ME 410.1
HEAT TRANSFER
SPRING 2008
(1/14/08-5/2/08, M W F 10:10A - 11:00A, 073 WILLARD)

Text: Fundamentals of Heat and Mass Transfer, 6th Edition, Incropera, Dewitt, Bergman and Lavine, John Wiley & Sons

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Period	**Topic**	**Reading**
1-3	Introduction, Heat Transfer Analysis	1.1-1.7
4	Heat Diffusion Equation	2.1-2.5
5-9	Conduction in a Plane Wall, Radial Conduction Conduction with Heat Generation, Extended Surfaces – Concept and Examples	3.1-3.8
10-12	Conduction - Numerical Formulation, 2-D Numerical Solutions	4.1-4.6
13	Transient Conduction, Lumped Capacitance Method	5.1-5.7, 5.10
14-17	Convection Boundary Layers, equations, similarity	6.1-6.9
18	Exam #1	
19-22	External Flow - Flat Plate, Convection Calculations Cross Flow and Hot Wire Method	7.1-7.6
23-26	Internal Flow, Energy Balance Laminar and Turbulent Flows in Ducts, Concentric Tube Annulus	8.1-8.7
27-30	Free Convection – Vertical Plates, Enclosures	9.1-9.11
31-33	Heat Exchangers, LMTD and Effectiveness-NTU Methods Performance and Design Calculations	11.1-11.7
34	Exam #2	
35-39	Thermal Radiation, Radiation Intensity Emission, Irradiation and Radiosity Blackbody Radiation, Band Emission Kirchoff's Law and the Gray Surface	12.1-12.7
40-44	Radiation View Factor, Radiation Exchange Radiation Shields, Reradiating Surfaces Combined Heat Transfer Modes	13.1-13.2

Note: Exam times shown on the schedule are approximate exact dates will be announced in the class at least a week in advance.

ME 410.3
Course Policy

1. The prerequisites for ME 410 are: ME 320, CmpSc 201, Math 220 or NucE 309. Successful completion of these courses is necessary for enrollment in ME 410.

2. The course grade will be based on: 2 Midterms (30% each) and one comprehensive final exam (30%), remaining 10% will be the homework, which will be handed out in class and collected in class on the due date specified. No late homework will be accepted. These homeworks will be graded.

3. No make-up exams will be given. If an exam is missed for reasons of acceptable cause (illness, death in the family, etc.) that exam will be dropped when the final grade is computed. Otherwise missed exam will be given a zero grade. Excuses will be more believable if advance notice is given to the instructor.

In addition to the graded homework the following list shows problems from the text. These will not be collected or graded, however they should be worked out. Solution of additional problems is also encouraged. Solutions of the recommended problems are on ANGEL course web site.

Recommended Problems

Chapter 1	1.7, 1.13, 1.25, 1.37
Chapter 2	2.8, 2.24
Chapter 3	3.3a, 3.8a, 3.36, 3.68, 3.101, 3.116
Chapter 4	4.33, 4.34, 4.45, 4.49
Chapter 5	5.1, 5.5, 5.8, 5.11, 5.44a, 5.68, 5.96a
Chapter 6	6.4, 6.11, 6.14, 6.14, 6.18, 6.19, 6.34, 6.36
Chapter 7	7.2a&b, 7.6, 7.10, 7.42, 7.78a&b, 7.83
Chapter 8	8.6, 8.8, 8.12, 8.16a&b, 8.22a, 8.26, 8.52a
Chapter 9	9.7, 9.24, 9.25a, 9.51, 9.54
Chapter 11	11.5, 11.9, 11.14, 11.32, 11.39, 11.52
Chapter 12	12.6, 12.9, 12.10, 12.11, 12.29a&b, 12.45, 12.49
Chapter 13	13.1, 13.2, 13.16, 13.21, 13.22a, 13.63

ME 410 Course Objectives: (Mapping to Program Outcomes shown in brackets)

A. Develop both qualitative and quantitative understanding of the three modes of heat transfer. [1b]

B. Make appropriate approximations, develop and apply simplified model equations for specific applications. [2b]

C. Apply mathematical and numerical methods to solve heat transfer problems. [1c, 1d, 1f, 5e]

D. Understand the role of and use dimensionless parameters in heat transfer analysis. [2b]

E. Design thermal systems for engineering applications. [2c, 2e, 5b]

F. Advance proficiency in professional communications and interactions. [3f]

Course Learning Outcomes: (Mapping to Course Objectives shown in brackets)

1. Sketch and interpret temperature distributions and heat flux distributions for mathematical models of heat conduction with planar and radial geometries, including heat generation. [A]

2. Derive fundamental differential thermal energy equations and develop mathematical models for thermal/fluid systems, including:

    a. Lumped capacitance for unsteady heat transfer

    b. 1D unsteady heat conduction equation with heat generation

    c. Quasi 1D heat conduction for extended surfaces (fins), including variable cross-sectional areas

    d. Mean axial temperature variation for internal flows with uniform surface temperature or uniform wall heat flux. [B]

3. Apply ODE solution methods to solve the differential heat transfer equations for applications including:

    a. Lumped capacitance for unsteady heat transfer

    b. Steady 1D planar and radial conduction with heat generation

    c. Quasi 1D fins with variable cross-sectional area

    d. Internal flows with uniform surface temperature or uniform wall heat flux. [C]

4. Apply existing PDE solutions to analyze 1D and quasi 1D unsteady heat conduction systems. [C]

5. From an energy balance, derive the finite difference equations for conduction with surface convection. Describe numerical solution methods used to solve the finite difference equations. [B]

6. For convective heat transfer over a flat plate with uniform surface or uniform wall heat flux, sketch

and interpret:

   a. Hydrodynamic and thermal boundary layer thicknesses

   b. Hydrodynamic and thermal boundary layer profiles

   c. Local skin friction and local heat transfer coefficient as a function of distance from the leading edge. [A]

7. Sketch and interpret hydrodynamic and thermal profiles for internal flows with uniform surface or uniform wall heat flux. [A]

8. Develop and apply conduction and convection thermal circuits. [B]

9. Choose and apply appropriate dimensionless correlations for external and internal flows to solve convection heat transfer problems. [D]

10. Understand and apply the Reynolds Analogy for convection heat transfer. [B]

11. Analyze thermal sensors such as hot wires and thermocouples. [E]

12. Define and properly apply in an energy balance the following terms: emission, radiosity, irradiation, net radiation heat flux, emissivity, absorptivity, reflectivity, and transmissivity. [A]

13. Understand the spectral characteristics of radiation heat transfer including black and gray surfaces. [A]

14. Develop thermal circuit diagrams for radiation analysis and determine surface temperatures for two and three surface geometries including reradiating surface and radiation shield. [B]

15. Set up and solve combined conduction, convection, and radiation heat transfer problems. [B & C]

16. Apply fundamental heat transfer principles to perform heat exchanger design and performance calculations. [E]

17. Make effective use of spreadsheets as an analysis tool. [C]

18. Demonstrate the ability to solve problems in a clear step-by-step manner and follow policies and instructions as outlined in the syllabus and other course materials. [F]

19. Demonstrate professionalism in interactions with colleagues, faculty, and staff. [F]

STATEMENT ON ACADEMIC INTEGRITY

Academic honesty and integrity is of utmost importance. Detailed information on this topic can be found at www.engr.psu.edu/undergrad/acad_int/students. Some examples are given below:

CHEATING: Using crib sheet; pre-programming a calculator; using notes or books during a closed book exam etc.

COPYING ON TEST: Looking at another unsuspecting student's exam and copying; copying in a complicit manner with another student; exchanging color-coded exams for the purpose of copying; passing answers via notes; discussing answers in exam, etc.

PLAGIARISM: The fabrication of information and citations; submitting others work from professional journals, books, articles and papers; submission of other students papers or lab results or project reports and representing the work as one's own; fabricating in part or total, submissions and citing them falsely, etc.

ACTS OF AIDING OR ABEADING: Facilitating acts by others; unauthorized collaboration of work; permitting another to copy from exam; writing a paper for another; inappropriately collaborating on home assignment or exam without permission or when prohibited, etc.

UNAUTHORIZED POSSESSION: Of examinations, through purchase or supply; stealing exams; failing to return exams on file; selling exams; photocopying exams; buying exams; any possession of an exam without the custodian's permission, etc.

SUBMITTING PREVIOUS WORK: Submitting a paper, case study, lab report or any assignment that had been submitted for credit in a prior class without the knowledge and permission of the instructor.

TAMPERING WITH WORK: Changing own or another students work product such as lab results, papers, or test answers; tampering with work either as a prank or in order to sabotage another work, etc.

GHOSTING: Taking a quiz, an exam, performing a laboratory exercise or similar evaluation in place of another; having another take a quiz, an exam, or perform an exercise or similar evaluation in place of the student, etc.

ALTERING EXAMS: When instructor returns graded exams for in class review and subsequently collects them, student changes incorrect answers and seeks favorable grade adjustment asserting that instructor made mistake in grading; other forms may include changing the letter or and/numerical grade on test; obtaining test in discretely, etc.

COMPUTER THEFT PROGRAM: Electronic theft of computer programs, data, or text belonging to another etc.