

Total No. of Questions : 8]

SEAT No. :

P7657

[Total No. of Pages : 3

[6180]-179

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 100°C. If the temperature of water increases from 25°C to 55°C, find length of tube required.

$Nu = 0.023 Re^{0.8} Pr^{0.4}$, Properties of water : $\rho = 977.8 \text{ kg/m}^3$,
 $K=0.6672 \text{ W/m}^\circ\text{C}$, $\mu = 405 \times 10^{-6} \text{ Ns/m}^2$, $C_p=4.187\text{kJ/kg } ^\circ\text{C}$. [10]

- b) Explain [8]
- i) Reynolds Number
 - ii) Nusselt Number
 - iii) Grashof Number
 - iv) Stanton Number

OR

Q2) a) A hot plate $1\text{m} \times 0.5 \text{ m}$ at 130°C is kept vertically in still air at 20°C . [10]
Find:

- i) Heat transfer coefficient,
- ii) Initial rate of cooling the plate in $^\circ\text{C}/\text{min}$.

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

Take properties of air as $C_p = 1007 \text{ J/kg } ^\circ\text{C}$, $K=0.029 \text{ W/m}^\circ\text{C}$,
 $\bar{v} = 19.1 \times 10^{-6} \text{ m}^2/\text{s}$, $Pr = 0.7$

Assume mass of plate = 20 kg and specific heat of plate = 400 J/kg $^\circ\text{C}$
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 an 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 emissivities 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 $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$
- 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 kgm³, 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 25°C , 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°C , $C_c = 20000\text{W/K}$, hot flow enters at 150°C , $C_h = 10000\text{W/K}$, $A = 30\text{ m}^2$, The overall heat transfer coefficient is $500\text{ W/m}^2\text{K}$. 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 to 180°C . The overall heat transfer coefficient has a value of $95\text{ W/m}^2\text{K}$. Determine the area required. For gas $C_p = 1005\text{ J/kg K}$. [12]
- b) Explain TEMA standards. [5]

