Total No. of Questions : 8]

SEAT No. :

PE2633

[Total No. of Pages : 3

[6583]-165
T.E. (Mechanical/Mechanical - S.W.)
HEAT AND MASS TRANSFER
(2019 Pattern) (Semester - V) (302042)

Time : 2½ Hours] *[Max. Marks : 70*

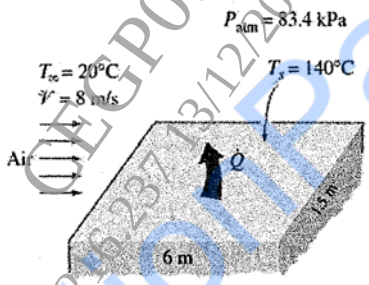
Instructions to the candidates:

1) ***Answer Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data wherever necessary.***

Q1) a) The local atmospheric pressure in Denver, Colorado (elevation 1610 m), is 83.4 kPa. Air at this pressure and 20°C flows with a velocity of 8 m/s over a 1.5 m 6 m flat plate whose temperature is 140°C (Figure). Determine the rate of heat transfer from the plate if the air flows parallel to the **[9]**

i) 6-*m*-long side and

ii) the 1.5-*m* side.



Properties : k = 0.02953 W/m ºC Pr = 0.7154 υ @ 83.4kPa = 2.548×10^{-5} m²/s
Use the correlation for Turbulent Flow Nu = $(0.037\ Re_L^{0.8} - 871)Pr^{1/3}$.

b) When 0.5 kg of water per minute is passed through a tube of 20 mm diameter, it is found to be heated from 20°C to 50°C. The heating is accomplished by condensing steam on the surface of the tube and subsequently the surface temperature of the tube is maintained at 85°C. Determine the length of the tube required for fully developed flow.
Take the thermo-physical properties of water at 60°C as: ρ = 983.2 kg/m², C_p = 4.178 kJ/kgK, *k* = 0.659 W/m°C, *v* = 0.478×10^{-6} m²/s For Laminar and fully development flow N*u* =3.65 **[9]**

OR

P.T.O.

Q2) a) Explain pool boiling and Regimes of pool boiling. **[8]**

b) Differentiate between Thermal Boundary layer and Hydrodynamic boundary layer. **[6]**

c) Explain significance of Grashoff number and Nusselt number. **[4]**

Q3) a) What do you understand by surface resistance and space resistance? **[7]**

b) Explain the following **[10]**

i) Stefan's Boltzmann's law

ii) Wiens Displacement law

iii) Kirchoff's law

iv) Plank's law

OR

Q4) a) A sphere of radius 5cm is concentric with another sphere. Find the radius of the outer sphere so that the shape factor of outer sphere with respect to the inner sphere is 0.6. Let shape factor of inner with respect to the outer sphere is 1. **[8]**

b) Determine the radiant heat exchange in W/m^2 between two large plates of emissivities 0.8 and 0.3 held at temperatures of 1000 K and 500 K respectively, if a thin copper plate of emissivity 0.1 is introduced as a radiation shield between the two plates. Use $\sigma = 5.67 \times 10^{-3}$ W/m^2K^4. **[9]**

Q5) a) A steel rectangular container having walls 16mm thick is utilized to store hydrogen gas at elevated pressure. The molar concentrations of hydrogen in the steel at the inside and outside surfaces are 1.2kg mole/m^3 and zero respectively. Assuming the diffusion coefficient for hydrogen in steel as $0.248 \times 10^{-12} m^2/s$, Calculate the molar diffusion flux for hydrogen through the steel. **[9]**

b) Define: **[8]**

i) Mass Diffusion velocity

ii) Molar Diffusion velocity

iii) Mass Diffusion Flux

iv) Molar Diffusion Flux

OR

Q6) a) State and explain Fick's law for mass diffusion. **[8]**

b) Pipe carrying ammonia at 1 bar and 40°C is vented into a large tank containing dry air at 1 bar and 40°C to avoid pressure build up. The pipe is 5 mm in diameter and 5 m long. Determine the rate of diffusion of air into the ammonia stream. Take $D = 0.28 \times 10^{-4}$ m^2/s as diffusion coefficient or mass diffusivity. **[9]**

Q7) a) Derive an expression for LMTD of a Parallel flow heat exchanger. **[8]**

b) Define following terms. **[10]**

i) Fouling factor

ii) Capacity ratio

iii) Effectiveness

iv) NTU

v) Over all heat transfer coefficient

OR

Q8) a) Derive an expression for effectiveness of a parallel-flow heat exchanger in terms of NTU and capacity ratio. **[8]**

b) In a counter flow double pipe heat exchanger, water is heated from 25°C to 65°C by an oil with specific heat of 1.45 kJ/kg K and mass flow rate of 0.9 kg/s. The oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 $W/m^{2o}C$, calculate the following **[10]**

i) The rate of heat transfer

ii) The mass flow rate of water and

iii) The surface area of the heat exchanger.