MECH 410I / 550I
Thermal Radiation (3 Credits)
Course Syllabus

Instructor

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Office Hours: Wednesday 4-5pm (CEME 2062), or via email.

Course Outline

1. Introduction
   1.1. Definitions
   1.2. Electromagnetic spectrum, Planck's Law, Wien's Displacement Law, blackbody surfaces
   1.3. Absorptivity, Emissivity, Reflectivity, Kirchoff's Law
   1.4. Spectral/total, directional/hemispherical properties
2. Surface Radiation
   2.1. Diffuse/specular surfaces, gray/non-gray surfaces
   2.2. Radiation exchange, configuration factors
   2.3. Radiation shields, cavities
   2.4. Radiosity Method
   2.5. Monte Carlo Method
3. Participating Media
   3.1. Extinction, absorption, and scattering coefficients; optical thickness; albedo
   3.2. Bouguer's Law, emission within a medium
   3.3. Spectral/total absorptance, emittance, and transmittance
   3.4. Scattering, phase function
   3.5. Equation of radiative transfer, source function
4. Solution Methods
   4.1. Approximations: near transparent, emission, diffusion, two flux model.
   4.2. Monte-Carlo for participating media

Learning Objectives and Outcomes

This course will provide students with a fundamental basis of thermal radiation heat transfer, as well as an introduction to analytical and numerical methods suitable for analyzing idealized and practical engineering systems involving thermal radiation. Students will apply their understanding of thermal radiation to consider applications related to heat transfer, as well as light-matter interactions for instrumentation applications. Through this course, students will:

- Apply the radiative transfer equation and concepts for emission, absorption, reflection, and transmission to characterize energy transfer via radiation in engineering-relevant systems.
- Develop and implement numerical tools for radiation heat transfer, including for view factor estimation.
- Identify and explain the relevance of material and system properties for the design of engineering systems, under consideration of radiative energy exchange.
- Implement the above concepts to demonstrate how they may be used for instrumentation and diagnostic applications.

Course Structure, Evaluation Criteria, and Learning Activities

Material will be presented during scheduled lectures using a combination of board notes and prepared materials. Students should be prepared to take notes during lectures. Handouts will be provided during the lecture as well as archived on Canvas.

Students will be evaluated based on assignments (3-4), a midterm examination and a final examination. Assignments will include analytical exercises, as well as those requiring numerical solutions (e.g., Matlab, Python). Where appropriate experimental data will be provided for analysis.

Students enrolled in MECH 550I will complete a term project including a report and presentation focussing on a topic related to radiative energy transfer and its applications. This topic can be assigned by the instructor or proposed by the student (pending instructor approval). Exams and assignments for MECH 550I will include additional and/or more advanced questions.

Grade Weighting

MECH 410I		**MECH 550I**	
Assignments	20%	Assignments	15%
Midterm	30%	Project and presentation	15%
Final	50%	Midterm	20%
		Final	50%

NOTE: In undergraduate MECH courses where at least 50% of the final grade is assigned to examinations, students may only **pass the course if they achieve a weighted average examination grade of at least 50%**. The "examination grade" includes scores from the final examination, midterms, and other tests done individually in a classroom setting. This policy applies unless it is explicitly waived by the instructor in the course syllabus. This policy is also available in the *Vancouver Academic Calendar* at http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,195,272,43.

References

The course will follow the following text, from which suggested readings will be assigned:
Thermal Radiation Heat Transfer. John Howell, Robert Siegel, M. Pinar Menguc. CRC Press, 2016. Sixth Edition.
Other editions may be substituted.

Students are also encouraged to use the following references to increase their understanding of the material:
Radiative Heat Transfer. M.F. Modest. Academic Press, 2003.

Radiative Transfer. H. C. Hottel and A. F. Sarofin. McGraw Hill, 1967.

Radiative Heat Transfer by the Monte Carlo Method, in Advances in Heat Transfer. W. J. Yang, H. Taniguchi, and K. Kudo. Academic Press, 1995

Plagiarism and Misconduct

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences. Further information can be found in the UBC Calendar at:

http://www.calendar.ubc.ca/Vancouver/index.cfm?tree=3,54,111,959

The consequences of academic misconduct can range from a grade of zero on the work in question, to expulsion from your program. It is your responsibility to read, understand and abide by these regulations. Note that plagiarism detection tools are used on submitted projects and reports (UBC uses turnitin.com). If it is not clear to you what constitutes plagiarism, it is your responsibility to review the above calendar section and/or consult the course instructor – *prior to submitting work*.

Many, if not all, of the materials used in this course are copyright protected. You are able to use them for the purpose of study; however, you should not reproduce or distribute them.

Policies and Resources to Support Student Success

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom.

UBC provides appropriate accommodation for students with disabilities and for religious and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available at https://senate.ubc.ca/policies-resources-support-student-success. Mechanical Engineering also has a Student Services Office (students@mech.ubc.ca), located in CEME 2205, where there are staff who can provide support and refer students to the appropriate resources.

Inclusive Environment

The Department of Mechanical Engineering is committed to providing an inclusive learning experience, and affirms the UBC Statement on Respectful Environment (https://www.hr.ubc.ca/respectful-environment/files/UBC-Statement-on-Respectful-Environment-2014.pdf). You are encouraged to contact their instructor should situations arise that are not consistent with this expectation. You are also invited to advise the instructor if you wish to be addressed by or referred to with particular pronouns.