Code No: R1632034 **R16** SET - 1

**III B. Tech II Semester Supplementary Examinations, April - 2021**

# HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**
4. Heat transfer data book allowed

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## PART –A (14 Marks)

1. a) In the case of insulating an electrical wire, should the outer radius of insulation be more or less than the critical radius and why? [3M]
   b) Write the expression for Fourier number and explain its physical significance. [2M]
   c) Write the continuity equation and explain its significance. [2M]
   d) What do you understand by entrance length for the flow through a tube? [2M]
   e) Write the differences between nucleate and film boiling. [3M]
   f) Explain black and grey surfaces. [2M]

## PART –B (56 Marks)

2. a) A plane wall of thickness L and maintained at temperatures $T_1$ and $T_2$ on both of its face is generating heat internally according to the equation $\dot{q} = q_0 e^{-ax}$. Where $q_0$ and $a$ are constants. Derive the expression for temperature distribution in the plate. [7M]
   b) A certain material 200 mm thick, with a cross-sectional area of 0.1 $m^2$, has one side maintained at $35^0$C and the other at $95^0$C. The temperature at the centre plane of the material is $62^0$C, and the heat flow through the material is 10 kW. Obtain an expression for the thermal conductivity of the material as a linear function of temperature. [7M]

3. a) Derive the expression for temperature distribution and heat transfer for a uniform cross-sectional area fin with its end insulated. [7M]
   b) A masonry brick wall (k=0.60 W/mK and $\alpha=5x10^{-7}$ $m^2/s$) of 150 mm thickness and originally at $30^0$C is suddenly exposed on one side to hot gases at $780^0$C. The other side of the wall is already insulated. The convection heat transfer coefficient on the hot gas side is 20 $W/m^2K$. Determine, by making use of Heisler charts, [7M]
   i) the time required for the insulated surface to attain a temperature of $480^0$C and
   ii) the heat transferred to the wall per unit area during that time.

4. a) What do you understand by Nusselt number and Rayleigh number? Discuss their significance. [6M]
   b) Explain the procedure to form dimensionless groups by Buckingham π-theorem. [8M]

5. a) Discuss the criteria in natural convection to decide whether it is laminar or turbulent? [6M]
   b) Air at one atmospheric pressure and $75^0$C enters a tube of 4 mm internal diameter with an average velocity of 2 m/s. The tube length is 1 m and a constant heat flux is imposed by the tube surface on the air over the entire length. An exit bulk mean temperature of air of $125^0$C is required. Determine: (i) the heat transfer coefficient at exit $h_L$, (ii) the constant surface heat flux $q_W$, and (iii) the exit tube surface temperature. [8M]



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6. a) Discuss the differences between drop-wise and film condensation. Which of the two is the more effective way of condensation and why? [7M]
   b) A double-pipe counter flow heat exchanger is to cool ethylene glycol [$c_p$=2.56 kJ/kg K] flowing at the rate of 2 kg/s from $80^0$C to $40^0$C by water [$c_p$=4.18 kJ/kg K] that enters at $20^0$C and leaves at $60^0$C. The overall heat transfer coefficient based on the inner surface area of the tube is 250 W/m$^2$K. Determine: [7M]
   i) the rate of heat transfer,
   ii) the mass flow rate of water, and
   iii) the heat transfer surface area on the inner side of the tube.

7. a) State and explain Lambert`s cosine law and its significance. [6M]
   b) State the important properties of view factor. Determine the view factors from the base of a cube to each of the other five surfaces. [8M]

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