Week 3

Lecture 1
Read Chapter 3;
Solutions of one-dimensional Laplace and Poisson equations in Cartesian, cylindrical and spherical coordinates; applications of the three types of boundary conditions; three methods to find R: (i) full solution of governing equation with Dirichlet boundary conditions; (ii) integration of Fourier equation of conduction after separation of variables; (iii) physical approach; text discusses the first two methods.

Lecture 2
Thermal resistance, R, and shape factor, S, for long cylindrical shell and spherical shell; physical approach based on $dR = dr/(kA(r))$ and $R = \int dR$;
for cylindrical shell: $\boxed{R = \ln(r_2/r_1)/(2\pi Lk)}$; $\boxed{S = 2\pi L/\ln(r_2/r_1)}$;
for spherical shell: $\boxed{R = 1/(4\pi k)(1/r_1 - 1/r_2)}$; $\boxed{S = 4\pi/(1/r_1 - 1/r_2)}$;
special case: isolated sphere of radius r_1 in an infinite domain $r_2 \to \infty$ of conductivity k: $\boxed{R = 1/(4\pi k r_1)}$; $\boxed{S = 4\pi r_1}$;
see Table 3.3 for summary of one-dimensional solutions, in plane wall, cylindrical wall and spherical wall.

Lecture 3
ME 353 Web Site; example of how Maple can be used to derive governing equation, and obtain the resistance and shape factor for a plane wall; contact resistance: $R_c = 1/(h_c A)$; see Table 3.1 for typical values of $R''_{t,c}$; how to get h_c, contact conductance, from Table 3.1; $h_c = 1/R''_{t,c}\,[W/m^2K]$; thermal resistance R of composite systems; upper and lower bounds on resistance of composite wall; actual resistance of composite system lies between the bounds: $\boxed{R_{\rm LB} < R_{\rm actual} < R_{\rm UB}}$;
to estimate the resistance take some average of the lower and upper bounds;
arithmetic mean: $\boxed{R = (R_{\rm LB} + R_{\rm UB})/2}$;
geometric mean: $\boxed{R = (R_{\rm LB} R_{\rm UB})^{1/2}}$;

harmonic mean: $\boxed{R^{-1} = (R_{\mathrm{LB}}^{-1} + R_{\mathrm{UB}}^{-1})/2}$;
the geometric mean is recommended, specially when $R_{\mathrm{UB}} >> R_{\mathrm{LB}}$;
when the bounds are close, the arithmetic, geometric and harmonic means give similar, but different results.
