Reg. No. : ……..
Name : ……..

M-Tech Degree Examination

First Semester

Model question paper I
Branch: Mechanical Engineering
Specialization: Thermal Power Engineering

MMETP 103 - Advanced Heat and Mass Transfer

Answer *All Questions*

(Use of heat and mass transfer table is permitted)

Time: 3 hrs **Max. Marks: 100**

1. Three sides of a thin rectangular plate are maintained at a constant temperature T_1, while the fourth side is maintained at a constant temperature of T_2 which is different form T_1. Derive a general equation for temperature distribution along the plate. **25 Marks**

OR

2. An iron plate (k= 60 W/mK), C= 0.46 kJ/kgK, ρ=7850 kg/m^3 and α=1.6 x 10^{-5} m^2/s) of 50 mm thickness is initially at 225^{0}C. Suddenly, both surfaces are exposed to an ambient temperature of 25^{0}C with a a heat transfer coefficient of 500 W/m^{2}K. Calculate a). The centre temperature at 2 min. after start of cooling b). The temperature at a depth of 1 cm from the surface at two minute after the start of cooling and c). The energy removed from the plate per sq.m. during this time. **25 Marks**

3. Derive a correlation between Colburn's j-factor and the local friction coefficient for flow over a flat plate for a Prandtl number equal to unity. **25 Marks**

OR

4. Air at 20^{0}C and a pressure of 1bar is moving over a flat plate at a velocity of 3 m/s. If the plate is 280mm wide and at 56^{0}C, estimate the following quantities at x=280mm when the bulk mean temperature of air is 38^{0}C; a). Boundary layer thickness, b). Local friction coefficient, c). Shear stress due to friction, d). Thickness of thermal boundary layer,

e).Local convective heat transfer coefficient, f). Rate of heart transfer by convection and g). Total mass flow through the boundary. **25 Marks**

5. A diffuse circular disc of diameter D and area A_j is kept parallel to a plane diffuse surface of area A_i $<<A_j$. Ai is located at a distance of L from the centre of A_j. Obtain an expression for the view factor F_{ij} **25 Marks**

OR

6. A spherical vessel of diameter 0.4 m encloses a gas mixture at a total pressure of P=2 atm. The gas mixture contains nitrogen at a partial pressure of 1 atm., water vapor at a partial pressure of 0.4 atm., and carbon dioxide at a partial pressure of 0.6 atm. The gas is at a temperature of 800K, while the sphere surface is at 400K. The sphere is gray with an emissivity of ε=0.5. Determine the radiant heat transfer to the shell. **25 Marks**

7. Based on Nusselt's assumptions, derive a correlation for the velocity profile of the condensate across its thickness, for film condensation process of pure vapors on a vertical plate. **25 Marks**

OR

8. Helium gas is stored at 20^0C in a spherical container of fused silica (S_iO_2) which has a diameter of 0.20m and a wall thickness of 2mm. If the container is charged to an initial pressure of 4 bars, what is the rate at which this pressure decreases with time?. Properties of helium fused silica at 293K are, a). Mass diffusion coefficient = 0.4×10^{-13} m^2/s and b). Solubility S= 0.45×10^{-3} $kmol/m^3$ bar. ` **25 Marks**