Department of Mechanical Engineering

ME407– Heat Transfer

(Required)

Catalog Description: **ME 407 (3-0-3)**

A study of the three fundamental modes of heat transfer: conduction, convection, and radiation. A physical interpretation of the many quantities and processes in heat transfer using numerical methods. Theory is applied to the analysis and design of heat exchangers and other applications. Where appropriate, computer simulation is used.

Prerequisites: Math 222 – Differential Equations
ME 304 – Fluid Mechanics
ME 311 – Thermodynamics I

Textbook(s) Materials Required:

1. Frank P. Incropera and David P. DeWitt An Introduction to Heat Transfer, 7th edition. John Wiley & Sons 2002 (software included with the text)

Course Supervisor: Dr. E.L. Dreizin

Pre-requisite by topic

1. Calculus
2. Ordinary differential equations
3. Control volume analysis, potential flow, laminar and turbulent flows, Navier-Stokes equations
4. First and Second Laws of Thermodynamics; property relations

Course Objectives[1]:

1. To develop the students' skills in applying differential equations for describing steady and transient heat transfer problems (A, B)
2. To develop students' skills in applying mechanical design approaches for thermal engineering components and heat transfer systems (B, C)
3. To develop the students' skills in numerical modeling and dimensionless analysis for heat transfer problems in different geometries (A, B, C)
4. To provide the students with fundamental theoretical concepts and practical analysis skills associated with convective heat transfer including external and internal heat transfer configurations (A, B, C)
5. To provide the students with fundamental theoretical concepts and practical analysis skills associated with radiation heat transfer (A, B, C)
6. To develop students' skills in solving practical heat transfer problems using thermal resistance networks (B, C, D)
7. To develop students' skills in working with contemporary heat transfer related research literature and develop their own, application driven engineering solutions working as a team. (D, E)

Topics[2] :

1. Introduction to heat transfer (3 hrs)
2. Introduction to conduction heat transfer (3 hrs)
3. Steady heat conduction problems (3 hrs)
4. Fins, common fin shapes and models (3 hrs)
5. Quiz 1: steady conduction heat transfer, fins (1.5 hrs)
6. Introduction to transient heat transfer problems, lumped system (1.5 hrs)
7. Transient heat transfer in solids: analytical solutions (3 hrs)
8. Steady heat transfer: numerical analysis (3 hrs)
9. Transient heat transfer: numerical methods (1.5 hrs)
10. Quiz 2: transient heat transfer (1.5 hrs)
11. Heat transfer design project: introduction (1.5 hrs)
12. Introduction to convection heat transfer (1.5 hrs)
13. Forced convection, external/internal flows (3 hrs)
14. Natural convection (1.5 hrs)
15. Quiz 3: Convection heat transfer (1.5 hrs)
16. Introduction to radiation (3 hrs)
17. Solving practical radiation heat transfer problems (1.5 hrs)
18. Project defense (1.5 hrs)
19. Heat Exchangers (3 hrs)
20. Review (3 hrs)

Evaluation Method:
1. Homework
2. Quizzes
3. Exam
4. Project

Schedule: Lecture Recitation: 3 hours, per week

Professional Component: Engineering Science

Program Objectives Addressed: A, B, C, D, E

Course Outcomes[3] :

Objective 1

Students will demonstrate an ability to mathematically describe different practical heat transfer problems including governing equations together with boundary and initial conditions (1, 2, 3, 4) (a, c, e, h, k, m)

Objective 2

Students will demonstrate an ability to solve the heat transfer problems for a range of practically important simplified configurations and symmetries, including one-dimensional problems in cylindrical and spherical coordinates (1, 2, 3) (a, c, e, h, k, m)

Objective 3

Students will learn using generic data processing software to solve heat transfer problems (1, 4) (a, c, e, h, k)

Objective 4

Students will learn how to apply finite difference methods for describing complex configurations with distributed heat sources and variable properties (1, 2, 3, 4) (a, j, k)

Objective 5

Students will learn how to describe engineering heat transfer problems using non-dimensional criteria, such as Reynolds number, Nusselt number, Grashof number, etc. (1, 2, 3, 4) (a,e,h,k, o)

Objective 6

Students will demonstrate an ability to determine engineering design quantities (power, requirements, insulation thickness, material thermal conductivity, specific heat, etc.) required for design of thermal engineering devices and systems (3, 4) (a, b, c, d, e, h, k, o)

Prepared by: E.L. Dreizin Date: September 18, 2006

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[1] Capital Letters in parenthesis refer to the Program Objectives of the Mechanical Engineering
Department. Listed in Sec 2 d Tables B-2-9, B-2-12. Table B-2-8 links Program Objectives with the ABET a-k Criterion.

[2] Topi**c** numbers in parenthesis refer to lecture hours. (three hours is equivalent to 1 week)

[3] Outcome numbers in parenthesis refer to evaluation methods used to assess the student performance. Lower case letters in parenthesis refer to ABET a-k outcomes.