
Week 2

Lecture 1
Solutions to problems are available in Engineering Photocopy Center;
First makeup lecture: Thursday, 8:30 AM, CPH 3385;
Continued discuss of radiation; Stefan-Boltzmann Law of Radiation; thermal circuit; definition of radiative conductance, h_r; $Q_{12} = h_r A_1 (T_1 - T_2)$;
general relation: $\boxed{h_r = \dfrac{\sigma(T_1^2 + T_2^2)(T_1 + T_2)}{A_1 R_{rad}}}$;
special case: $A_2 >> A_1, F_{12} = 1$; $\boxed{h_r = \epsilon_1 \sigma (T_1^2 + T_2^2)(T_1 + T_2)}$;
compute h_r for black-body radiation: $\epsilon_1 = 1, T_2 = 300\,K$, and $\Delta T = (T_1 - T_2) = 1, 10, 100\,K$; see Web Site;
see Example 1.5 for system with conduction, convection and radiation; see corresponding Maple worksheet on Web Site.

Lecture 2
One-dimensional steady-state temperature $T(x)$ in plane wall with convection heating and cooling; film resistances: $R_{f1} = 1/(h_1 A), R_{f2} = 1/(h_2 A)$, solid resistance: $R_s = L/(kA)$; total resistance of system: $R_{\text{total}} = R_{f1} + R_s + R_{f2}$; thermal circuit: four temperature nodes: $T_{f1}, T_{s1}, T_{s2}, T_{f2}$; three resistances in series; heat flow rate through system: $Q = (T_{f1} - T_{f2})/R_{\text{total}}$; composite wall; contact resistance: R_c; contact conductance: h_c; relation: $R_c = 1/(h_c A)$; thermal resistances in parallel; upper and lower bounds on resistance

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Lecture 3
Tour of ME 353 Web Site;
Definitions of thermal resistance $R\,[K/W]$ and shape factor $S\,[m]$;
resistance defined by $\boxed{Q = (T_{source} - T_{sink})/R}$;
shape factor defined by relation: $\boxed{Q = kS(T_1 - T_2)}$;
relation between shape factor and solid resistance: $\boxed{S = 1/(kR)}$;
physical definition of thermal resistance: $\boxed{\text{resistance} = \dfrac{\text{flow distance}}{(\text{conductivity})(\text{flow area})}}$;

see Table 4.1 for some shape factors; solid resistance and shape factor of plane wall, $S = A/L$; $R = L/(kA)$; brief discussion of Methodology; see text and Web Site.

Lecture 4 (Makeup Lecture 1)

Conduction equations: Laplace equation (source free, steady-state): $\boxed{\nabla^2 T = 0}$, Poisson equation: (with sources, steady-state): $\boxed{\nabla^2 T = -\mathcal{P}/k}$, Diffusion equation (source free, transient): $\boxed{\nabla^2 T = (1/\alpha)\partial T/\partial t}$; initial condition (IC); three types of boundary conditions (BCs): (i) BC of first kind (Dirichlet); temperature is prescribed, (ii) BC of second kind (Neumann), temperature gradient is prescribed, (iii) BC of third kind (Robin), linear combination of Dirichlet and Neumann conditions; coordinate systems: Cartesian coordinates, $T(x, y, z, t)$; cylindrical coordinates, $T(r, \phi, z, t)$; spherical coordinates, $T(r, \phi, \theta, t)$; see text for derivation of general differential equation, and differential equations in the three coordinate systems.
