ME 353 M.M. Yovanovich

Week 5

Lecture 1
Monday, October 6, 11:30 AM lecture replaces November 18 lecture.
Circular annular fin: see section 3.6.4 of text for equation, solution, heat flow rate, fin efficiency and fin resistance; application to heat sink; discuss Project 1. See Table 3.5 for expressions for efficiency of several straight fins and pin fins having different cross-sections. See Examples 3.9 and 3.10. See Web Site for Maple solutions for Examples 3.9 and 3.10.

Lecture 2
Application of fin solution to system consisting of two finite length fins and a central portion modeled as a plane wall; its thermal circuit;
Chapter 4: steady-state, source free, two- and three-dimensional conduction problems; solution methods: (A) analytical; (B) numerical; (C) analog; (D) approximate methods;
analytical: (i) separation of variables; (ii) conformal mapping methods; (iii) transform methods such as Fourier sine or cosine, and other transform methods; limited by the geometry and the boundary conditions;
numerical: (i) finite difference methods; (ii) finite element methods; (iii) boundary integral equations method; (iv) surface element method; (v) other numerical methods based on some analytical method;
analog: electrical; mass transfer; hydrodynamic;
approximate: upper bound (parallel adiabats) and lower bound (parallel isotherms) on system resistance; flux plotting (based on sketching isotherms and adiabats); approximate methods are cost effective;
shape factors S; see Table 4.1 for a short list of some useful shape factors.

Lecture 3
Tuesday, October 7, 12:30 lecture replaces November 19 lecture.
Discuss shape factors given in Table 4.1; sphere buried in semiinfinite region; long circular cylinder buried in semiinfinite region; circular cylinder in a square cylinder; how to find approximate expression for square cylinder inside a square

cylinder using the exact solution for the circle inside a circle; two rule method: (a) set the inner areas equal; (b) set the volumes equal; discuss other rules that may be used to find the outer radius; it was suggested that (i) the outer areas can be set equal; (ii) the minimum spacing can be set equal; two approximations based on analog methods were presented: $\boxed{S/L = 2\pi/(0.93\ln(\beta/\alpha) - 0.0502)}$ for $\beta/\alpha > 1.4$ and $\boxed{S/L = 2\pi/(0.785\ln(\beta/\alpha))}$ for $\beta/\alpha < 1.4$.

Lecture 4

Complete discussion of shape factors.

Chapter 5: transient conduction; lumped capacitance model (LCM);

one-dimensional transient conduction in semiinfinite region: Dirichlet, Neumann and Robin solutions;

one-dimensional transient conduction in plane walls, long circular cylinders and solid spheres;

Lecture 5

Hand in Project 1.

Show Maple worksheet with solution to Project 1.

Lumped capacitance model; heating and cooling problems are identical when temperature excess is used: $\theta(t) = T(t) - T_f$ for cooling and $\theta(t) = T_f - T(t)$ for heating. See Web Site for Maple worksheet for lumped capacitance model.
