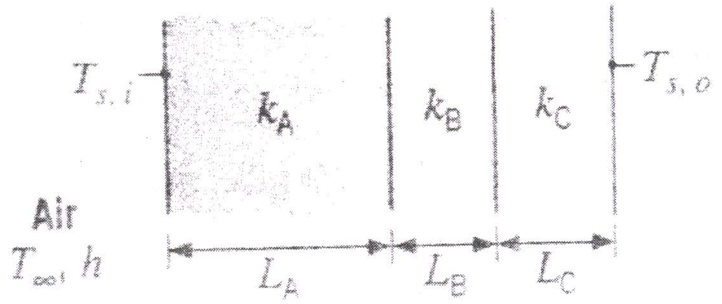
COLLEGE OF ENGIEERING PUNE
End Semester Exam
MT301: Transport Phenomena

Class: T.Y.B.Tech. (Met.Engg) **Time: 3 hours**
Year 2013-2014 **Marks: 60**
Instructions:

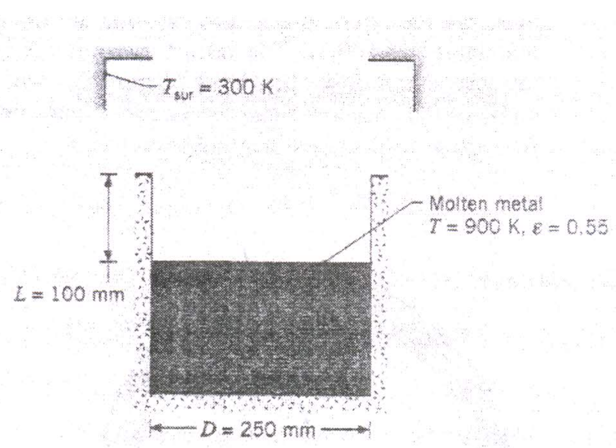
a) Solve Any **Six** out of **Seven** questions
b) Assume suitable data if necessary, draw neat figures.
c) Use of calculators is allowed.

Q1	The composite wall of an oven consist of three materials, two of which are of known thermal conductivity, K_A = 20 W/m.K, and K_C = 50 W/m.K, and known thickness, L_A = 0.30 m, and L_C = 0.15 m. The third material B which is sandwiched between materials A and C, is of known thickness, L_B = 0.15 m, but unknown thermal conductivity K_B. Under steady state operating conditions, measurement reveals outer surface temperature of Ts,o = 20°C, an inner surface temperature of Ts,i = 600°C and an oven air temperature of T_∞ = 800°C. The inside convection coefficient h is known to be 25 W/m^2.K. What is the value of K_B ?. Draw thermal circuit. 	10
Q2	Steel is sequentially heated and cooled (annealed) to relive stresses and to make it less brittle. Consider a 100 mm thick plate (k= 45 W/m.K, ρ= 7800 kg/m^3, Cp = 500 J/kg.K) that is initially at a uniform temperature of 300 °C and is heated (on both sides) in a gas fired furnace for which T_∞ = 700 °C and h = 500 W/m^2.K. How long will it take for a minimum temperature of 550 °C at centre and also at 60% of thickness to be reached in the plate?	10
Q3	An Aluminium alloy (2024) plate, heated to a uniform temperature of 227°C, is allowed to cool while vertically suspended in a room where the ambient air and surroundings are at 27°C. The plate is 0.3 m square with a thickness of 15 mm and an emissivity of 0.25. **Data:** Aluminum alloy 2024 (T = 500 K): ⟩ = 2770 kg/m3, k = 186 W/m. K, c = 983 J/kg.K; Air (T_f = 400 K, 1 atm): ν = 26.41.10^{-6} m^2 /s, k = 0.0388 W/m.K, α = 38.3. 10^{-6} m^2/s, Pr = 0.690.	10

$$\overline{Nu_L} = \left\{0.68 + \frac{0.670\ \mathrm{Ra_L}^{1/4}}{\left[1 + \left(\frac{0.492}{\mathrm{Pr}}\right)^{9/16}\right]^{4/9}}\right\}$$

a. Develop an expression for the time rate of change of the plate temperature, assuming the temperature to be uniform at any time.
b. Justify the uniform plate temperature assumption.

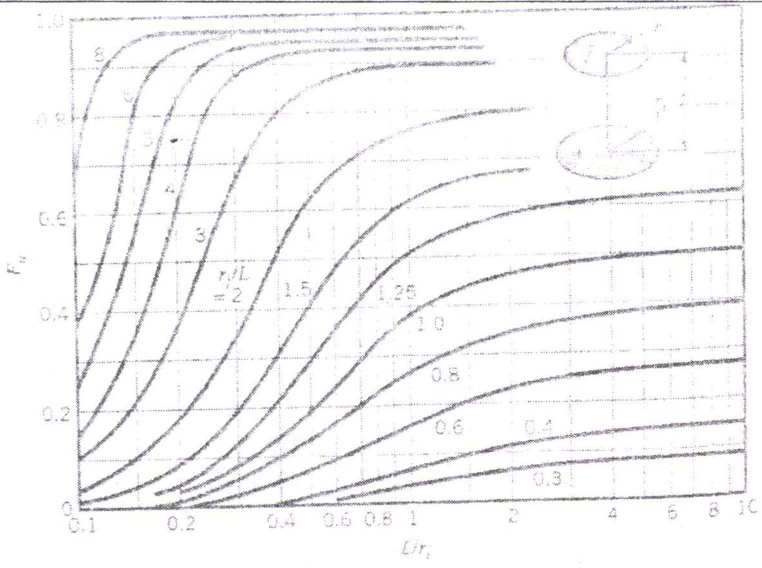
Q4	Hydrogen gas is maintained at 3 bars and 1 bar on opposite sides of a plastic membrane, which is 0.3 mm thick. The temperature is 25°C, and the binary diffusion coefficient of hydrogen in the plate is 8.7×10^{-8} m^2/s. The solubility of hydrogen in the membrane is 1.5×10^{-3} $kmol/m^3.bar$. What is the mass diffusive flux of hydrogen through the membrane?	10
Q5	A molten aluminium alloy at 900 K is poured into a cylindrical container that is well insulated from large surroundings at 300K. The inner diameter of the surface of the container is 250 mm and the distance from the surface of the melt to the top of the container is 100 mm. If the oxidised aluminium at the surface of the melt has an emissivity of 0.55, what is the net rate of radiation heat transfer from the melt? Alsp draw thermal circuit.	10



Q6	A bubble of diameter d is rising upward with terminal velocity V_t through the liquid metal of height H having Reynolds number greater than 2.. Develop an equation to calculate the residence time of the bubble. Use suitable symbols / terminology to describe the phenomenon	10

$$V_t = 1.09\left(\frac{g.d}{2}\right)^{1/2}$$

where, g is acceleration due to gravity.

Q7	Water at 300K is flowing through a brass tube that is 30 m long and 13 mm in diameter (inner). The water is moving through the tube at a rate of 3.2×10^{-3} m^3/s. The density of water is 1000 kg/m^3 and its viscosity is 8.55×10^{-4} $N.s/m^2$. Determine- a) Using momentum balance, derive equation for flow rate. b) Draw velocity and shear stress profile from the resultant equations c) Calculate pressure drop in Pa that accompanies this flow.	10
Data Sheet	 FIGURE 13.5 View factor for coaxial parallel disks.	

Data Sheet

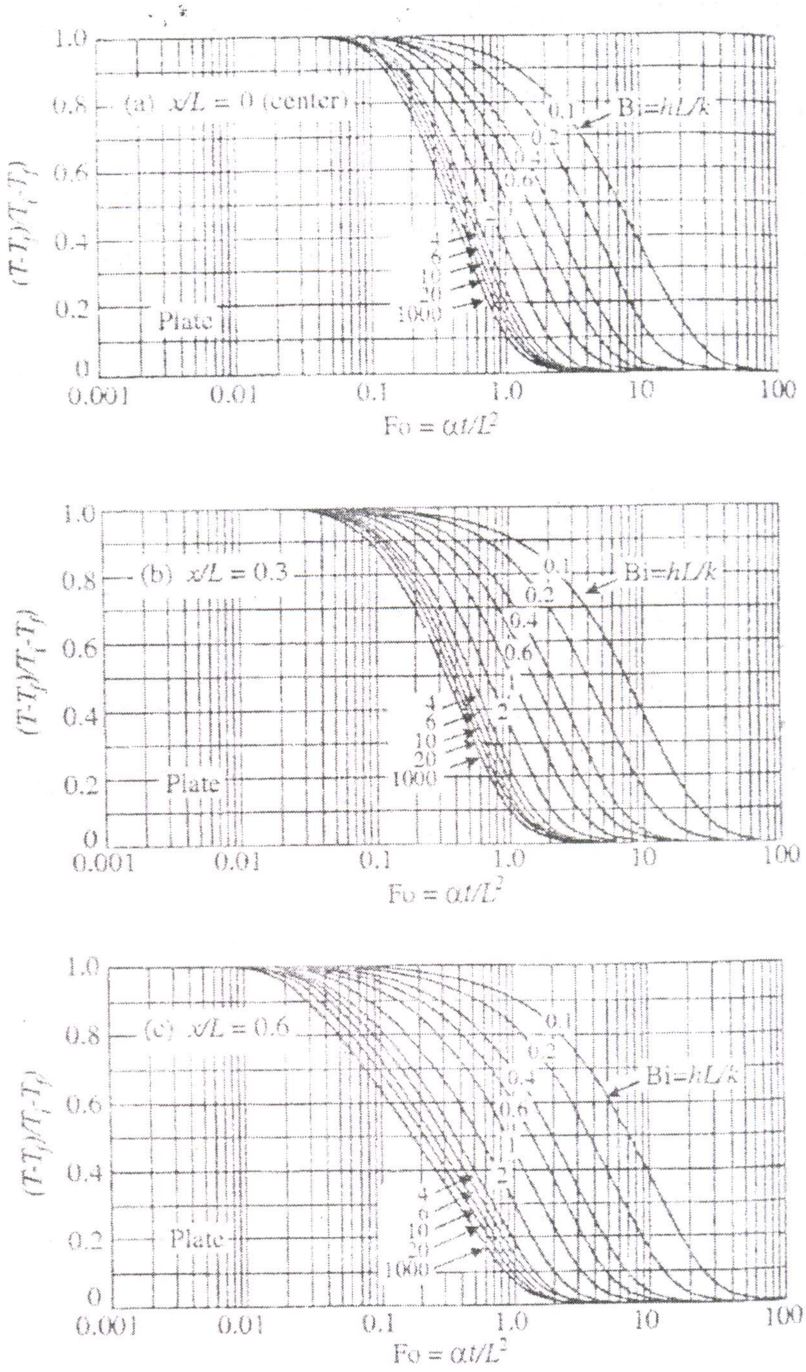


Fig. 9.8 Temperature response of an infinite plate initially at a uniform temperature T_i, and then subjected to a convective environment at T_f.

.................The End.......................