PVP 14

Code: ME5T3

III B.Tech - I Semester – Regular/Supplementary Examinations
October 2018

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) State the Fourier's law of conduction.
   b) Write general 3D conduction heat equation in Cartesian coordinate system.
   c) Name any two types of boundary conditions in conduction heat transfer.
   d) Define the effectiveness of a fin.
   e) What is the physical significance of Fourier Number?
   f) Classify the convection system based on condition of flow.
   g) Define Nusselt Number?
   h) List out various types of boiling.
   i) For the same terminal temperatures, write in descending order of their LMTD's of paralle flow, counter flow and cross flow heat exchangers.
   j) What is the law of reciprocity in radiation heat transfer?
   k) What the radiation shield is meant for?

PART – B

Answer any ***THREE*** questions. All questions carry equal marks.

16 x 3 = 48 M

2. Derive general three dimensional conduction heat equation in cylindrical coordinate system with justified assumptions and write its derivatives for various special cases. 16 M

3. a) It is proposed to use a thin wall of spherical metallic container of diameter 0.5 m for storing a liquid Nitrogen at -196°C . The container has insulation of thickness 25 mm and thermal conductivity 0.0017 W/mK. The outer surface is exposed to ambient at 25°C and the convection heat transfer coefficient is 20 W/m^2K. The latent heat of liquid Nitrogen is 2×10^5 J/kg. Determine the rate of infiltration and rate of evaporation of Nitrogen by neglecting the resistance offered by container? 8 M

   b) A solid iron rod of thermal conductivity 60 W/mK and thermal diffusivity 2×10^{-5} m^2/s and of diameter 6 cm is initially at uniform temperature 800°C. It is suddenly dropped into a quenching oil bath maintained at 50°C offering a convection heat transfer coefficient 400 W/m^2K. Calculate the centerline temperature of rod after 10 minutes of its immersion also determine the cumulative heat transfer for the above time period? 8 M

4. a) Prove by dimensional analysis that the Nusselt number for a forced convection is a function of Reynolds and Prandtl number? 6 M

b) Determine the convection heat transfer coefficient for a flow of air at 10 m/s and 20°C across the cylinder of diameter 2.5 cm at a temperature of 80°C and also estimate the rate of convection heat transfer? 6 M

c) Explain the boundary layer formation for a plate hangs vertically in stand still ambient? 4 M

5. a) A copper kettle possessing a flat bottom of diameter 25 cm contains water at atmospheric pressure that is being heated electrically from its bottom. Calculate the rate of boiling of water if bottom surface of the kettle is maintained at a temperature of 110°C? 4 M

b) Derive the correlation of average condensation heat transfer coefficient by adopting Nusselt's theory for laminar film wise condensation over a flat vertical plate? 6 M

c) Design a single pass counter flow heat exchanger for heating a cold fluid enters at 30°C and having heat capacity 15000 W/K by making use of hot fluid that enters at 120°C and heat capacity 10000 W/K. The overall heat transfer coefficient is 400 W/m^{2}K and the surface area is 20 m^2. Calculate the effectiveness of heat exchanger?

6 M

6. a) Distinguish between (i) A black body and gray body (ii) Specular and diffuse surfaces (iii) Absorptivity and emissivity of a surface (iv) Monochromic and spectral emissive power 8 M

b) A pipe carrying steam having and outside diameter of 20 cm runs in a large room and is exposed to air at a temperature of 30°C. The pipe surface temperature is 400°C and emissivity is 0.8. Calculate the loss of heat to surroundings per meter length of pipe due to thermal radiation.

What would be the loss of heat due to radiation if the pipe is enclosed in a 40 cm diameter brick conduit of emissivity 0.91? 8 M