Code No: **R32033** **R10** **Set No. 1**

III B.Tech II Semester Supplementary Examinations, November - 2018
HEAT TRANSFER
(Mechanical Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks
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1 a) Discuss the basic laws of heat transfer. [8M]

b) Derive the generalized Fourier conduction equation in cylindrical coordinates. [7M]

2 a) Derive the expression for heat dissipation in a straight fin of rectangular profile when the fin is insulated at the tip. [7M]

b) A small electric heating application uses wire of 2 mm diameter with 0.8 mm thickness insulation (K = 0.12 W/m^{0}C). The heat transfer coefficient (h_0) on the insulated surface is 35 W/m^{20}C. Determine the critical thickness of insulation in this case and the percentage change in the heat transfer rate if the critical thickness is used, assuming the temperature difference between the surface of the wire and the surrounding air remains unchanged. [8M]

3 a) What are Fourier and Biot numbers? Discuss the physical significance of these numbers. [7M]

b) A 6 mm thick stainless steel plate (density (ρ) = 7820 kg/m^3, conductivity (K) = 17.3 W/m^{0}C, specific heat (C_P) = 460.8 J/kg^{0}C) is used to form the nose section of missile. It is held initially at a uniform temperature of 30^{0}C. When the missile enters the denser layers of the atmosphere at a very high velocity the effective temperature of air surrounding the nose region attains the value 2150^{0}C. The surface convective coefficient is estimated as 3395 W/m^2 ^{0}C. If the maximum temperature is not to exceed 1100^{0}C, determine i) Maximum permissible time in these surroundings, ii) Inside surface temperature under these conditions. [8M]

4 a) Describe Buckingham's Π theorem to formulate a dimensionally homogeneous equation between various physical quantities effecting certain phenomenon. [7M]

b) What is dimensional analysis? Discuss its advantages and limitations. [8M]

5 a) Derive the momentum equation for hydrodynamic boundary layer over a flat plate. [7M]

b) Find the convective heat loss from a radiator 0.6 m wide and 1.2 m high maintained at a temperature of 90^{0}C in a room at 14^{0}C. Consider the radiator as a vertical plate. [8M]

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6 a) Explain the physical mechanism of boiling and condensation. [7M]

b) Saturated steam at atmospheric pressure condenses on a vertical plate size 30 cm x 30 cm maintained at 80°C. Determine heat transfer rate and mass of steam condensed per hour and what is the value of condensation rate. [8M]

7 a) Derive an expression for LMTD for counter flow heat exchanger [7M]

b) A counter flow heat exchanger is to heat air entering at 400^0C with a flow rate of 6 kg/s by the exhaust gas entering at 800^0C with a flow rate of 4 kg/s. The overall heat transfer coefficient is 100 W/m^2 K and the outlet temperature of air is 551.5^0C. Specific heat at constant pressure for both air and exhaust gas can be taken as 1100 j/kg K. Calculate: i) Heat transfer area needed, ii) The number of transfer units. [8M]

8 a) Explain electrical network analogy for thermal radiation systems. [7M]

b) A small sphere with a surface temperature of 550K is located at geometric centre of a large sphere with an inner surface temperature of 280K. The outside diameter of a small sphere is 5cm and the inside diameter of a large sphere is 25cm. Assuming that both sides approach black body behavior, determine how much of the emission from the inner surface of the large sphere is incident upon the outer surface of the small sphere [8M]

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