Exam.Code:0942
Sub. Code: 6733

2054
B.E. (Mechanical Engineering)
Sixth Semester
MEC-604: Heat Transfer

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Part.

x-x-x

1 a State the assumptions on which Fourier's law of conduction is based. 10
b Draw configurations of annular fin and straight rectangular fin.
c Differentiate between pool boiling and forced convection boiling.
d How are heat exchangers classified?
e State and explain Stefan-Boltzmann law.

PART-A

2 Derive an expression for one dimensional time dependent heat conduction with internal heat generation and constant thermal conductivity in cartesian coordinate system. Reduce it as: 10
(i) Poisson equation,
(ii) Fourier equation,
(iii) Laplace equation.

2 a A hollow sphere of inside radius 30 mm and outside radius 50 mm is electrically heated at its inner surface at a constant rate of $10^5 W/m^2$. The outer surface is exposed to a fluid at 30°C, with heat transfer coefficient of 170 $W/m^2.K$. The thermal conductivity of the material is 20 W/mK. Calculate inner and outer surface temperatures. 5

b Explain electrical analogy by considering Thermal resistance network for a hollow sphere subjected to convection heat transfer at inner and outer surfaces. 5

4 a If a thin and long fin, insulated at its tip is used, show that the heat transfer from the fin is given by 6

$$Q_{fin} = h\,P\,K\,A_c\,(T_0 - T_\infty)\tanh(mL)$$

Where symbols or variables in above equation are being used in their conventional or standard sense.

b Write down temperature distribution and heat loss equations for fins of uniform cross-section (not derivation) 4
a) insulated tip b) infinitely long fin

PART-B

5 a Using dimensional analysis, derive an expression for heat transfer coefficient in forced convection in terms of Nusselt number, Reynolds number and Prandtl numbers. 6

Contd.....P/2

b Regarding the relative growth of velocity and thermal boundary layers in a fluid, how, for laminar conditions, thickness of thermal boundary layer is related to hydrodynamic boundary layer. 4

6 a The temperature of a body of area 0.1 m^2 is 900 K. Calculate the total rate of energy emission, intensity of normal radiation in $W/(m^2sr)$, maximum monochromatic emissive power, and wavelength at which it occurs. 7

b What does the view factor represent? When is the view factor from a surface to itself not zero? 3

7 a Differentiate between film condensation and drop-wise condensation. In which case is the heat transfer higher? Why? 3

b In a certain double pipe heat exchanger hot water flows at a rate of 5000 kg/h and gets cooled from 95°C to 65°C. At the same time 50000 kg/h of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^2 K. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for the both the streams $C_p = 4.2$ kJ/kg K. 7

x-x-x