Total No. of Questions : 8]

SEAT No. : ____

P7657

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T.E. (Mechanical)/(Mechanical Sandwich Engg.)

HEAT AND MASS TRANSFER

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

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

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.***
2) ***Draw neat diagram wherever necessary.***
3) ***Use of scientific calculator is allowed.***
4) ***Assume Suitable data if necessary.***
5) ***Figures to the right indicate full marks.***

Q1) a) Water is flowing at the rate of 50 kg/min through a tube of inner diameter 2.5cm. The inner surface of tube is maintained at 100ºC. If the temperature of water increases from 25ºC to 55ºC, find length of tube required.

Nu = 0.023 $Re^{0.8}$ $Pr^{0.4}$, Properties of water : ρ = 977.8 kg/m^3, K=0.6672 W/mºC, μ = 405 × 10^{-6} Ns/m^2, Cp=4.187kJ/kg ºC. **[10]**

b) Explain **[8]**

i) Reynolds Number

ii) Nusselt Number

iii) Grashof Number

iv) Stanton Number

OR

Q2) a) A hot plate 1m× 0.5 m at 130ºC is kept vertically in still air at 20ºC. **[10]**

Find:

i) Heat transfer coefficient,

ii) Initial rate of cooling the plate in ºC/min.

Assume 0.5 m side is vertical and heat transfer takes place from both the sides of the plates.

Take properties of air as Cp =1007 J/kg ºC, K=0.029 W/mºC, $\bar{\upsilon} = 19.1 \times 10^{-6}\ m^2/s$, Pr = 0.7

Assume mass of plate = 20 kg and specific heat of plate = 400 J/kg ºC

Use Nu = 0.59 $(GrPr)^{1/4}$

b) Mention difference between film wise and drop wise condensation, Explain pool boiling and Regimes of pool boiling. **[8]**

P.T.O.

Q3) a) Explain the following terminology of Radiation. **[12]**

i) Planck's Law

ii) Kirchhoff's law

iii) Wein's Displacement Law

iv) Stefan-Boltzmann law

b) Derive and expression for the shape factor in case of radiation exchange between two surfaces. **[5]**

OR

Q4) a) Two large parallel plates are maintained at temperatures of 600 °C and 300 °C having their emissivity's of 0.9 and 0.4 respectively. A radiation shield having emissivity of 0.02 is inserted in between them. Calculate **[10]**

i) Heat transfer rate without shield

ii) Heat transfer rate with shield and Use $\sigma = 5.67 \times 10^{-8} W/m^2K^4$

b) Define shape factor. Explain laws of shape factor. **[7]**

Q5) a) State Fick's Law of Diffusion and Explain Mass diffusion coefficient. **[6]**

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. **[8]**

i) Molar fractions

ii) Mass fractions

iii) Total pressure if temperature of mixture is 290K

c) Define following Terminology. **[4]**

i) Mass Diffusion velocity

ii) Molar Diffusion velocity

iii) Mass Diffusion Flux

iv) Molar Diffusion Flux

OR

Q6) a) A mixture of CO_2 and N_2 is in a container at 25ºC, with each species having a partial pressure of 1 bar. Calculate the molar concentration, the mass density, the mole fraction, and the mass fraction of each species. **[8]**

b) Draw Phase Diagram and explain different phases **[5]**

c) Write down the Physical origins of mass transfer and enlist the applications of mass transfer **[5]**

Q7) a) Consider the following parallel flow heat exchanger specification: cold flow enters at 40 ºC , Cc = 20000W/K, hot flow enters at 150 ºC, Ch = 10000W/K, A = 30 m^2, The overall heat transfer coefficient is 500 W/m^2K. Determine the heat transfer rate and the exit temperature. **[10]**

b) Derive LMTD for parallel flow heat exchanger and mention assumptions considered for derivations. **[7]**

OR

Q8) a) A cross flow heat exchanger with both fluids unmixed is used to heat water flowing at a rate of 20 kg/s from 25°C to 75°C using gases available at 300°C to be cooled to180°C. The overall heat transfer coefficient has a value of 95 W/m^2K. Determine the area required. For gas Cp = 1005 J /kg K. **[12]**

b) Explain TEMA standards. **[5]**

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