ME 610 Advanced Heat Transfer

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Course Description:

There are two main objectives of this course. One is to introduce advanced heat transfer principles beyond those lectured from basic heat transfer course (undergraduate). The other is to apply the associated heat transfer theories to simple engineering cases, with focuses on modeling establishment and problem closures. The advanced heat transfer theories include advanced heat conduction, advanced heat convection, radiation heat transfer with non-grey or non-diffusive surfaces, solar radiation, and heat transfer with phase changes.

Course Pre-requisite: basic heat transfer (undergraduate-level); basic fluid mechanics (undergraduate-level); or consent of course lecturer

Textbook: F. P. Incropera and D. P. DeWitt, *Introduction to Heat Transfer*, 4th Ed., Wiely, 2002

References:
1. A. F. Mills, *Heat and Mass Transfer*, Irwin, 1995.
2. F. White, *Heat and Mass Transfer*, McGill Hill, 1970.
3. F. C. McQuiston et al., *Heating, Ventilating, and Air Conditioning*, 2000:
   (for solar radiation; transient heat transfer)
4. Spray (droplet evaporation)
   (for liquid evaporation; general heat transfer coupled with mass transfer)

Course Arrangement

Week	Subject	Assignment due
1	Introduction of Heat Transfer; Thermal network; T-dependent Steady heat conduction; heat source/sink	
2	Fin theory; Transient heat conduction-1: Lumped model	
3	Transient heat conduction-2: general lumped model & semi-infinite medium	
4	Flow-Heat Transfer Coupling; Heat convection in a laminar flow	HW#1 (1-3)
5	HW Soln-1; Effect of turbulence on heat convection: boundary-layer theory (forced convection) & Reynolds analogy	
6	Natural convection; Boundary layer theory (natural convection)	
7	Thermal radiation and Thermal radiation networks among solid surfaces (through “vacuum”)	HW#2 (4-6)
8	HW Soln-2; Non gray-body radiation; Thermal radiation through absorptive medium (gases); Solar radiation	
9	"Midterm Exam"	
10	MT-soln; Solar radiation on a surface; green-house effect	HW#3 (7-8, 10)
11	HW Soln-3; Heat-mass transfer-1: physical phase change; Evaporation; condensation; boiling heat transfer	
12	Heat-mass transfer-2: chemical reaction --- heat sources/sinks	
13	Modeling of coupled heat-mass-momentum transfer	HW#4 (11-12)
14	HW Soln-4; Heat exchanger theory; effect of phase change	Project due

Grade Calculation Method

(1) class attendance (10%)
(2) homework (30% + 5% extra + 10% extra for a numerical heat transfer simulation project)
(3) mid-term (30% + 5% bonus)
(4) final exam (30% + 5% bonus)

Final grade is based on accumulative grade. There will be No Curve Adjustment.
Guaranteed "A": > 85%
Guaranteed "F": < 60%.

Homework Requirements

(a) Four Assignments will be given, with 4-6 problems (plus 1-2 extra) per assignment.
(b) Homework grade is based on 50% "problem-solving (modeling) logics" and 50% "completeness & solvability", not necessarily "correctness".
(c) Late submission will be given 50% grade deduction.
(d) Numerical simulation project can be self-defined and by a team of no more than 2 students, with a pre-approval of the lecturer. It must include:
    (1) Problem statement and simplifications
    (2) Closed governing equations
    (3) All initial/boundary conditions
    (4) Outline of numerical approaches
    (5) Sample results of (a) temperature field; and (b) heat flux field
    (6) Brief conclusions

Examination Requirements

(1) Open books, notes, and any reasonable references;
(2) No share of materials or calculators;
(3) No use of computer, cell phone calculator, or any devices that may be regarded for telecommunication;
(4) With I.D. for identity check-up