ME 419: Heat Transfer

Fall 2018

Instructor: Prof. Emily Ryan
Office: ENG 416 (110 Cummington Mall)
Email: ryanem@bu.edu
Phone: 617-353-7767
Office Hours: Tuesdays 11:30-12:30

TA: Atakan Ari
Office: PHO B17
Email: atakanba@bu.edu
Office Hours: Thursdays 4:00-5:00 PM

Course Information:

Textbook (Required): *Fundamentals of Heat and Mass Transfer* by Bergman, Lavine, Incropera & Dewitt, 6th, 7th or 8th Edition (Instructor will use 7th Edition as reference.)

Website: Blackboard (used for announcements, assignments, review material)
Course Meeting: Lecture: Tuesdays & Thursdays 1:30-3:15pm, EPC 208
Discussion: Wednesdays 3:35-4:25 PM, EPC 208

Course Description: While thermodynamics covers the end states of processes, heat transfer tells us about the nature and rate of movements of thermal energy within the process. This course emphasizes the development of a physical and analytical understanding of the three modes of heat transfer (conduction, convection, radiation), with emphasis placed on conduction and convection.

Topics Covered:

1. Steady and unsteady conduction
2. Numerical analysis of conduction
3. Natural and forced convection
4. Introduction to boiling, condensation and evaporation
5. Radiant heat exchange
6. Mass Transfer Analogy

Course Communication

Questions about Homework problems, Exam/Quiz review topics, and the Course Project should be posted to the appropriate Discussion Board on Blackboard. To insure fair access of information to all students, questions concerning any course material sent to either the Instructor or TA via email will not be answered via direct email, only through Discussions.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Understand and differentiate between the three modes of heat transfer: conduction, convection, radiation;
2. Derive and simplify the Heat Equation using conduction and radiation as boundary conditions in both steady and transient states.

3. Understand the fundamental relationships between fluid flow, and convective heat and mass transfer.
4. Apply the appropriate empirical correlations for forced and natural convection to determine convective heat transfer coefficients, with a focus on understanding the role of dimensionless parameters in heat transfer analysis.
5. Understand the differences between black body and gray body radiation.
6. Develop the analogous understanding between Fourier's Law for heat transfer and Fick's Law for mass transfer.

Reading Assignments: Course lectures will coincide with the textbook for each topic as listed below on the Course Schedule. Students are expected to familiarize themselves with material before coming to class to fully engage in classroom discussions.

Course Grading: Grading for ME 419 is broken down according to the point distribution below.

Homework:	10% (lowest 1 dropped)
Exams:	55%
Quizzes:	15%
Laboratory:	10%
Project:	10%

Homework: There are 8 problem sets assigned throughout the semester due at the ***beginning*** of class on the date listed on the Course Schedule; homework will be collected at 1:35 pm. Assignments turned in after 1:40 pm are considered late. Late Homework will be accepted within 24 hours of the due date for a 50% grading penalty if delivered to the Instructor's office. No late homework is accepted after 12 pm the day after the deadline as solutions will be posted to Blackboard. The lowest Homework grade will be dropped (except for the homework where student is Team Leader, see below).

Homeworks 1, 3, 5, 6, 8 are individual assignments. Students must turn in their own, individual solutions; though you may consult with classmates, solutions should represent your own, final individual work in your own handwriting.

Homeworks 2, 4, 7 are Team-based assignments; you will work in groups of three (with the same three students throughout the semester). Each student will serve as "Team Leader" once during the semester, and is responsible for turning in the assignment. The assignment in which you serve as Team Leader will count twice towards your homework grade and cannot be dropped, and you will also submit a Team Assessment for this assignment. *You may choose your own groups (or they will be assigned if you are unable to find a group of 3); you may not work with any of the same two other students for your course project.*

<u>Assessment</u>: Homeworks will consist of 3-6 problems each. They will be graded out of 10 points for each assignment. ~50% of the grade is for approach to the problem (i.e. "setting it up") with the remaining points awarded for a reasonable solution. In engineering, a clear organized solution of a problem is as important as the final numerical answer; on your Homeworks, all important steps and assumptions must be included in the solution. A statement about the method of solution may be included for clarity.

- *Any problems requesting a graph should be done on a computer; hand-drawn figures are not accepted, unless otherwise noted*
- *Students are encouraged to study the solutions posted on Blackboard in detail, as quizzes and exams may build on these assignments (similar idea, new problem formulation).*

Exams: There are 3 exams during the semester, as listed in the Course Schedule. Missing an exam due to vacation or early departure for a scheduled break is not excusable. Arrangements will be made on a case-by-case basis for documented medical, University conflicts (***must be arranged 1 week prior***) or other emergencies. Students requiring additional time to complete examinations must make arrangements with the Instructor at ***least 3 business days in advance*** of an examination so suitable arrangements can be made.

Exam 1: Steady Conduction	**Thursday, September 27th**	**In Class**
Exam 2: Conduction & Forced Convection	**Thursday, October 18th**	**In Class**
Exam 3: Three Modes of Heat Transfer	**Thursday, November 29th**	**In Class**

Quizzes: There are 3 quizzes throughout the semester. Quizzes focus on specific material taught the two weeks before the quiz, though by the nature of the course material they are cumulative. These are "fast" quizzes lasting 20 minutes during discussion, and require no calculation. *They are closed-book.*

Project: There is a team-based project for this course in lieu of a final exam, comprising an oral presentation, and a written component. More information will follow, including sample assignments and rubrics. This is a team-graded assignment. *You may choose your own groups (or they will be assigned if you are unable to find a group of 3); you may not work with any of the same two other students you are working with for your Homework group.*

Boston University Academic Conduct Code*:* Honesty is a core value of Boston University. Any violations of the BU academic honesty and integrity standards ***will be pursued*** through appropriate University channels. Academic misconduct is conduct by which a student misrepresents his or her academic accomplishments, or impedes other students' opportunities of being judged fairly for their academic work. Knowingly allowing others to represent your work as their own is as serious an offense as submitting another's work as your own. If you have any questions as to what constitutes an honor code violation, please ask. ***Ignorance is not an excuse for cheating***. You may access the BU Academic Conduct Code at: http://www.bu.edu/academics/policies/academic-conduct-code/

Proposed Course Schedule (Please note: changes/updates to this schedule will be posted on Blackboard, but nothing will ever be due earlier than the posted dates here.)

		ME 419 - Fall 2018		**Updated: August 31, 2018**
Date	**Day**	**Topic**	**Textbook Reading**	**Assignment Due**
9/4/2018	Tuesday	Introduction to Heat Transfer	Chapter 1	
9/5/2018	Wednesday	No Discussion		
9/6/2018	Thursday	Introduction to Conduction: The Heat Equation	Chapter 2	
9/11/2018	Tuesday	Solving the Heat Equation: Boundary Conditions	Chp 2.4, 3.1-3.3	
9/12/2018	Wednesday	Optional - Homework Help		
9/13/2018	Thursday	1D Steady Conduction: Thermal Circuits	2.3-2.5, 3.1-3.5	
9/18/2018	Tuesday	Fins & Finned Surfaces	3.5, 3.10	*Homework 1*
9/19/2018	Wednesday	***Quiz 1 (Steady Conduction)***		
9/20/2018	Thursday	2D & 3D Steady Conduction	Chapter 4	
9/25/2018	Tuesday	Review: Steady Conduction in Practice	Chapters 1-4	
9/26/2018	Wednesday	Optional - Exam 1 Review		
9/27/2018	Thursday	**Exam 1: Steady Conduction (Chapters 1-4)**		
10/2/2018	Tuesday	Transient Conduction: Lumped Systems	5.1-5.3	*Homework 2*
10/3/2018	Wednesday	Optional - Homework Help		
10/4/2018	Thursday	Unsteady Conduction (Slabs, spheres, cylinders)	5.1-5.6	
10/9/2018	Tuesday	**Monday Schedule**		
10/10/2018	Wednesday	***Quiz 2 (Transient Conduction)***		
10/11/2018	Thursday	Semi-infinite Bodies	5.7-5.8	
10/16/2018	Tuesday	2D & 3D Transient Conduction, Conduction Review	(Supplemental Notes)	
10/17/2018	Wednesday	Optional - Exam 2 Review		
10/18/2018	Thursday	**Exam 2: Conduction (Emphasis on Unsteady Conduction)**		
10/23/2018	Tuesday	Introduction to Convection: Fluids & Mass Transfer	6.1-6.3	*Homework 3*
10/24/2018	Wednesday	Optional - Homework Help		
10/25/2018	Thursday	Boundary Layers and Dimensionless Numbers	Chapter 6	
10/30/2018	Tuesday	External Forced Convection by Correlations	7.1-7.3	
10/31/2018	Wednesday	Optional - Homework Help		
11/1/2018	Thursday	External Forced Convection; Internal Forced Convection	7.4-7.9; 8.1-8.5	*Homework 4*
11/6/2018	Tuesday	Internal Forced Convection by Correlations; Natural Convection	8.1-8.5; Chapter 9	
11/7/2018	Wednesday	Optional - Homework Help		
11/8/2018	Thursday	Introduction to COMSOL		
11/13/2018	Tuesday	Natural Convection; Review of Convection	Chapters 6-9	
11/14/2018	Wednesday	***Quiz 3: Convection***		
11/15/2018	Thursday	Boiling & Condensation; Heat Exchangers: LMTD Method	10.1-10.5; 11.1-11.3	*Homework 5*
11/20/2018	Tuesday	Heat Exchangers	11.4-11.6	
11/21/2018	Wednesday	No Discussion		*Homework 6 -COMSOL Due by 5PM*
11/22/2018	Thursday	**Thanksgiving**		
11/27/2018	Tuesday	Effectiveness-NTU Method; Introduction to Radiation	11.4-11.6; Chapter 12	
11/28/2018	Wednesday	Optional - Exam 3 Review		
11/29/2018	Thursday	**Exam 3: Convection**		
12/4/2018	Tuesday	Radiation	Chapter 12-13	*Homework 7*
12/5/2018	Wednesday	Optional - Homework Help		
12/6/2018	Thursday	Heat Transfer in Practice; The Mass Transfer Analogy: Fick's Law	Chapters 1-12; 14.1-14.5	*Homework 8*
12/11/2018	Tuesday	**Course Project Due; Presentations - Attendance Required**		
12/12/2018	Wednesday	**Presentations - Attendance Required**		