Mechanical Engineering 375
Heat Transfer

Spring 2007 Number 17629 Instructor: Larry Caretto

Course Outline (January 24)

Catalog Description

Prerequisites: MATH 250; PHYS 220A/L. Basic principles of heat transfer and their application. Introduction to conductive, convective, and radiative heat transfer. Applications to design.

Instruction information	
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Course Information	
Course number	11585
Class hours	Monday and Wednesday, 3:00 to 4:15 pm
Class location	Jacaranda (Engineering) 1610
Web site	http://www.csun.edu/~lcaretto/me375

Expanded Description

The analysis of fluid mechanics is an essential part in the design of many engineering systems, including rocket engines, the engines in your cars and trucks, the heating and cooling of your residences and workplaces, the circuit boards in electronic devices *etc*. In your everyday life, you are familiar with the three principal modes of heat transfer, which we will consider in this course. When you touch a hot (or cold) surface, heat is transferred to (or from) your hand by conduction. When you sit in the sun you receive radiative heat transfer from the sun. A hot or cold wind blowing past your body heats or cools it by convective heat transfer.

Thermodynamics introduces the concept of heat as energy in transit due only to a temperature difference and thermodynamics courses discuss the total amount of heat transferred. In this course you will learn how to design systems to produce a certain heat transfer rate. The main parameters in heat transfer problems are the temperature difference available (or the desired maximum or minimum temperature allowed for a performance standard), the heat transfer properties of the materials used, and the geometry of the system.

Although advanced applications of heat transfer are based on the application of partial differential equations, the emphasis in this introductory course will be on the use of basic principles, in an integrated form, to solve common engineering problems in heat transfer.

Text

Yunus A. Çengel, *Heat and Mass Transfer A Practical Approach* (third edition), McGraw-Hill, 2007.

Course Conduct

Course Learning Objectives – As a result of taking this course, students should be able to

- understand and be able to formulate and solve problems in conduction, convection and radiation heat transfer using basic material properties: thermal conductivity, density, heat capacity, thermal diffusivity, and viscosity,
- solve problems with multiple modes of heat transfer, using heat transfer coefficients and the circuit analogy where appropriate,
- solve one-dimensional, steady conduction heat transfer problems in various geometries with constant and variable thermal conductivity,
- solve one-dimensional, steady conduction heat transfer problems in various geometries with heat sources,
- solve multi-dimensional, steady heat transfer problems using shape factors,
- be familiar with the partial differential equations used for transient and steady heat transfer in one or more dimensions and be able to apply solutions to these equations to find temperatures,
- solve transient heat transfer problems known as “lumped capacity” problems where the main heat transfer resistance is from external convection,
- use charts to solve transient heat transfer problems,
- understand the important parameters that govern the accuracy of a finite difference solution and be able to use these parameters to obtain accurate computer solutions with software packages,
- understand the differences between laminar and turbulent flows, between external and internal flows, and between free convection and forced convection, and calculate appropriate dimensionless parameters in each of these situations,
- solve convection problems for a variety of flow conditions using appropriate empirical or theoretical equations for heat transfer coefficients,
- solve problems in heat exchangers using both the U factor and the NTU methods,
- use the blackbody distribution function and radiation properties (emissivity, transmissivity, and absorbtivity) to find average radiation properties for solving radiation heat exchange problems, and
- use shape factors and the gray body assumption to solve radiation heat transfer problems in diffuse enclosures.

Relation to program outcomes – As part of the accreditation process, the BS degree programs in electrical and mechanical engineering have a set of outcomes that students should achieve by the time that they graduate. This course is designed to contribute to the following program outcomes for the two degree programs: (a) the ability to apply knowledge of mathematics, science and engineering, and (b) the ability to formulate and solve engineering problems.

Class participation – Learning engineering subjects is a difficult task that can only be done by working problems on your own. Your learning in this course will be a combination of textbook material, lecture material and in-class discussion. Your active participation in class exercises and discussion is essential to your learning of the subject matter. Your own work in problem solving is a key to your mastery of the subject matter.

Course organization – The course is organized into twelve subject matter units. Each unit, which will take one week, consists of an introductory lecture, self study by groups of students, and a quiz. Wednesdays will generally start with a quiz on the previous unit followed by the introductory lecture on the new unit. Mondays will be used for self study. The first quiz will be on Monday, February 7.

Homework – Weekly homework assignments will be given, but not graded. The date for each homework assignments, given at the end of this outline, is the date of the quiz on the material covered in the assignment. Students should complete the homework prior to the quiz. Solutions to the homework will be posted on the course web site. Doing the homework is important practice for learning the subject material. Problems on quizzes and exams will be similar to (but not exactly the same as) homework problems.

Assignments – In addition to the weekly quizzes, there will be a computer design project, a midterm exam and a final exam. The computer design project will be due at the end of the semester. The details of the project will be provided at least one month before the assignment is due.

Grading – Your grade in this course will be based on

Design project	15%
Weekly quizzes	35%
Midterm Examination	20%
Final	30%

Only the ten highest quiz grades will be counted in computing the quiz grade for the semester. Students who take eleven or twelve quizzes will have their lowest grade or two lowest grades, respectively, removed before computing the quiz grade for the semester. The quiz grade for students who take ten or fewer ten quizzes will be calculated from the quizzes taken; there will be no make-up or adjustment for students who take fewer than ten quizzes.

The translation of a final numerical score into a letter grade rests solely on the judgment of the instructor. The following criteria will be used for letter grades:

A: Student knows almost all of the course material and is able to apply it to new problems.

B: Student satisfies one, but not both, of the conditions for an A grade.

C: Student knows fundamentals of the course and is able to apply this knowledge to routine problems.

D: Student has learned some course material but is not able to apply all the fundamental points of the course.

F: Student has failed to demonstrate knowledge of the course material beyond a minimal level.

Plus/minus grading will be used in this course. A plus grade indicates that the criterion for a given grade has been clearly met, but the student performance does not begin to approach the requirements for the next highest grade. A minus grade is given when the student performance does not quite meet the requirements for the grade, but the criterion for the next lower grade has been substantially exceeded.

Class courtesy – To keep a good learning environment your fellow students you should come to class on time and not leave before class is over. Turn off your cell phone and other personal electronic devices while you are in class. Do not disturb others by talking during lecture. If you do not understand some point of the lecture, ask the instructor for clarification. During group work, encourage all members in your group to participate. Answer questions your fellow students ask you, in a respectful manner (as you would like to have your questions answered when you ask.) Do not wear perfumes, colognes, after-shave lotions, and the like that upset others in the class, especially individuals with allergies.

No make-up exams – There are no make-up exams or quizzes. Students who miss the midterm exam will receive a calculated midterm grade, based on their performance on all the other exams and quizzes that they took. See the grading section above for the treatment of quiz grades. Students who do not take the final examination will receive a grade of unsatisfactory incomplete (WU) in the course. This grade counts the same as an F in your grade point average.

Plagiarism vs*. Collaboration* – Students often work together on assignments. This collaboration is helpful and encouraged. By working together, each of you can improve your learning of the subject. However, there is a difference between working together to learn the material and copying another student's work and passing it off as your own. Submitting another person's work as your own is a violation of academic standards and University regulations. It is unethical behavior for people working in engineering or studying to work in this field. Each student must submit his or her own work to pass the course.

Written assignments, design projects, or exam solutions that are identical and, in the instructor's judgment, indicating copying, will result in an F grade in the course for both students involved. The instructor will notify the Associate Dean of the College of Engineering and Computer Science and the Dean of Students of any cheating incidents in this class.

Add-drop policy – Students are expected to be familiar with the University regulations for adding and dropping classes. Students who find that they do not have enough time to prepare for this class or whose performance on the initial quizzes is poor should consider dropping the class within the appropriate deadline. (Students can withdraw from the class on line up to February 16; Between February 16 and February 23 a petition approved by the instructor and department chair is required. Withdrawals after February 23 are not permitted.) Students who do not complete the course work and do not withdraw from the class will receive a grade of WU, denoting an unsatisfactory withdrawal. Such grades count the same as an F grade in the computation of students' grade point averages.

Changes – Students are responsible for all changes to this outline announced in class.

Schedule of lecture topics, exams and quizzes

The reading column below gives the pages to be read from the text by Çengel, unless otherwise stated. Readings should be completed prior to the lecture. Monday quizzes, at the start of the class, are on the topic of the previous week.

Date	Quiz and Lecture Topics	Reading
January 29	Course introduction, dimensions and units	Notes on units
January 31	Unit one: Basic equations for conduction, convection and radiation heat transfer. Introduction to Ohm's law analogy	1–40
February 5	Self study on unit one.	
February 7	**Unit one quiz.** Unit two: basic conduction equations. Consideration of variable thermal conductivity and heat sources	61–112
February 12	Self study on unit two	
February 14	**Unit two quiz.** Unit three: steady heat transfer with combined conduction and convection	131–159
February 19	Self study on unit three	
February 21	**Unit three quiz.** Unit four: fin heat transfer	159–179

Date	Quiz and Lecture Topics	Reading
February 26	Self study on unit four	
February 28	**Unit four quiz.** Unit five: unsteady heat transfer – lumped parameter model and introduction to charts	217–234
March 5	Self study on unit five	
March 7	**Unit five quiz.** Unit six: charts, infinite medium, and product solutions for unsteady heat transfer	234–256
March 12	Self study on unit six	
March 14	**Unit six quiz.** Unit seven: introduction to convection	355–389
March 19	Self study on unit seven	
March 21	**Unit seven quiz.** Unit eight: external forced convection and start of internal forced convection	395–423, 451–466
March 26	Review for midterm exam	
March 28	**Midterm exam**	
April 2	**Spring Break – no class**	
April 4	**Spring Break – no class**	
April 9	Self study on unit eight	
April 11	**Unit eight quiz.** Unit nine: completion of internal forced convection and free convection	467–489, 503–532
April 16	Self study on unit nine	
April 18	**Unit nine quiz.** Unit ten: Heat exchangers	608–646
April 23	Self study on unit ten	
April 25	**Unit ten quiz.** Unit eleven: fundamentals of radiation heat transfer	663–701
April 30	Self study on unit eleven	
May 2	**Unit eleven quiz.** Unit twelve: radiation heat exchange	709–752
May 7	Self study on unit eleven	
May 9	**Unit twelve quiz.** Software for heat transfer	285–334
May 14	Heat transfer software applications	
May 16	Review for final	
May 23	**Final Exam, Wednesday, 3 – 5 pm**	

Homework Assignments

The homework assignments should be done by the date shown below. Each date (except January 31) is the date of the quiz on the subject matter of the assignment.

Date	Homework problems assigned in Çengel
January 31	Download problem set from web site
February 7	1-55, 1-59E, 1-64, 1-66, 1-78, 1-95, 1-101
February 14	2-48, 2-79, 2-80, 2-87, 2-101C, 2-103
February 21	3-19, 3-20, 3-29E, 3-36, 3-47, 3-133E
February 28	3-111, 3-112, 3-114, 3-115, 3-117, 3-121,
March 7	4-14, 4-15E, 4-19, 4-24, 4-35, 4-37

Date	Homework problems assigned in Çengel
March 14	4-38, 4-43E, 4-45, 4-72, 4-83, 4-86
March 21	6-8, 6-9, 6-18C, 6-37, 6-38, 6-51
March 28	No homework – midterm exam
April 4	No homework – spring break
April 11	7-16, 7-32, 7-67, 8-22, 8-39, 8-41
April 18	8-55, 8-63E,9-29, 9-39, 9-47, 9-68E
April 25	11-42, 11-46, 11-49E, 11-90, 11-93, 11-118
May 2	12-14, 12-20, 12-48, 12-50E, 12-61E, 12-63
May 9	13-8, 13-14, 13-26E, 13-36, 13-43, 13-59