COURSE SYLLABUS

COURSE INFORMATION

Course Number & Title:	ME 420 Intermediate Heat Transfer
Course Credit Hours:	4 Credit Hours
Class Meeting Time:	13:00 – 13:50 Monday, Wednesday, Friday
Class Meeting Location:	2055 LuMEB
Course Canvas Page:	
Prerequisites:	ME 310/TAM 335 and ME 320

INFORMATION ABOUT THE COURSE INSTRUCTOR

Name of the instructor:	Professor Bumsoo Han
Office Location:	3050 LuMEB
Phone number:	(217) 300-0516
Email Address:	bumsooh@illinois.edu
Office hours:	15:00 – 16:00 Monday and Wednesday or by appointment

INFORMATION ABOUT THE TEACHING ASSISTANT

Name of the TA:	TBA
Office Location:	TBA
Email Address:	TBA
Office hours:	TBA

COURSE DESCRIPTION

ME 420 is a dual-level course in heat and mass transfer that may be taken for graduate credits or as an undergraduate elective. Three modes of transport processes of heat and mass will be covered - diffusion, convection, and radiation. Students are expected to gain an in-depth understanding of the underlying fundamentals and with improved analytical skills related to heat and mass transfer. ***Solid understanding of undergraduate-level fluid mechanics and heat transfer are essential with knowledge on differential equations and engineering mathematics***.

The scope of the course includes following topics: Heat and mass transfer by diffusion, moving boundary problems with phase change. Convective heat transfer for external and internal flows. Similarity and integral solution methods. Heat, mass, and momentum analogies. Turbulence. Convection with phase change and in porous media. Radiation exchange between surfaces and radiation transfer in participating media. Multimode heat transfer problems.

TEACHING PHILOSOPHY

My teaching philosophy is to educate students to be capable of critical thinking and interdisciplinary learning, and to prepare students for contemporary technical challenges and applications. To achieve this goal while providing a solid background in heat and mass transfer, students are expected to be critical thinkers who can effectively search out the necessary information, evaluate it, and apply it to real-world technical problems. Thus, I will use the inquiry-driven active learning method. Often, examples and quizzes will be given prior to lectures covering the topic. Students are expected to attempt to solve these examples and quizzes by themselves, and to correct their answers through in-class discussion and lectures.

LEARNING OBJECTIVES

By the end of the course, you will be able to:

1. Advance the understanding of heat and mass transfer processes
2. Provide experience in analyzing and designing transport processes
3. Strengthen analytical skills and the ability to cope with complex problems
4. Learn modern computational and experimental techniques for heat/mass transfer

LEARNING RESOURCES

Required Textbook

1. Fundamentals of Heat and Mass Transfer, by Bergman et al., 8th Edition or later

Additional References

1. Bird, R.B. Stewart, W.E. and E.N. Lightfoot, *Transport Phenomena*, John Wiley (2006).
2. Eckert and Drake, *Analysis of Heat and Mass Transfer*, McGraw-Hill (1972).
3. Ozisik, M.N., *Heat Conduction*, John Wiley (1993).
4. Bejan, *Convection Heat Transfer*, John Wiley (2013).
5. Siegel and Howell, *Thermal Radiation Heat Transfer*, Hemisphere (2010)
6. Kreyszig, *Advanced Engineering Mathematics*, Wiley (2011)

COURSE LOGISTICS AND POLICIES

Course Grade

The course grade will be based on homework, quizzes, examinations and a project report according to the following tentative distribution. Details on these assignments and exams, including grading rubrics will be posted on the course website.

- Homework — No grades (For your study only)
- Quizzes — = 100 points (5 of 8 Quizzes × 20 pt)
- Exams — = 350 points (3 of 4 Exams × 150 pt)
- Team Project Report — = 300 points (Proposal: 100 pt, Final report: 200 pt)
- Class participation — = 50 points (3 attendances among 6 random checks)
- Total Score — = 800 points

Grading Scale

In this class grades reflect the sum of your achievement throughout the semester. You will accumulate points as described above, with each assignment graded according to a rubric. At the end of the semester, final grades will be calculated by translating these points into the percentage (100% of total possible score) and following letters (no partial points or rounding).

A+= 100 ~ 97,	A = 96 ~ 93,	A- = 92 ~ 90	
B+= 89 ~ 87,	B = 86 ~ 83,	B- = 82 ~ 80	
C+= 79 ~ 77,	C = 76 ~ 73,	C- = 72 ~ 70	
D+= 69 ~ 67,	D = 66 ~ 63,	D- = 62 ~ 60	F = Below 59

Attendance Policy

Classroom attendance is expected except in cases of illness, emergencies, or other special circumstances. In case of an absence, an email notice should be sent to the instructor before the lecture or as soon as possible. You will be responsible to get lecture notes, handouts and assignments of the missed lecture.

Homework
Homework problems and solutions will be uploaded at the course website for your practice and improving your understanding. The homework will not be graded but you are strongly encouraged to review and fully understand the solution procedures for exam preparation.

Quizzes
Multiple quizzes will be given during the class without prior announcement, typically at the beginning of the class. These quizzes are intended to highlight key concepts of the class subjects and/or review understanding of the pre-requisites. Please bring your textbook and pen to each lecture.

Exams
Four exams will be arranged throughout the semester to evaluate student's learning on each mode of transport processes – conduction, convection, radiation and mass transport, as planned in the class schedule. All the exams will be close-book format. No make-up exams will be given. Although each exam covers a given mode of transport processes, acceptable knowledge of other transport modes may be necessary.

Team Project Report
The objective of this **Team** project is to practice how to apply heat and mass transfer knowledge we discussed in the class to real-world applications. For the project, you should form a team of no more than three. The project consists of following two steps:

1. *Project Proposal: Postulate or identify a process or a product where more than two of the following transport phenomena occur.*

   Your team needs to propose a project to satisfy the requirement below in a one-page project proposal. The process can be related to your research project or industrial experience. It can also be any natural process be encountered in your daily life. You can also perform literature review to postulate an engineering process or product of your interest. Only constraints are the process should include at least two of the following transport processes of heat or mass: 1) Diffusion, 2) Convection, 3) Radiation, 4) Phase Change and 5) Chemical reaction. **Note: These transport phenomena should occur within your control volume rather than just providing boundary conditions for one transport phenomenon within the control volume.**

2. *Final Report: Describe the analysis including formulation and solution of relevant governing equations, boundary or initial conditions, and necessary constitute equations.*

   After getting the approval of the project, your team will analyze the project problem by mathematical or numerical methods. Clear description of problem statement is a must including defining your control volume, governing equations, boundary and initial conditions. You also need to clearly show how you model the process with proper assumptions so that the final set of equations can be solvable by mathematical, numerical or experimental methods.

Academic Integrity
Academic integrity (see the UIUC Student Code, Article 1, Part 4) is one of the highest values that the University holds. All submitted work must be the result of an individual's own effort. Any violations of this policy breach the standard of academic integrity that is vital to the mission of the university. Note that plagiarism is "copying or imitating the language, ideas, and thoughts of other authors and passing off the same as one's original work" (Barnhart, 1968) and is a violation of academic integrity. Any student detected of cheating on assignments, examinations or not following proctor's instruction will receive a failing grade, and report will also be filed at Faculty Academic Integrity Report (FAIR) portal, recommending termination from the University.

Students with Disabilities
If students anticipate or experience physical or academic barriers based on disability, the students inform the instructor and discuss alternative options. Students may also contact the Disability Resource and Educational Services at: disability@illinois.edu or (217) 333-1970.

Instructor's Email Availability and Policy
Unless announced differently, the instructor and/or TA will be available via email daily, and try to respond within 48 hours, if not traveling nor during weekend/holidays. When emailing the instructor and/or TA, please start your subject line with "[ME 420]" and the topic (e.g., [ME 420] Assignment 2 Question).

Course Etiquette

- Arrive before the class start time. Be seated and prepared to participate before the class begins. If you are late, be quiet as you enter and find a seat quickly and quietly. If you have to leave before the class ends, exit the room quietly without distracting your classmates or the instructor.
- During the regular class sessions, cell phones and other electronic devices are allowed only for your learning activities.
- During tests and exam periods, all cell phones and other electronic devices must be turned off and kept away from the student's immediate view unless the instructor has given permission for use.

Sale of Class Materials or Note
Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course including exams and solutions for homework assignments and quizzes. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in the courses are permitted to take notes, which they may use for individual/ group study or for other non-commercial purposes.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the instructor.

Emergency Protocol

- If we hear **a fire alarm**, we will immediately evacuate the building and proceed to the **west side grass of Transportation Building**.
- If we are notified of a Shelter in Place requirement for a tornado warning, we will shelter in **the hallway of the basement level of this building**.
- In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Information about changes will be available via: Canvas web page or E-mail and phone inquiries to the Instructor and Teaching Assistant.

Diversity and Inclusion Statement
We are committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach own potential. In pursuit of its goal of academic excellence, we seek to develop and nurture diversity.

DISCLAIMER
This syllabus is subject to change throughout the semester. Any changes will be announced by email and/or at the course Canvas site.

Class Schedule

Weeks	Lectures	Topics	Textbook Reading	Assignments
	8/25	Introduction to Heat/Mass Transfer		
1	8/27	Conservation of Energy & Rate Equations	Chapter 1	
	8/29	Introduction to Conduction	Chapter 2	HW#1
	9/1	**Labor Day (No Class)**		
2	9/3	Steady State Conduction	3.1-3.5	
	9/5	Heat Transfer with Extended Surfaces	3.6 - 3.7	
	9/8	Mulit-dimensional Conduction & Spatial Discretization	Chapter 4	
3	9/10	Transient Conduction & Temporal Discretization	Chapter 5	
	9/12	Semi-infinte Solids	5.7	HW#2
	9/15	Moving Boundary Problem	Ch.11 from Ozisik	
4	9/17	Bioheat Transfer	Ch.17 from Truskey	
	9/19	Introduction to Convection	6.1 - 6.3	Team Formation
	9/22	Boundary Layer: Physical Consideration	6.4 - 6.5	
5	9/24	**Exam 1: Conduction (a 2hr evening exam)**		
	9/26	**No Class in lieu of Exam 1**		
	9/29	Boundary Layer Analysis	7.1 - 7.3	
6	10/1	Cylinder in a Cross Flow & Impinging Jet	7.4 - 7.7	
	10/3	Internal Convection	8.1 - 8.6	
	10/6	Free Convection	9.1 - 9.4	
7	10/8	Pool Boiling	10.3 - 10.4	HW#3
	10/10	Heat Transfer in Porous Materials	References	
	10/13	Heat Pipe	References	
8	10/15	Introduction to Radiation	12.1 - 12.3	Pre-Proposal Due
	10/17	Blackbody Radiation	12.4 - 12.5	
	10/20	Radiation Properties	12.6 - 12.8	
9	10/22	**Exam 2: Convection (a 2hr evening exam)**		
	10/24	**No Class in lieu of Exam 2**		
	10/27	Enviromental Radiation	12.9	
10	10/29	View Factors	13.1 - 13.2	
	10/31	Radiation Exchange Between Surfaces	13.3	
	11/3	Multimode Heat Transfer	13.4	
11	11/5	Participating Media & Radiative Transfer Equation	References	HW#4
	11/7	Diffusion Approximation	References	
	11/10	Mass Diffusion & Fick's Law	14.1	
12	11/12	Mass Advection & Governing Equation	14.2 - 14.5	
	11/14	Osmotic Pressure & Membrane	References	
	11/17	Mass Transfer in Porous Materials	Ch.8 from Truskey	
13	11/19	**Exam 3: Radiation (a 2hr evening exam)**		
	11/21	**No Class in lieu of Exam 3**		
	11/24	Fall Break (No Class)		
14	11/26	Fall Break (No Class)		
	11/28	Fall Break (No Class)		
	12/1	Poroelasticity	Ch.8 from Truskey	HW#5
15	12/3	Biologics Delivery	Shah et al.	
	12/5	3D Printing of Soft Materials	Cheng et al	Final Report Due
	12/8	**No Class in lieu of Exam 4**		
16	12/10	**Exam 4: Mass Transport (a 2hr exam)**		