Total No. of Questions : 8]

SEAT No. :

PB3898

[Total No. of Pages : 3

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

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) *Neat diagrams must be drawn wherever necessary*
3) *Figures to the right indicate full marks.*
4) *Assume suitable data wherever necessary.*

Q1) a) Explain the following Non dimensional numbers **[9]**

i) Reynold Number,

ii) Grashoff Number

iii) Nusselt Number

b) Estimate heat loss from a vertical wall exposed to nitrogen at 1 atm and 4 °C. The wall is 2 m high and 2.5 m wide and is maintained at 56 °C. The average Nusselt number over height of the wall for natural convection is given by

$Nu_H = 0.13(Gr\ Pr)^{1/3}$

The properties for nitrogen at a mean film temp are given as $\rho = 1.142$ kg/m^3, K = 0.026 W/mK, $\nu = 15.63 \times 10^{-6}$ m^2 /s, Pr = 0.713. **[9]**

OR

Q2) a) Explain in short Critical Heat Flux. **[4]**

b) Differentiate between filmwise and dropwise condensation. **[4]**

c) Air at atmospheric pressure and 30 °C flows over a flat plate at 3m/s. Plate is 50cm × 100 cm. Find heat loss in Watt if air flow is parallel to 100 cm side of plate. Consider both sides of plate.

If 50cm side is kept parallel to air flows. What will percentage increase in heat transfer rate? Plate temperature is 110°C. Given that for forced convection, use following relation $Nu = 0.664\ Re^{0.5}\ Pr^{0.33}$

Air properties at 70°C: Kinematic Viscosity = 20.02×10^{-6} m^2/s, K = 2.964×10^{-2} W/mK, $C_p = 1.009$ KJ/Kg.K, $\mu = 20.6 \times 10^{-6}$ Ns/m^2. **[10]**

Q3) a) Write Note on radiation shield. **[5]**

b) Calculate the net radiant heat exchange per m^2 area for two large parallel plates at temperatures 427°C and 27°C respectively ε (hot plate) = 0.9 and ε (cold plate) = 0.6.

If a polished aluminium shield is placed between them, find the percentage reduction in the heat transfer, ε (shield) = 0.4. **[12]**

OR

Q4) a) Explain the following **[8]**

i) Black Body

ii) Wien's displacement law

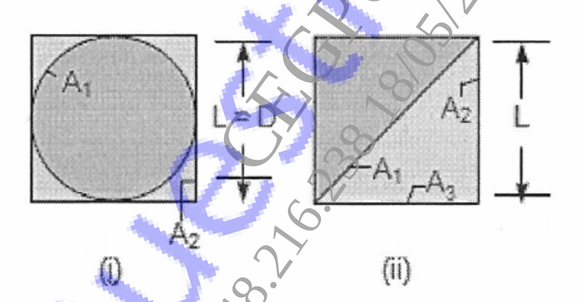
iii) Kirchhoff 's law

iv) Solid angle

b) Calculate the shape factor F12 and F21 for the following geometries **[9]**

i) Sphere of diameter D inside a cubical box of length D

ii) Diagonal partition within a long square duct



Q5) a) Enumerate applications of mass transfer. **[4]**

b) Explain the mode of mass transfer. **[4]**

c) A well is 40 m deep and 9 m diameter and the atmospheric temperature is 20°C. The air at the top is having a relative humidity of 50%. Determine the rate of diffusion of water vapour through the well. $D = 0.58 \times 10^{-5}$ m^2/s. The partial pressure is equal to saturation pressure at 25°C = 0.03169 bar. At RH = 50% the partial pressure can be taken as 0.5 × 0.03169 bar. **[10]**

OR

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

b) Write the Mass Diffusion Equations in Cartesian, Cylindrical and Spherical Coordinate system. **[6]**

c) Explain the following term **[4]**

i) mass concentration

ii) molar concentration

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

b) Determine the area required in parallel flow heat exchanger to cool oil from 60°C to 30°C using water available at 20°C. The outlet temperature of the water is 26°C. The rate of flow of oil is 10 kg/s. The specific heat of the oil is 2200 J/kg K. The overall heat transfer coefficient $U = 300\ W/m^2\ K$. **[9]**

OR

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

b) Consider the following parallel flow heat exchanger specification cold flow enters at 40°C : $C_c = 20,000$ W/K

hot flow enters at 150°C : $C_h = 10,000$ W/K

$A = 30m^2$: $U = 500W/m^2.K$

Determine the heat transfer rate and the exit temperatures **[9]**

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