ES 3073 Heat Transfer
(Required course for ChE, ME and PE programs)

Current Catalog Description: Transfer of heat by conduction, radiation, and convection. Analysis of steady-state and transient heat processes. Introduction to heat exchanger design. Introduction to numerical heat transfer using finite-element analysis.

Prerequisites: ES 3003 (Fluid Mechanics) Corequisite: Math 3073 (Differential Equations)

Prerequisites by Topic: Solution of ordinary differential equations; energy balances; fluid properties; laminar and turbulent flow and the basic concepts of boundary layer theory.

Recent Textbook: *Heat Transfer*, 9th Edition by J.P. Holman; McGraw Hill (2002).

Other Required Material: None

Course Objectives: At the end of this course, students will be able to:

1. Solve steady state and transient conduction problems.
2. Solve forced convection and natural convection systems.
3. Solve basic radiation problems.
4. Size basic heat exchangers.
5. Work effectively in multi-disciplinary teams.

Major Topics Covered in the Course: Steady-state conduction; unsteady-state conduction; principles of convection; forced convection heat transfer; natural convection; radiation heat transfer; condensation and boiling heat transfer, heat exchanger design and analysis; steady and transient numerical heat transfer using finite-element analysis.

Class/Laboratory Schedule: Lecture meets for two 75-minute sessions each week for 14 weeks.

Professional Component Contribution: This course applies mathematics and basic chemistry and physics to engineering applications of heat transfer. Computer skills are extended in this course to numerical solution of differential equations. A minimum of one design project is assigned in this course. Throughout the course, safety and ethics are emphasized.

Relationship to Student Outcomes	
outcome:	**Description of related course content:**
(a) an ability to apply knowledge of mathematics, science and engineering	The course requires solution of differential equations and use of series solutions as well as introduces finite difference/finite element methods to solve applied engineering problems. Problems in this course build on a background of chemistry, physics, thermodynamics and fluid mechanics.
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	Students design a heat exchanger in this course to satisfy a specific set of constraints based on suggestions from local industry. Problems relating to health and safety are often assigned as homework.
(d) an ability to function on multi-disciplinary teams	The design project or projects and occasional homework problems are done in teams. Every effort is made to ensure a mix of two or more majors on each team.
(e) an ability to identify, formulate, and solve engineering problems	A variety of homework problems are assigned each 1-1.5 weeks so that students will develop the necessary problem solving skills. Quizzes are also given occasionally that accomplish the same outcome.
(f) an understanding of professional and ethical responsibility	
(g) an ability to communicate effectively	In addition to the communication skills required to function on a team and successfully write an exam, students are required to write a paper summarizing their design project.
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	
(i) a recognition of the need for, and an ability to engage in life-long learning	
(j) a knowledge of contemporary issues	
(k) an ability to use the techniques, skills and modern engineering tools necessary for engineering practice	

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Course objectives from Spring 2009 added by G. L. Price
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