ME 3345 Heat Transfer (Required)

Catalog Description: ME 3345 Heat Transfer (3-0-3)

Prerequisites: MATH 2403 Differential Equations (C or better), ME 3322 Thermodynamics, and ME 3340 Fluid Mechanics

Introduction to the study of heat transfer, transport coefficients, steady-state conduction, transient conduction, radiative heat transfer, and forced and natural convection.

Textbook: Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 7th Edition, John Wiley & Sons, 2011.

Topics Covered:

1. Basic concepts. Fourier's law, Newton's law of cooling, Stefan-Boltzmann law. Conservation of energy, heat flux, boundary and initial conditions.
2. One-dimensional steady-state conduction with and without heat generation, heat transfer from extended surfaces.
3. Two and three dimensional steady-state conduction, numerical solutions.
4. Transient conduction: lumped capacitance method, semi-infinite media.
5. Fundamentals of thermal radiation: black and gray surfaces, surface properties.
6. View factor, radiative exchange among black surfaces and among diffuse gray surfaces, electric analogs, radiation shields.
7. Fundamentals of convection. Conservation of energy, thermal boundary layers, similarity and dimensionless parameters, momentum/heat/mass transfer analogies.
8. Forced convection external flows: similarity parameters; laminar and turbulent boundary layers on flat surfaces; heat transfer to cylinders, spheres, tube banks, and packed beds; impinging jets.
9. Forced convection internal flows: laminar and turbulent flow through circular and noncircular ducts, fully developed flow, hydrodynamically and thermally developing flows, empirical correlations.
10. Free convection boundary layer equations: laminar boundary layers on flat surfaces, turbulence, empirical correlations.
11. Heat exchangers: overall heat transfer coefficient; cocurrent and countercurrent flow; cross flow; effectiveness-NTU method; condensers, evaporators, and compact heat exchangers.

Course Outcomes:

Outcome 1: To teach students the basic principles of conduction, radiation, and convection heat transfer.

1.1 Students will demonstrate an understanding of the basic concepts of conduction, radiation, and convection heat transfer.

Outcome 2: To extend the basic principle of conservation of energy to systems that involve conduction, radiation, and heat transfer.

2.1 Students will demonstrate an understanding of the concept of conservation of energy and its application to problems involving conduction, radiation, and/or convection heat transfer. This principle will be used to formulate appropriate mathematical models and associated thermal boundary conditions.

Outcome 3: To train students to identify, formulate, and solve engineering problems involving conduction heat transfer.

3.1 Students will demonstrate the ability to formulate practical conduction heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique, and evaluating the significance of results.

Outcome 4: To train students to identify, formulate, and solve engineering problems involving radiation heat transfer among black surfaces and among diffuse gray surfaces.

4.1 Students will demonstrate the ability to formulate practical radiation heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique, and evaluating the significance of results.

Outcome 5: To train students to identify, formulate, and solve engineering problems involving forced convection heat transfer, natural convection heat transfer, and heat exchangers.

5.1 Students will demonstrate the ability to formulate practical forced and natural conduction heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique, and evaluating the significance of results. Students will also demonstrate an ability to analyze the performance of heat exchangers.

Correlation between Course Outcomes and Student Outcomes:

ME 3345											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X				X						X
Course Outcome 2.1	X				X						X
Course Outcome 3.1	X				X						X
Course Outcome 4.1	X				X						X
Course Outcome 5.1	X				X						X

GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(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
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(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

Prepared by: Srinivas Garimella, Satish Kumar, and David Orloff