McGill University – Department of Civil Engineering

Course: CIVE 570: Solar Driven Environmental Processes and Technologies

Outline: An overview of natural and engineered processes that are driven by solar energy. Fundamental physics of light and environmental photochemistry. Terrestrial energy balance. Solar driven environmental transformation and decay processes, including chemical and biological case studies. Solar energy harnessing materials and their applications in sustainable green energy generation and environmental remediation including solar cells, photocatalysts, solar heating & cooling, and solar water treatment.

Instructor: Prof. Stephanie Loeb
E-mail: stephanie.loeb@mcgill.ca
Office: ENGMD 569B
Office hours: Tuesday 10 – 11 am on zoom at mcgill.zoom.us/j/4992720351. Inform me by email if you will be logging on, no advance notice required.

Teaching Assistant: …..

Schedule: Lecture: Friday 8:35 – 11:25 am
Location: Wong Building (3610 Rue University) Room 1050

Objectives: This course will teach students about the role of light in natural and engineered environmental processes, while introducing current research topics and novel technological developments in the field. Students will demonstrate mastery of these topics through mathematical, written, and oral assessments. Students will engage in discussions on the historical progress, current state, and future trajectory of the field.

Textbook: There is no mandatory textbook for this course. Any required readings will be posted to MyCourses. Some useful references are listed below. Most are available through the McGill library.

Optics and Photonics: An Introduction. 2nd Edition F. Graham Smith, Terry A. King, Dan Wilkins. 2007. Wiley.

Introduction to modern optics. 2nd Edition. Grant R. Fowles. 1989. Dover Publications.

Colour and Optical Properties of Materials. 3rd Edition. Richard J. D. Tilley. 2019. Wiley.

Modern molecular photochemistry of organic molecules. Nicholas J. Turro, V. Ramamurthy; J. C. Scaiano. 2010.

Physics of Solar Cells: From Basic Principles to Advanced Concepts. 3rd Edition. Peter Wurfel. 2016.

Light-emitting diodes. 2nd Edition. E. Fred Schubert. 2006. Cambridge University Press.

Communication: The course syllabus, schedule, homework assignments, and other supplementary materials will be posted on the webpage at mycourses2.mcgill.ca. New content and assignments will be announced in lecture; however, you are responsible for routinely checking the course webpage and staying current on the material.

Assessments:

Problem Sets. Problem sets are designed to develop both your conceptual and quantitative understanding of the material. Problem sets will be assigned at least one week in advance and will be due the following week typically on Tuesday, submitted to the assignments folder on MyCourses. Late submissions will be penalized at a rate of 10% per day reduction to the grade obtained. No submissions will be accepted more than 4 days after the due date. Any assignments submitted after this time will receive a grade of zero. You are encouraged to discuss approaches and problem-solving strategies with your classmates; however, all submissions must be prepared independently and represent an individual effort. Problem sets will include both calculations, graphical, and interpretative short answer questions and will be evaluated based on completeness, correctness, accuracy, and clarity of presentation.

Article Discussion Leader. A series of readings relevant to the material in this course are provided on MyCourses under the article discussions section. Each reading will be assigned a discussion leader. The discussion leader will present to their peers a summary and critical analysis of the article and lead the class in a "book club" style discussion using a series of thoughtfully prepared questions. The discussion should aim to foster a deeper understanding of the article while contextualizing the reading in regard to the topics presented in this course, and sustainability more broadly. An assignment sheet with further guidelines and a detailed marking scheme for this assessment is posted to MyCourses.

Commented [SL1]: Students are asked in the assignment sheet to connect their article to concepts of sustainability

Article Discussion Report. Each student will select a reading (not the reading for which you are discussion leader). The student will produce a brief written report of approximately 1,500 words including a summary of the reading and an answer to each discussion question based on your personal reflections and the discussion conducted in class. To assist with this, you are encouraged to take notes during the class discussion. An assignment sheet with further guidelines and a detailed marking scheme for this assessment is posted to MyCourses.

Participation. All students must complete the readings BEFORE the class discussion. Participation will be formally evaluated using "exit cards" that are completed through the MyCourses discussions tab. During the last 10 minutes of class, students will respond to a prompt on the exit card, aiming to demonstrate their knowledge of the reading and attention to the discussion. The exit card entries will be evaluated at the end of the term for completeness, accuracy, and insight to determine your participation grade. You will not be permitted to complete the exit card if you have not attended the discussion lecture.

Final Exam. The exam will be closed book, with each student permitted to bring a one page "crib sheet". The final exam will be comprehensive, covering all material presented in the course including lectures, problem sets, discussions, and readings. Exam questions will include short and long calculations, written short answers, and multiple choice.

Mark Breakdown:

✓ Problem Sets	4 at 5% each	20%
✓ Article Discussion Leader		30%
✓ Discussion Summary Report		15%
✓ Participation		10%
✓ Final Exam		25%
	Total:	**100%**

Dates	Lecture	Topics

Jan 5	L1	Introduction to Sustainability; Properties of Light
Jan 12	L2	Principles of Light Transmission
Jan 19	L3	Terrestrial Energy Balance
Jan 26	L4	Intro to Photochemistry
Feb 2	L5	Atmospheric Photochemistry
Feb 9	L6	Aquatic Photochemistry
Feb 16	L7	Solar Energy Harnessing Materials
Feb 23	L8	Solar Cells and Light Emitting Diodes
March 1	L9	Photocatalysis
March 15	L10	Photobiology and Solar Disinfection
March 22	L11	Water Treatment & Environmental Remediation
April 5	L12	Passive Solar Design

Commented [SL2]: Introductory lecture includes an activity that defines concepts of sustainability and has students explore their understanding of the topic

Calendar, Winter Semester, 202X, CIVE 570

Month & week #	Monday	Tuesday	Wednesday	Thursday	Friday
January 1	1	2	3	4	5 **Lecture 1**
2	8	9	10	11 PS1 Assigned	12 **Lecture 2**
3	15	16 Add/Drop Deadline	17	18 PS1 Due	19 **Lecture 3**
4	22 PS2 Assigned	23	24	25	26 **Lecture 4**
February 5	29	30 PS2 Due	31	1	2 **Lecture 5**
6	5	6	7	8	9 **Lecture 6**
7	12 PS3 Assigned	13	14	15	16 **Lecture 7**
8	19	20 PS3 Due	21	22	23 **Lecture 8**
March 9	26	27	28	29	1 **Lecture 9**
	March 4 – March 8: Winter Reading Break				
10	11	12	13	14	15 **Lecture 10**
11	18 PS4 Assigned	19	20	21	22 **Lecture 11**
12	25	26	27	28	29 Good Friday
April 13	1	2 PS4 Due	3	4	5 **Lecture 12**
14	8	9	10	11	12 **Final Exam**
	Exam Period April 15th – April 30th				

CEAB Curriculum Content

Accreditation Units:

Natural Science: 11 hours

Engineering Science: 11 hours

Engineering Design: 8 hours

Complementary Studies: 9 hours

Learning Outcomes:

1. ***Fundamentals***: Qualitatively and quantitatively describe the fundamental physical and chemical properties of light and its interaction with matter in the environment
2. ***Applications***: Apply the fundamental science of light to the concepts behind light driven technologies and light driven environmental processes
3. ***Design***: Relate the principles of design to the design of select solar driven environmental technologies
4. ***Implications***: Connect the science and engineering of light to the impact of natural processes on human and environmental health, uncertainties in safety/performance, and the current and potential future role of solar based technological advancements in society
5. ***Technical Communication:*** Develop skills for interpretation and communication (written and oral) of findings from primary research, policy, or other technical articles on the topic of light driven environmental processes

Commented [SL3]: Primary learning outcome linked to sustainability

Learning Outcome	CEAB Curriculum content category: AUs	Graduate Attribute Indictors	Evaluations
1. Fundamentals	Natural Science (5)	KB.4 (A)	PS1-2
2. Applications	Natural Science (4) Engineering Science (9) Engineering Design (2)	KB.4 (A), KB.6 (A), DE.1 (D)	PS1-3; Article Report; Final Exam
3. Design	Engineering Design (6)	DE.2 (D), PA.4 (A)	PS4; Article Discussion
4. Implications	Natural Science (2) Engineering Science (2) Complementary Studies (4.5)	PA.4 (A), IE.4 (A)	Article Discussion; Class Participation
5. Communication	Complementary Studies (4.5)	CS.2 (A), CS.3 (A)	Discussion & Report; Class Participation