QUESTION BANK

CHAPTER 1: FUNDAMENTALS

1	Derive an expression for three dimensional time dependent heat conduction with internal heat generation and constant thermal conductivity in Cartesian coordinate system. Reduce it as i. Poisson equation ii. Fourier equation and iii. Laplace equation.
2	Derive general heat conduction equation in cylindrical coordinate system.
3	Write a short note on thermal conductivity. What is effect of temperature on it?
4	Differentiate three modes of heat transfer?

CHAPTER 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

CHAPTER 3: CONVECTION

1	Define the Newton's law of cooling under convection? Therefore, state what is local heat transfer coefficient and hence derive an equation for average heat transfer coefficient also state the factors affecting it.
2	Explain Reynold Colburn analogy for laminar flow over a flat plate.
3	Distinguish between natural and forced convection heat transfer. Also define velocity and thermal boundary layer thickness.
4	Using dimensional analysis, obtain a general form of equation for forced convective heat transfer.
5	For natural convective heat transfer, prove that $Nu = \emptyset\,(Pr)(Gr)$, where Nu is Nusset Number, Pr is Prandtl Number and Gr is Grashoff number.
6	What is physical significance of dimensionless parameters? Explain all numbers in brief.
7	Explain with neat sketch Boundary Layer concept and show velocity boundary layer growth due to flow over plate.

CHAPTER 4: RADIATION

1	Define the following terms: (i) Total emissivity, (ii) Grey body, (iii) Radiosity, (iv) Solid angle (v) Kirchhoff's law (vi) Lambert cosine law (vii) Monochromatic emissive power (viii) Emissivity
2	Define total emissive power (E_b) and intensity of radiation (I_b). Show that $E_b = \pi \times I_b$
3	State and explain Stefan Boltzmann law.
4	Define and explain Radiation Shield and Radiation Shape factor.
5	Define view factor and hence derive an expression for view factor between two parallel infinite grey plates.
6	Derive expression for Radiation Heat exchange between two concentric infinite long grey cylinders.
7	Derive the expression for radiant heat exchange between two non-black parallel surfaces.

CHAPTER 5: HEAT EXCHANGER

1	How are the heat exchangers classified? Sketch the temperature variations in (i) parallel flow heat exchanger (ii) counter flow heat exchangers (iii) Boiler (iv) Condenser
2	What are fouling factors? Explain their effect in heat exchanger design.
3	Derive an expression for log mean temperature difference of parallel and counter flow heat exchanger.
4	Derive the expression for effectiveness of parallel and counter flow heat exchanger.

CHAPTER 6: TWO PHASE HEAT TRANSFER

1	Explain the film boiling. Why is it avoided in practice?
2	Distinguish between (a) Sub cooled and saturated boiling (b) Nucleate and film boiling
3	Explain dropwise and film wise condensation
4	With the help of a neat sketch explain the various boiling regimes in the case of a pool boiling operation.
5	Discuss the various regimes in boiling and explain (i) the condition for the growth of bubbles and (ii) effect of bubble size on boiling
6	Explain nucleate boiling with mechanism of nucleate boiling.