PVP 14

Code: ME5T3

III B.Tech - I Semester – Regular/Supplementary Examinations
October 2019

HEAT TRANSFER
(MECHANICAL ENGINEERING)

Duration: 3 hours Max. Marks: 70

PART – A

Answer ***all*** the questions. All questions carry equal marks

11x 2 = 22 M

1.

a) Write the Fourier rate equation for heat transfer by conduction. Give the physical significance of each term.
b) Define thermal conductivity and explain its significance on heat transfer.
c) What are the different types of boundary conditions?
d) What is the difference between efficiency and effectiveness of fin?
e) What is lumped system analysis? When it is applicable?
f) Give a general equation for the rate of heat transfer by convection and define the coefficient of heat transfer.
g) Sketch thermal and Hydro dynamic boundary layers when heat flows over a flat plate.
h) Differentiate between Film wise and Drop wise condensation.

i) Draw the temperature distribution in a concentric tube heat exchanger when operated under parallel and counter flow conditions.

j) Distinguish between Black body and Grey body.

k) Explain and state the reciprocity theorem.

PART – B

Answer any ***THREE*** questions. All questions carry equal marks. 3 x 16 = 48 M

2. Derive general heat conduction equation in cylindrical co-ordinate system. 16 M

3. a) Derive the general equation for the temperature distribution along a fin. State different boundary conditions and derive the equation for heat flow for an infinitely long fin. 10 M

b) Determine the time required to heat a steel plate of 24 mm thick from the initial temperature of 25^0 C to final temperature of 450^0 C by placing the plate into a furnace at 600^0 C. Take the following properties of steel k = 45.4 W/mC, C_p = 0.5 kJ/kg C, ρ = 7800 kg/m^3, h (heat transfer coefficient between the plate and surroundings in the furnace) = 23.03 W/m^2 C. 6 M

4. a) What do you understand by the hydrodynamic and thermal boundary layers? Illustrate with reference to flow over a flat heated plate. 8 M

b) A 5 cm diameter, 1.5 m long vertical tube at a uniform temperature of 100 ^{0}C is exposed to quiescent air at 20 ^{0} C. Calculate the rate of heat transfer from the surface to air. What would be the heat transfer rate if the tube were kept horizontally? 8 M

5. a) Briefly explain the Nusselt's condensation theory on vertical plate by drawing temperature and velocity profiles. State the assumptions made. 8 M

b) A counter flow tubular oil cooler is to be designed to cool 1500 kg/h of oil from 90^0 C to 30^0 C by means of water entering the cooler at 20^0 C and leaving at 50^0 C. Calculate the amount of water flow rate required and the transfer area. Take C_p of oil as 3 kJ/kgK and U = 1200 W/m^{2}K. 8 M

6. a) Prove that intensity of radiation is given by $I_b = \pi E_b$ 8 M

b) Derive an expression of shape factor for the radiation heat exchange between two surfaces. 8 M