Total No. of Questions : 8]

SEAT No. :

P998

[Total No. of Pages : 3

[5870]-1021

T.E. (Mechanical/Mechanical Sandwich)

HEAT AND MASS TRANSFER

(2019 Pattern) (Semester - I) (302042)

Time : 2½ Hours] ***[Max. Marks : 70***

Instructions to the candidates:

1) *Solve 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 side indicate full marks.*
4) *Use of Calculator is allowed.*
5) *Assume Suitable data if necessary.*

Q1) a) A vertical plate is maintained at 40ºC in 20ºC still air. Determine the height at which the boundary layer will turn turbulent if turbulence sets in at A Gr. Pr = 10^9. Repeat the problem for water flow at film temperature of 30ºC. Comment on the results of solution. **[9]**

b) Explain in brief (Any two) **[8]**

i) Local and average Heat Transfer coefficient

ii) Hydrodynamic and Thermalboundary layer

iii) Critical Heat Flux

iv) Significance of any 2 non dimensionless numbers

OR

Q2) a) Explain the types of boiling and pool boiling phenomenon in detail with neat sketch of boiling curve. **[8]**

b) Air at atmospheric pressure and 40ºC flows with velocity of U = 5 m/sec over a 2 m long flat plate whose surface is kept at a uniform temperature of 120ºC. Determine the average heat transfer coefficient over 2 m length of plate. Also determine the rate of heat transfer between the plate and air per 1 m width of plate (Air at 1 atm. And 80ºC, $v = 2.107 \times 10^5$ m^2/sec, k = 0.03025 W/mk, Pr = 0.695). **[9]**

Q3) a) The energy received from the sun at the earth's atmosphere has been measured as 1353 W/m^2. The diameter of the earth = 1.29×10^7m. Diameter of the sun = 1.39×10^9 m. Mean distance = 1.5×10^{11}m. Estimate the emissive power of the sun and the surface temperature assuming it to be black. Assuming that the source of energy for the earth is from the sun and earth to be black, estimate the temperature of the earth. **[8]**

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b) Explain in brief **[10]**

i) Kirchoffs Law

ii) Stefan Boltzmans law

iii) Wiens Displacement law

iv) Shape Factor

v) Electrical analogy for radiation

OR

Q4) a) Two large parallel plates with $\varepsilon = 0.5$ each are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates; find the percentage reduction in net radiative heat transfer. **[10]**

b) Define shape factor algebra and explain any 4 salient features of shape factor. **[8]**

Q5) a) Explain Fick's law for mass diffusion. **[8]**

b) The molecular weights of the two components A and B of a gas mixture are 24 and 28 respectively. The molecular weight of gas mixture is found to be 30. If the mass concentration of the mixture is 1.2 kgm^3, determine the following **[9]**

i) Molar fractions

ii) Mass fractions

iii) Total pressure if temperature of mixture is 290K

OR

Q6) a) Explain in brief convective mass transfer and Explain the term conservation of species. **[8]**

b) Hydrogen gas is maintained at pressure of 2.4 bars and 1 bar on opposite sides of a plastic membrane 0.3 mm thick. The binary diffusion coefficient for hydrogen in the plastic is 8.6x 10-8 m^2/s and solubility of hydrogen in the membrane is 0.00145 kg mole/m^3-bar. (molecular weight of hydrogen - 2kg/kg mole)

Calculate under uniform conditions of 24°C, the following: **[9]**

i) Molar concentration of hydrogen at opposite face of membrane

ii) Molar and mass diffusion of hydrogen through membrane

Q7) a) Derive LMTD for parallel flow heat exchanger. **[8]**

b) In a double pipe heat exchanger hot water flows at the rate of 5000kg/h and gets cooled from 95ºC to 65ºC. At the same time 50000kg/h of cooling water at 30ºC enters heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^2K. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for both the streams C_p = 4.2 kJ/kgK. **[10]**

OR

Q8) a) Derive LMTD for Counter flow heat exchanger. **[8]**

b) A counter flow double pipe heat exchanger uses superheated steam to heat water at the rate of 10500kg/h. The steam enters the heat exchanger at 180ºC and leaves at 130ºC. The inlet and exit temperatures of water are 30ºC and 80ºC, If the overall heat transfer coefficient from steam to water is 814 W/m^{20}C. Calculate the heat transfer area. What would be the increase in area if the fluid passes are in parallel? **[10]**

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