Hall Ticket No | | | | | | | | | | Question Paper Code: AME016

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER

B. Tech VI Semester End Examinations (Regular), Apr / May – 2019

Regulations: IARE-R16

HEAT TRANSFER

(MECHANICAL ENGINEERING)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit All Questions Carry Equal Marks All parts of the question must be answered in one place only

UNIT – I **Marks**

1. a) Derive an expression for general heat conduction equation in cylindrical co-ordinate system **[7M]**

   b) The door of a cold storage plant is made from two 6mm thick glass sheets separated by a uniform air-gap of 2mm. The temperature of the air inside the room is -20^{0}C and the ambient air temperature is 30^{0}C. Assuming the heat transfer coefficient between glass and air to be 23.26 W/m^{2}K. Determine the rate of heat leaking in to the room per unit area of the door. Neglect the convection effects in the air-gap. **[7M]**
   K_{glass} = 0.75WmK ; k_{air} = 0.02W/mK

2. a) Enumerates the basic laws which govern the heat transfer and explain in brief with suitable examples **[7M]**

   b) A plate 2 cm thick and 10 cm wide is used to heat a fluid at a 30°C. The heat generation rate inside the plate is 7×10^6 W/m^2. Determine the heat transfer coefficient to maintain the temperature of the plate below 180°C. Given k (plate) = 26 W/m °C. Neglect heat losses from the edge of the plate. **[7M]**

UNIT-II

3. a) What is critical thickness of insulation? Derive expression for critical thickness of insulation for a cylinder. **[7M]**

   b) A steel pipe line (k = 50W/mK) of inner diameter (I.D) is 100mm and outer diameter (O.D) is 110mm is to be covered with two layers of Insulation, each having a thickness of 50mm. The thermal conductivity of the first insulation material is 0.06 W/mK and that of the second is 0.12 W/mK. Calculate the loss of heat per metre length of pipe and the interface temperatures between the two layers of insulation when the temperature of the inside tube surface is 250 ^{0}C and that of the outside surface of the insulation is 50 ^{0}C. **[7M]**

4. a) Describe the temperature distribution along the length of a fin for various Boundary Conditions at tip. **[7M]**

b) A standard cast iron pipe (inner diameter = 50 mm and (outer diameter = 55 mm) is insulated with 85 percent magnesium insulation ($k = 0.02$ W/m^{0}C). Temperature at the interface between the pipe and insulation is 300^{0}C. The allowable heat loss through the pipe is 600 W/m length of pipe and for the safety, the temperature of the outside surface of insulation must not exceed 100^{0}C. Determine i) Minimum thickness of insulation and ii) the temperature inside surface of the pipe assuming its thermal conductivity as 20 W/m^{0}C. **[7M]**

UNIT-III

5. a) Using Buckingham π dimensional analysis, derive an expression for heat transfer coefficient for a free convection. The variables involved are h (heat transfer coefficient), ρ (fluid density), D (tube diameter), μ (fluid viscosity), c_p (specific heat), k (thermal conductivity), $\beta g\ \Delta t$ (β - coefficient of volume expansion of the fluid, Δt - difference of temperatures between the heated surface and the undisturbed fluid). **[7M]**

   b) Estimate the heat loss from a vertical wall exposed to nitrogen at one atmospheric pressure and 4 ^{0}C. The wall is 0.2 m high and 2.5 m wide, and is maintained at 56 ^{0}C. The average Nusselt number NuH over the height of the plate for natural convection is given by NuH = 0.13(Gr. Pr) 1/3. The properties for nitrogen at a mean film temperature of (56 + 4)/2 = 30^{0}C are given as ρ= 1.142 kg/m^3, k = 0.026 W/m K, v = 15.63 × 10-6 m^2 /s, Pr = 0.713. **[7M]**

6. a) Explain the natural convection heat transfer on a Vertical hot plate with the help of velocity and temperature profiles. **[7M]**

   b) Estimate the heat transfer coefficient for a laminar fully developed fluid (k=0.175W/mK) inside a 6mm inner diameter tube under uniform wall temperature boundary condition. Also compute heat transfer rate between the tube wall and the fluid for a length of 8m if the mean temp difference between the wall and the fluid is 50^{0}C. **[7M]**

UNIT-IV

7. a) What is boiling? Explain in detail about the different stages of boiling with neat sketch. **[7M]**

   b) Two parallel plates 0.5 by 1.0 m are spaced 0.5 m apart. One plate is maintained at 1000 ^{0}C and the other at 500 ^{0}C. The emissivities of the plates are 0.2 and 0.5, respectively. The plates are located in a very large room, the walls of which are maintained at 27 ^{0}C. The plates exchange heat with each other and with the room, but only the plate surfaces facing each other are to be considered in the analysis. Find the net transfer to each plate and to the room. **[7M]**

8 a) Derive the expression for average heat coefficient over a vertical plate for film wise condensation. **[7M]**

   b) A glass plate 30 cm square is used to view radiation from a furnace. The transmissivity of the glass is 0.5 from 0.2 to 3.5 µm. The emissivity may be assumed to be 0.3 up to 3.5 µm and 0.9 above that. The transmissivity of the glass is zero, except in the range from 0.2 to 3.5 µm. Assuming that the furnace is a blackbody at 2000 ^{0}C, calculate the energy absorbed in the glass and the energy transmitted. **[7M]**

UNIT-V

9. a) Derive an expression for LMTD in case of a counter flow double pipe heat exchanger. **[7M]**

b) A flow of 0.1kg/s of exhaust gases at 70^0K from a gas turbine is used to preheat the incoming air, which is at the ambient temperature of 30^0K. It is desired to cool the exhaust to 40^0K and it is estimated that an overall heat coefficient of $30W/m^2K$ can be achieved in an appropriate exchanger. Determine the area required for a counter flow heat exchanger. Take the specific heat of exhaust gasses the same as for air, Which is1000J/kg.K. **[7M]**

10. a) Classify different types of flows. And also derive NTU of parallel flow and counter flow heat exchangers. **[7M]**

b) 3000 kg/hr of furnace oil is to be heated from 10^0C in a shell and tube type heat exchanger. The oil is to flow inside the tubes while steam at 120^0C is flowing through the shell. If the tube size is 1.9cm outer diameter and 1.65cm Inner diameter determine the number of passes, number of tubes per pass and the length of each tube. **[7M]**