ME 419 A2
Prerequisite: ME 303, 304
Corequisite: ME 400

BOSTON UNIVERSITY

HEAT TRANSFER

Spring 2011

Instructor: Prof. Aaron Schmidt
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Lecture: Monday and Wednesday, 12–2pm (PSY B33)
Tutoring: Friday, 10am–2pm (ENG 202)
Office Hours: Monday and Wednesday, 9–10am (ENG 305)

Textbook: *A Heat Transfer Textbook* by Lienhard and Lienhard (2003)
⋆ Available as a PDF on Blackboard

Heat and Mass Transfer by Çengel and Ghajar, 4th Edition (2010)

Content and Goals

The discipline of Heat Transfer is concerned with understanding and controlling the rate of thermal energy transfer caused by a difference in temperature. It plays a critical role in countless natural processes and engineered systems. The temperature of the earth, for example, is maintained by a precise balance of the rates of heat transfer from the sun to the earth and the from the earth into the empty blackness of space. On a human scale, heat transfer is essential to design a car radiator or an energy-efficient building. And down at the smallest engineering scales, the performance and durability of semiconductor chips, solar cells, and energy-efficient LED light sources are all limited by the rate at which heat can be transferred from one part of a device to another.

This course will cover the fundamentals of heat transfer, with a strong emphasis on modeling and the use of simplifying approximations to solve commonly encountered engineering problems. Topics will include: steady and unsteady heat conduction in one or more dimensions, steady conduction in multidimensional configurations, and numerical simulation of conduction; natural and forced convection heat transfer; heat transfer during condensation, boiling and evaporation; thermal radiation, black bodies, grey radiation networks, spectral and solar radiation. Problems and examples will be taken from manufacturing, electronics, consumer products, and energy systems.

Course Details

Lectures will be divided in two roughly equal parts. Problem sets are due at the beginning of each class. After they are collected, we will work through some or all of the problems on the board. Similarly, quizzes will be held at the beginning of class, and then we will go through the solutions together. The quizzes will emphasize the most recent material but may include anything covered up to and including the class before the quiz. In the second part of lecture, we will cover the main points of that day's material. The assigned reading should be done beforehand.

There are two experimental labs for this course. Sign-up sheets will be posted once the labs have been scheduled. The experiments will be done in groups, but the reports are individual. There will also be a lab on the numerical simulation of heat conduction. Scheduling and details TBD.

On matters of academic conduct, we will follow the College of Engineering's Undergraduate Conduct Code. A copy has been placed on the course Blackboard site.

Exams and Grading

60% Two mid-terms and a final, 20% each. Exams are closed book, one or two pages of notes allowed.

20% Problem sets + quizzes (top 15 count, no re-scheduling)

20% Lab reports (includes numerical simulation report)

Problems sets will be announced in lecture and posted on the course website. Collaboration with other students is allowed, but each student must write up their own solution and cite any collaborators. Problem sets turned in after the solution has been discussed in class will not receive credit. The use of solution manuals is forbidden.

Schedule[1]

Date	Topics	Reading	Deadlines
Jan 19	Heat, temperature, modes of heat transfer	L: 3–36; Ç: 1–35	
Jan 24	The heat equation, steady conduction	L: 49–77; Ç: 61–112	Pset 1
Jan 26	Thermal resistance networks		Quiz 1
Jan 31	Heat exchangers I	L: Chpt 3, Ç: Chpt 13	Pset 2
Feb 2	Heat exchangers II		Quiz 2
Feb 7	Fins		Pset 3
Feb 9	More steady conduction		Quiz 3
Feb 14	Transient conduction		Pset 4
Feb 16	Transient conduction II		Quiz 4
Feb 22	Exam review		Pset 5
Feb 23	**Exam 1**		
Feb 28	Numerical Simulation I		
Mar 2	Numerical Simulation II		
Mar 7	Convection		Pset 6
Mar 9	Forced convection I		Simulation report
Mar 21	Forced convection II		Quiz 5
Mar 23	Natural convection		Pset 7
Mar 28	Boiling and condensation		Quiz 6
Mar 30	Evaporation		Pset 8
Apr 4	Exam review		
Apr 6	**Exam 2**		
Apr 11	Introduction to radiation		
Apr 13	View factors		Pset 9
Apr 20	Gray body networks		Quiz 7
Apr 21	Spectral surfaces, solar spectrum		Pset 10
Apr 25	Mass transfer		Quiz 8
Apr 27	Small-scale heat transfer		Pset 11
May 2	Electronics cooling, review		
May	**Final Exam (Comprehensive**		

[1]Subject to change. Check the course website for the latest version.