca/page/quality-education/academic-services/student-rights).

The paper is quite interesting. Some clarifications are required.

- In section 3, the methodology, an introductory paragraph is required, where the general methodology is summarized, and to introduce each of the activities that the

authors are accounting for, and how they can be helpful to attain the objective of the paper (for instance how outdoor activity is of relevance, etc.).

- In line 45-51: The statement related to the 649 days of data is a bit obscure: how the authors determine this number while it is mentioned above that the data were collected for for 3 days. Please explain it in the text.
- In 3.2, the results presented would be easier to follow if the authors present the information in a Table or graph.
- In 3.2.1: The authors should give a summary of the variation index and not only refer readers to other paper. A paper should stand on its own.