ENG ME 419 Heat Transfer

2008 - 2009 Catalog Data:
ENG ME 419 Heat Transfer Prereq: ENG ME 303 and ENG ME 304; coreq: ENG ME 400. Fundamentals of heat exchange processes and applications to heat exchanger design. Principles of steady and unsteady conduction. Introduction to numerical analysis. Natural and forced convection heat transfer in internal and external flows. Radiant heat exchange. Introduction to boiling and condensation heat transfer. Includes lab and design project. 4 cr.

Class/Lab Schedule: 4 lecture hours per week; 2 two hour labs per semester

Status in Curriculum: Required

Textbook(s) and/or Other Required Material: Y.A. Cengel, Heat And Mass Transfer: A Practical Approach, 3rd ed., McGraw-Hill, 2006

Coordinator: Katherine Zhang, Assistant Professor, Mechanical Engineering

Prerequisites by Topic:
1. First law of thermodynamics
2. Basic calculus and differential equations
3. Partial differential equations/Vector field theory
4. Fluid mechanics of internal flows
5. Concept of boundary layer

Goals:
To present a broad-based introduction to heat transfer processes by illustrating the physical origin of heat exchange mechanisms and demonstrating applications of these principles to engineering problems. The course is specifically structured to facilitate an early start on a design project. Subsequently, the details of the various modes of heat transfer- convection, conduction, and radiation - are presented.

Course Learning Outcomes:
As an outcome of completing this course, students will:

i. Become proficient in the application of heat transfer principles (conduction, convection and radiation) to modeling and solution of engineering problems including: analytical and numerical solutions to governing equations, the interpretation and use of non-dimensional parameters, concept of thermal boundary layers, Reynolds analogy and the use of equivalent radiation network as applied to enclosure heat transfer. (A, E, K)

ii. Gain experience in the use of concept of thermal resistance, both its quantitative use in problem solving via the overall heat transfer coefficient approach and its qualitative use in conceptual understanding of heat transfer phenomena. (A, E, L)

iii. Gain experience and confidence in thermal system design through a design project, including consideration of alternative designs to achieve optimal performance (e.g., capacity) within a specified set of constraints (e.g., size, pressure, drop or cost). (C, G, J, M)

iv. Gain experience with thermal systems measurements and data acquisition techniques through the operation of two experiments: (1) a double-wall heat exchanger experiment and (2) an unsteady heat transfer experiment. (B, E, G, L)

Course Learning Outcomes mapped to Program Outcomes:
(For Program Outcomes, please see attached page or Department Web Site)

Program:	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Course:	i, ii	iv	iii	-	i, ii, iv	-	iii, iv	-	-	iii	i, iv	i, ii, iv	iii	-
Emphasis:	5	3	4	1	5	1	3	1	1	2	3	4	4	1

Topics (time spent in weeks):
1. Introduction, modes of heat transfer (0.5)
2. Steady, one-dimensional conduction (no internal energy generation) thermal resistance, overall heat transfer coefficient (1.5)
3. Lumped capacitance (0.5)
4. Heat exchangers (1.5)
5. Fins (0.5)
6. Forced convection, internal flows (1)
7. Forced convection, external flows (1.5)
8. Natural convection (1)
9. Steady one-dimensional conduction with internal energy generation (0.5)
10. Transient one-dimensional conduction (1.5)
11. Numerical analysis, including steady two-dimensional conduction (1)
12. Thermal radiation (3)
13. In-class exams (1)

Contribution of Course to Meeting the Requirements of Criterion 5:
Engineering Topics: 100%

Status of Continuous Improvement Review of this Course:
Date: April 11, 2007 **Reviewed by:** Fluids-Thermal Committee
Prepared by: Katherine Zhang **Date:** January 21, 2009