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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech VI Semester End Examinations (Regular) - May, 2019

Regulation: IARE – R16

HEAT TRANSFER

Time: 3 Hours **(ME)** **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

1. (a) Derive the general heat conduction equation in Cartesian coordinates. Simplify the obtained equation to Poisson's Equation, Fourier's Equation and Laplace Equation. **[7M]**

   (b) A furnace is to be designed for a maximum wall temperature of 500^0C. The hot gas temperature on one side of the wall is 1000^0C and the air temperature on the other side of the wall is 30^0C. The value of 'h' for hot side and cold side are 232.6 W/m^2 ^0C and 348.9 W/m^2 ^0C respectively. Calculate the permissible thermal resistance per m^2 area of the metal wall. **[7M]**

2. (a) Define Thermal Conductivity. Explain the effect of temperature on Thermal Conductivity for various substances. **[7M]**

   (b) A reactor's wall, 320mm thick, is made up of an inner layer of fibre brick (K=0.84 W/m ^0C) covered with a layer of insulation (K=0.16 W/m ^0C). The reactor operates at a temperature of 1325^0C and the ambient temperature is 25^0C.

   Determine the thickness of the fibre brick and insulation. Calculate the heat loss presuming that the insulation material has a maximum temperature of 1200^0C. **[7M]**

UNIT – II

3. (a) Distinguish the effect of adding insulation layer to the outer periphery of slab and cylinder on heat transfer? **[7M]**

   (b) It is proposed to evaluate the performance of a boiler assuming its heating surface to be in the form of a plane wall of thickness 1.2 cm and k = 50 W/mK. The wall is exposed to the flue gases at 1000^0C on one side offering a convection heat transfer coefficient 100 W/m^2K, while on the other side of the wall there is a boiling water at 200^0C with h = 5000 W/m^2K. The surface of the wall exposed to the flue gases is found to be covered with a suit layer of thickness 1 mm of k = 0.08 W/mK. On water side it is found to be 2mm thick scale of k = 0.8 W/mK is formed. Calculate the rate of heat flow. **[7M]**

4. (a) What are various performance parameters of a fin and write the physical significance of each? **[7M]**

(b) A solid iron rod of thermal conductivity 60 W/mK and thermal diffusivity 2×10^{-5} m^2/s of diameter 6 cm is initially at a uniform temperature 800^0C. It is suddenly dropped into a quenching oil bath that is at 50^0C and offering a convection heat transfer coefficient 400 W/m^2K. Calculate the center line temperature of the rod after ten minutes of time. Also, calculate the time taken by the center line temperature to reach 100^0C. **[7M]**

UNIT – III

5. (a) Show that in forced convection Nu = f(Re, Pr) by using Buckingham's Π - method. **[7M]**

   (b) The crank case of an IC engine measuring 80cm X 20 cm may be idealized as a flat plate. The engine runs at 90 km/hr and the crank case is cooled by the air flowing past it at the same speed. Calculate the heat loss from the crank surface maintained at 85^0C, to the ambient air at 15^0C. Due to road induced vibration, the boundary layer becomes turbulent from the leading edge itself. **[7M]**

6. (a) Water at 50^0C enters a 1.5cm diameter and 3m long tube with a velocity of 1m/s. The tube wall is maintained at a constant temperature 90^0C. Calculate the heat transfer coefficient and the total amount of heat transferred if the exit water temperature of 64^0C. **[7M]**

   (b) A vertical pipe of 20 cm outer diameter, at a surface temperature of 100^0C in a room where the air is at 20^0C. The pipe is 3m long. What is the rate of heat loss per meter length of the pipe? **[7M]**

UNIT – IV

7. (a) The rate of condensing heat transfer in drop wise condensation is more than that of film wise condensation, explain? Also describe how to achieve a drop wise condensation?. **[7M]**

   (b) A copper kettle possessing a flat bottom of diameter 25 cm contains water at atmospheric pressure that is being heated electrically from its bottom using an auxiliary source. The rate of boiling of water in the kettle is measured to be 2.5 kg/hr. Calculate the temperature of the bottom of the surface? **[7M]**

8. (a) State the following laws related to black body Radiation: **[7M]**
   (i) Lambert's Cosine law (ii) Planck's law (iii) Wien's Displacement law

   (b) Estimate the power required to boil water in a copper pan, 0.35m in diameter. The pan is maintained at 120^0C by an electric heater. What is the evaporation rate? Estimate the critical heat flux? **[7M]**

UNIT – V

9. (a) Classify various types of heat exchangers. **[7M]**

   (b) In an oil cooler, oil enters at 160^0C. If the water entering at 35^0C flows parallel to oil, the exit temperatures of oil and water are 90^0C and 70^0C respectively. Determine the exit temperatures of oil and water if the two fluids in opposite directions. Assuming that the flow rates of the two fluids and U_0 remain unaltered. What would be the minimum temperatures to which oil could be cooled in parallel flow and counter flow operations? **[7M]**

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

    (b) Water enters a counter flow, double pipe heat exchanger at 15^0C, flowing at the rate of 1300 kg/hr. It is heated by oil (C_p = 2000 J/kg-K) flowing at the rate of 550 kg/hr from the inlet temperature of 94^0C. For an area of $1m^2$ and an overall HT coefficient of 1075 W/m^2 K, determine the total heat transfer and the outlet temperatures of water and oil. **[7M]**

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