The University of Manitoba

Department of Biosystems Engineering

Course Number	BIOE 2110	**Course Title**	Transport Phenomena
Academic Session	Fall 2020	**Credit Hours**	3

Prerequisites and how they apply to this course

ENG 1460 Thermal Sciences (or equivalent course such as thermodynamics) provides students with an introduction to the thermodynamics (such as conservation of energy and efficiency of heat engines); the fundamentals of analyzing systems involving heat and energy; and application of mathematics and science to engineering problem solving. BIOE 2110 will build upon these experiences. Math 1500 (1510) and Math 1700 (or 1710) provide students with the knowledge of calculus. This knowledge will help students to understand the mathematical models of heat transfer.

Classroom Location On-line
Meeting Days and Class Hours MWF 12:30-1:20 pm

Tutorial Location On-line
Tutorial Hours Tuesday 8:30 – 9:45 am

Department Office location E2-376 EITC
Department Phone Number 474-6033

Student Contact Time (Hrs)

Lectures: 3 hrs lecture/week × 13 weeks/term = 39 hrs
Laboratories: 0 × 12 weeks = 0 hrs
Tutorials: 2 hr tutorial × 12 weeks = 24 hrs

Instructor Information

Name & Title Dr. Fuji Jian, P.Eng.
Office Location E1-532 EITC
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Office Hours By appointment

Teaching Assistant(s) (if applicable) TBA
TA Office Hours and Location TBA

Important Dates

First day of class	Sep. 9, 2020
Voluntary withdrawal date	November 23, 2020
Midterm I examination	Before Oct. 16, 2020
Midterm II examination	Before Nov. 13, 2020
Final examination	Arranged by the Department

Assignment Due Date Approximately in a week

Course Philosophy

Students' Learning Responsibilities
Attendance for lectures and laboratories is strongly expected. To benefit the most from this class, you must be willing to participate in class discussions. You are expected to read the texts and course materials, do assignments independently (even though you are encouraged to discuss with your classmates and instructor), and understand principles and theories. Deadlines are a reality in the world of engineering; I expect assignments to be completed on time.

Why this course is useful?
Heat and mass transfer and calculation are the fundamentals of engineering education and engineering career. The law and principle taught in the lectures will be used in our daily life and work. The problem solving skills developed in this course are key to understanding fundamental principles of heat and mass transfer, numerical solving skill, model development and analysis, and estimation of complex systems through simpler models.

Who should take this course?
This is a required course in the Biosystems Engineering program and most engineering programs.

How this course fits into the curriculum?
It is intended that students take this course during or after the second year after being accepted into the Department of Biosystems Engineering. The general applied mathematical problem solving skills are beneficial in most engineering science and design courses. The comprehension of heat transfer, steady state heat flow, conduction, convection, and radiation is key to understanding material properties and energy consumption in bioprocessing, alternative building systems, biomedical device components and agricultural systems.

Course Description/Objectives

Undergraduate Calendar Description
Principles of heat transfer, solar radiation, psychometrics, molecular diffusion, mass transfer and refrigeration and their application to biosystems.

Instructional Methods
Learning is most effective when both the teacher and the student are engaged in the subject materials. The role of the teacher, therefore, is to create an environment that facilitates student engagement (and therefore learning). In this course, most dissemination of information will occur using the traditional lecture format (power point slides) and is delivered via online WebEx. A substantial portion of the content will be "presented" experientially through assignments and in-class examples. Therefore, you will be expected to prepare for class by reading the course text, completing the assignments and questioning the professor whenever possible.

Course Content:

1. Introduction
2. Steady-state heat conduction
3. Transient heat transfer
4. Forced convective heat transfer
5. Free convection
6. Radiative heat transfer
7. Solar radiation
8. Psychometrics and mass diffusion
9. Heat exchangers

Course Objectives

The intent of this course is to introduce students to:
1. Model and analyze heat and mass transfer problems.
2. Use numerical computation, estimation from graphs, and mathematical models (equations) to obtain information to solve problems.
3. Document technical computations to ensure that assumption, solution technique, and calculations can be validated.
4. Investigate the impact of materials' physical properties on heat and mass transfer (e.g., conductivity, density, thermal diffusivity, and emissivity).

Learning Outcomes
At the end of the course, the student should be able to:
- Model and solve heat transfer problems as electrical analogue circuitry,
  - Understand the correspondence between electrical and heat based systems,
  - Apply steady state assumptions to determine the solutions,
- Apply geometry simplification to generate and solve models of systems involving heat transfer,
- Identify assumptions of typical heat transfer modelling,
- Identify mechanisms of heat and mass transfer in a given situation,
- Identify and compute thermophysical material properties, and
- Compute estimations of heat loss from structures.

Description of Assignments
There will be 10 written assignments throughout the semester. Each assignment will consist of questions (typically from the text book). They are to be answered in full using the methodology described in the class and assigned text. A question will be considered correct only if it is answered in the appropriate format, using appropriate significant digits and has an answer(s).

Description of Examinations
Two midterm examinations will be scheduled in the October and November, respectively. A final examination will be scheduled at the end of the semester. The examination will test the student's knowledge of the lecture material covered in this course.

Texts, Readings, Materials

Textbook(s) – Authors, Titles, Edition
Bergman T.L., Lavine A.S., Incropera F.P., and D.P. DeWitt, 2011. *Fundamentals of heat and mass transfer*, 8th ed., John Wiley & Sons, Inc., Toronto.

Supplementary Reading
Borgnakke, C., Sonntag, R.E., and G.J. Van Wylen 2009. *Fundamentals of Thermodynamics*, 7th. ed., John Wiley & Sons, New York.

Additional Materials
Supplied by instructor.

Course Policies

Late Assignments
Will not be accepted and will receive a zero grade.

Missed Assignments
Will receive a zero grade.

Missed Exams
There will be no "make-up" midterms. If a midterm examination is missed and the student has a valid medical certificate or compassionate reason (i.e., death of an immediate family member), the grade will be transferred to the final. Students who miss a midterm examination without a valid reason will receive a grade of zero for the midterm examination.

Academic Integrity

Plagiarism or any other form of cheating in examinations, term tests or academic work is subject to serious academic penalty. Cheating in examinations or tests may take the form of copying from another student. Exam cheating can also include exam impersonation. A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty. Students should acquaint themselves with the University's policy on plagiarism, cheating, exam impersonation and duplicate submission.

Use of Third Party Detection and Submission Tools
Electronic detection tools may be used to screen assignments in cases of suspected plagiarism.

Group Work Policies:
All assignments are to be done as individuals and the University's policy plagiarism does apply to assignments (see Academic Integrity above).

Recording Class Lectures

Dr. Fuji Jian and the University of Manitoba hold copyright over the course materials, presentations and lectures that form part of this course. No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without permission from Dr. Fuji Jian. Course materials (both paper and digital) are for the participant's private study and research.

Additional Policies:
The tutorials **are not optional** and **attendance** will be taken. Policies for the faculty of engineering regarding attendance will apply.

Grade Evaluation
The grade for this course will be based on assignments, two midterm examinations, and a final examination. The final grade is the combination of the following grades:

45% Final Examination (3hrs)
40% Midterm I (90 min, before middle October, TBA)
40% Midterm II (90 min, before middle November, TBA), use the highest mark in the two midterms
15% Assignments, assigned weekly or biweekly.

Mapping of Course Evaluation to Graduate Attributes & Indicators

Grade Component	Specific Evaluation Point	Graduate Attribute [a]	Level [c]
Assignments (15%)	Assignment 1 to 9	Knowledge Base for engineering	D
	Assignment 10	Problem analysis	A
Midterm Examination I (40%) [b]	Part I	Knowledge Base for engineering	D
	Part II	Problem analysis	D
Midterm Examination II (40%) [b]		Knowledge Base for engineering	D
		Problem analysis	D
Final Examination: (45%)	Part I	Knowledge Base for engineering	D
	Part II	Problem analysis	A

[a] Refer to evaluation rubrics provided by the department and scale used for the evaluation rubrics.

[b] Use one of the highest marks.

[c] Level of Development of Graduate Attributes (D = Intermediate; A = Advanced)