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

BOSTON UNIVERSITY

HEAT TRANSFER

Fall 2011

Instructor: Prof. Aaron Schmidt
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Lecture: Tues and Thurs 2–4pm (ENG 202)
Tutoring: Fri 2–4pm (ECL Lab, 15 St. Mary's rm 125)
Office Hours: Mon, 10am–12pm (ENG 305)
Textbook *A Heat Transfer Textbook: Fourth Edition* by Lienhard and Lienhard
Available as a PDF on Blackboard, or paperback (Amazon.com, $23.00)

Overview

The science of Heat Transfer is concerned with understanding and controlling the rate of thermal energy transfer. It plays a critical role in countless natural processes and engineered systems: The temperature of the earth 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; 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 taken from manufacturing, electronics, consumer products, and energy systems. Topics will include:

1. Steady and unsteady heat conduction in one or more dimensions
2. Steady conduction in multidimensional configurations
3. Numerical simulation of conduction
4. Natural and forced convection heat transfer
5. Heat transfer during condensation, boiling and evaporation;
6. Thermal radiation, black bodies, grey radiation networks
7. Spectral and solar radiation.

Course Details

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 reports are individual. There will also be a numerical design project using the COMSOL software package. We will follow the College of Engineering's Undergraduate Conduct Code; a copy has been placed on the course Blackboard site.

Students are expected to be familiar with fluid dynamics (ME 303 or equivalent), thermodynamics (ME 304 or equivalent) and engineering mathematics with partial differential equations (ME 400 or equivalent).

The GTF will be available for drop-in tutoring two hours each week in the ECL (15 St Mary's rm 125) to help with course material, homework questions, and COMSOL.

Exams and Grading

50% Two mid-terms (15% each) and a comprehensive final exam (20%). Mid-terms are closed book, two pages of notes allowed.

30% Problem sets (12 total, top 10 count). Problem sets are due at the beginning of class.

20% Lab reports & design project

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. 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
Sep 6	1: Heat, modes of heat transfer	3–35	
Sep 8	2: The heat equation, steady 1D, thermal circuits	49–77	
Sep 13	3: Fins	163–183	Pset 1
Sep 15	4: Fins		
Sep 20	5: Unsteady conduction: lumped capacitance	22–26, 193–200	Pset 2
Sep 22	6: Unsteady conduction: slabs, spheres, cylinders	203–219	**Lab 1 starts**
Sep 27	7: Semi-infinite bodies	220–235	Pset 3
Sep 29	8: Semi-infinite bodies II		
Oct 4	9: Multi-dimensional conduction	235–252	Pset 4
Oct 6	10: Multi-dimensional conduction, Exam review		
Oct 11	**Exam 1**		
Oct 13	11: Numerical simulation		**Design project starts**
Oct 18	12: Convection		Pset 5
Oct 20	13: Boundary layers		
Oct 25	14: Internal flow		Pset 6
Oct 27	15: External flow		**Lab 1 due**
Nov 1	16: Natural convection, boiling and condensation		Pset 7
Nov 3	17: Heat exchangers		**Lab 2 starts**
Nov 8	18: Heat exchangers, Exam review		Pset 8
Nov 10	**Exam 2**		
Nov 15	19: Blackbody radiation, surface properties		Pset 9
Nov 17	20: Radiation view factors		
Nov 22	21: View factor relations		Pset 10
Nov 24	**Thanksgiving**		
Nov 29	22: Gray body networks		Pset 11
Dec 1	23: Solar energy, building technology		
Dec 6	**In-class prsentations**		**Design project & Lab 2 due**
Dec 8	24: Final exam review		Pset 12
Dec 16	**Final Exam (Comprehensive)**		

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