SQ-84

Seat No.	

Total No. of Pages : 03

T.Y.B.Tech. (Part-III) (Semester-V) (CBCS)

Examination, May, 2025

MECHANICAL

HEAT AND MASS TRANSFER

Subject Code : 80755/66243/81009

Day and Date : Wednesday, 07/05/2025 **Total Marks : 70**

Time : 2.30 p.m. to 5.00 p.m.

Instructions : 1) All questions are compulsory.

2) Figures to the right indicate full marks.

3) Assume suitable data if necessary and state clearly.

4) Use of calculator is permited.

Q.1) Solve any two : **[12]**

a) State and explain Fourier's law for heat transfer. Mention the assumptions on which it is based. Define thermal conductivity.

b) Derive differential equation of conduction in Cartesian coordinate system.

c) The inner surface of furnace wall is at 200°C and outer surface at 50°C. Calculate the heat lost per m^2 area of the wall if thermal conductivity of the brick is 0.5 W/m°C and the wall thickness is 200 mm.

Q.2) Solve any two : **[12]**

a) Derive expression for temperature variation for solid body with respect to time by using lumped head Capacity approach.

b) Derive expression for temperature distribution of Solid cylinder generating heat at the rate of q unit per unit volume.

[P.T.O.]

c) A plate 2 cm thick and 2 cm wide is used to heat a fluid at 30°C. The heat generation rate inside the plate is 7×10^6 W/m^3. Determine heat transfer coefficient to maintain the temperature of plate below 180°C. Take K for plate 26W/mK. Neglect heat losses from the edge of plate.

Q.3) Solve any two : **[12]**

a) Why fins are used? State some applications of fins.

b) Derive expression for heat dissipation from infinitely long fin.

c) A one m long 5 cm diameter cylinder placed in an atmosphere of 40°C is provided with 12 fins (K=75 W/mK), 0.75 mm thick. They extend 2.5 cm from the cylinder surface. The heat transfer coefficient is 23.3 W/m^{2}K. Calculate the rate of heat transfer if the surface temperature of cylinder is 150°C.

Q.4) Solve any two : **[12]**

a) Give the physical significance of Reynolds number and Nussselt number.

b) Explain Newton's law of cooling and find unit for coefficient of convective heat transfer.

c) Air at 20°C and 1.013 bar flows over flat plate at 40 m/s. The plate is 1 m long and maintained at 60°C. Assuming unit depth, calculate the heat transfer from plate. Use the correlation $Nu_1 = Pr^{0.33}$ $(0.037\ Re_1^{0.8} - 850)$. Properties of air at 40°C are, ρ=1.128 kg/m^3. Cp=1.005 kJ/KgK, Kinematic viscosity v=16.96 $\times$ 10^{-6} m^2/s, Pr=0.699 and K=0.0275 W/mK.

Q.5) Solve any two : **[12]**

a) Define radiation State the range of wavelengths for ultraviolet, visible and thermal radiation.

b) Explain the following terms, black body and grey body.

c) The effective temperature of a body having an area of 0.12 m^2 is 527°C. Calculate the intensity of normal radiation.

Q.6) Solve any two : **[10]**

a) 45 kg/hr of water is to be heated from 10°C to 70°C with flue gases having an initial temperature at 160°C. The mass flow rate of flue gases is 170 kg/hr. The specific heat of flue gases is 1.05 kJ/kgK. The overall heat transfer coefficient may be taken as 114 W/m^2K. Calculate heat transfer area required for counter flow type heat exchanger. Assume specific heat of water as 4.18 kJ/kg.K.

b) What do you mean by fouling factor? What are the causes of fouling?

c) Explain pool boiling curve.