GOVERNMENT OF GUJARAT

LUKHDHIRJI ENGINEERING COLLEGE, MORBI

Mechanical Engineering Department

Question Bank

Subject: Heat Transfer (3151909)

Q.1 Which are the different modes of heat transfer? Explain giving suitable examples and figure heat transfer by various modes.

Q.2 State and explain Fourier's law for heat transfer. Mention the assumptions on which it is based. Define thermal conductivity and give its unit.

Q.3 Explain how fins can increase the rate of heat transfer. Mention the most common types of fins and sketch them. Give some practical examples of fins.

Q.4 Derive the expression for the temperature distribution and heat dissipation from a fin insulated at the tip.

Q.5 What is Critical thickness? Why an insulated small diameter wire has a higher current carrying capacity than an uninsulated one?

Q.6 Explain the physical significance of critical thickness of insulation considering the example of small diameter wire and steam pipe.

Q.7 By dimensional analysis show that for forced convection heat transfer, Nusselt number can be expressed as a function of Prandtl number and Reynolds number.

Q.8 By dimensional analysis show that for free convection heat transfer, Nusselt number can be expressed as a function of Prandtl number and Grashof number.

Q.9 Discuss the various regimes of nucleate boiling and explain the conditions for the growth of bubble. What is the effect of bubble size on boiling?

Q.10 Explain the concept of hydrodynamic and thermal boundary layers. Superimpose hydrodynamic and thermal boundary layer profiles for $Pr < 1$, $Pr = 1$ and $Pr > 1$

Q.11 With a neat sketch and thermal circuit diagram explain the heat transfer through a hollow cylinder. Also derive the expression for rate of heat transfer through a hollow cylinder having radii r_1 & r_2 , temperatures t_1 & t_2 and constant thermal conductivity k.

Q.12 State and explain Ficks law of diffusion. Explain various symbols used in it. Show the similarity of this law to Fourier equation for conduction

Q.13 Derive an expression for the heat flow rate through a hollow sphere of inside radius r_1 and outside radius r_2, whose internal and external surfaces are maintained at temperatures t_1 and t_2 respectively. The thermal conductivity of the sphere material has a quadratic variation with temperature. $k = k_o (1 + \alpha t + \beta t^2)$.

Q.14 With usual notations derive the generalized equation for steady state heatconduction in 3 - dimensional Cartesian Coordinates. Simplify the same for one dimensional heat conduction, without internal heat generation through a plane slab.

Q.15 Explain the following terms: Efficiency of fin, Effectiveness of fin, Biot number

Q.16 Explain the following : Capacity ratio, Heat exchanger effectiveness, Number of transfer units.

Q.17 Distinguish between:

(i) Black body and white body

(ii) Absorptivity and emissivity of a surface

Q.18 Explain the following terms : Thermal conductivity, Thermal resistance, Thermal diffusivity.

Q.19 What are the different modes of heat transfer? State the law governing each of them and write the equation for rate of heat transfer.

Q.20 Explain the analogy between heat transfer by conduction and flow of electricity through ohmic resistance. Illustrate the concept by considering composite wall of building. Three layers of materials of thermal conductivities k1,k2, k3 and thickness δ1, δ2, δ3 are placed in good contact. Deduce from first principle an expression for the heat flow through the composite slab per unit surface area in terms of the overall temperature difference across the slab.

Q.21 Explain the following as applied to radiation heat transfer.
(i) Wien's displacement law
(ii) Lambert's cosine law
(iii) Shape factor

Q.22 Derive an expression for LMTD of a counter flow heat exchanger. Hence deduce its value when the heat capacities of both the fluids are equal.

Q.23 Explain dropwise condensation and film condensation

Q.24 A steam pipe 50 mm diameter and 2.5 m long has been placed horizontally and exposed to still air at 25^oC. If the pipe wall temperature is 295^oC, determine the rate of heat loss. The thermo physical properties of air at 160^oC are $k = 3.64 \times 10^{-2}$ W/m-deg , $\nu = 30.09 \times 10^{-6}\ m^2/s$, Pr = 0.682. Use co relation $Nu = 0.53\ (Gr\ Pr)^{1/4}$

Q.25 Radiant energy with an intensity of 800 W/m2 strikes a flat plate normally. The absorptivity is twice the transmissivity and thrice the reflectivity. Determine the rate of absorption, transmission and reflection of energy.

Q.26 Briefly explain the significance of following dimensionless numbers.
Reynolds number, Grashof number and Prandtl number.

Q.27 A kitchen oven has its maximum operating temperature set at 290^oC where as the atmospheric temperature is 30^oC. The thickness of insulation outside the oven is 10cm having thermal conductivity 0.035 W/ m deg. Calculate the heat transfer per unit area and outside temperature of the insulation. Take average heat transfer coefficient between the outside surface of insulation and atmosphere is 10 W/m^2 deg.

Q.28 A 3 mm thick metal plate, having thermal conductivity k = 98.6 W/m-deg is exposed to vapour at 100^oC on one side and cooling water at 30 ^oC on the opposite side. The heat transfer coefficients are : h_i= 14200 W/m^2-deg (on the vapour side) and h_o= 2325 W/m^2-deg (on the water side). Determine the rate of heat transfer, the overall heat transfer coefficient and the drop in temperature at each side of heat transfer.

Q.29 In a food processing plan, a brine solution is heated from -12^0C to - 65^0C in a double pipe parallel flow heat exchanger by water entering at 35^0C and leaving at 20.5^0C at the rate of 9 kg/minute. Determine the heat exchanger area for an overall heat transfer coefficient of 860 W/m^2K. for water c_p = 4186 J/ kg K.

Q.30 Derive the expression for net radiant heat exchange between two infinite parallel planes.

Q.31 Write a short note on compact heat exchangers.

Q.32 Derive Von-Karman integral momentum equation for hydrodynamic boundary layer over a flat plate. Solve this equation for cubical velocity profile and derive the expression for hydrodynamic boundary layer thickness.

Q.33 Explain diffusion mass transfer and convective mass transfer by giving two examples of each.

Q.34 A furnace emits radiation at 2000 K. Treating it as a black body, calculate the (i)

	monochromatic radiant flux density at 1 μ wavelength (ii) wavelength at which emission is maximum and the corresponding radiant flux density (iii) total emissive power.
Q.35	Derive the relationship between the effectiveness and the number of transfer units for a counter flow heat exchanger.
Q.36	What is gray body? Also explain Total emissive power and monochromatic emissive power.
Q.37	Explain Kirchhoff's law in detail.
Q.38	What is Plank's law? Explain it in detail and discuss that it is basic law of thermal radiation?
Q.39	What is Stefan-Boltzmann law? How is it derived from Plank's law of thermal radiation?
Q.40	What is thermal conductivity? How does it vary with the temperature vary in solid?