Assignment: 2

CONDUCTION

1. Write the general heat conduction equation in spherical coordinates. Using this equation, show that the resistance offered by a hollow sphere of radii r_1 and r_2 and constant thermal conductivity is given by

$$R_{spr} = \frac{r_1 - r_2}{4\pi k r_1 r_2}$$

2. Derive equation of heat transfer by conduction through composite wall.
3. Explain thermal contact resistance. How contact pressure effects thermal contact resistance.
4. For cylinder, prove that critical radius of insulation, $r_{critical} = k/h$, where k = thermal conductivity of insulation and h = convective heat transfer coefficient. Explain effect of thickness of insulation on heat transfer.
5. Derive equation of heat transfer by conduction through a multi-layer cylindrical wall.

TRANSIENT HEAT CONDUCTION

1. Explain lumped heat capacity method and state its assumptions.
2. Prove that the temperature distribution in a body at a time t during Newtonian heating or cooling is given by

$$\frac{T - T_\infty}{T_i - T_\infty} = e^{-B_i F_o}$$

3. Explain unsteady state heat transfer when Bi < 0.1

CONDUCTION THROUGH EXTENDED SURFACES

1. Derive the basic differential equation for an extended surface or fins using the principle of energy balance and hence drive the expression for steady state heat transferred by an infinitely long fin using relevant boundary conditions.
2. Derive equations of temperature distribution and heat dissipation for Fin insulated at tip.
3. Derive an equation for heat transfer from very thin and long enough fin so that the heat loss from the fin tip may be assumed negligible.
4. Derive equations of temperature distribution and heat dissipation for fin non-insulated at tip.
5. State and explain: (i) efficiency of fins (ii) effectiveness of fins