A Reg. No. : | | | | | | | | | | |

Question Paper Code: 56703

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2018

Sixth Semester

Mechanical Engineering

15UME603 - HEAT AND MASS TRANSFER

(Regulation 2015)

(Approved Heat and Mass Transfer Data Book & Steam Tables are allowed)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The heat of sun reaches to us according to CO1- R

   (a) Conduction (b) Convection (c) Radiation (d) None of These

2. Thermal conductivity of a solid metal with rise in temperature normally CO1- R

   (a) Increases (b) Decreases (c) Remains same (d) Un predicted

3. The value of Prandtl number for air is about CO2- R

   (a) 0.1 (b) 0.3 (c) 0.7 (d) 1.7

4. The unit of overall coefficient of heat transfer is CO2- R

   (a) W/m^2K (b) W/m^2 (c) W/mK (d) W/m

5. Sensible heat is the heat required to CO3- R

   (a) Change vapour into liquid (b) Change liquid into vapour

   (c) Heat the water up to its boiling point (d) Heat the water above to its boiling point

6. The automobile radiator is a heat exchanger of CO3- R

   (a) Parallel flow type (b) Counter flow type

   (c) Cross flow type (d) Regenerator type

7. Heat transfer by radiation mainly depends upon CO4- R

(a) Its temperature (b) Nature of the body

(c) Kind and extent of its surface (d) All of these

8. The amount of radiation must be depends upon the CO4- R

(a) Nature of the body (b) Temperature of the body

(c) Type of surface of the body (d) All of the above

9. In a solution containing 0.30 Kg mole of solute and 600 kg of solvent, the molality is CO5- R

(a) 2.0 (b) 0.5 (c) 0.6 (d) 1.0

10. The condition for Laminar Flow for Flow over Flat Plate in Forced Convection, if the Reynolds Number is . CO5- R

(a) < 2300 (b) $<5 \text{ X } 10^5$

(c) >2300 (d) $<10^7$

PART – B (5 x 2= 10Marks)

11. State Fourier's law of conduction CO1- R

12. Define Prandtl Number. CO2- U

13. What is meant by fouling factor? CO3- U

14. State Kirchoff's law of radiation CO4- R

15. What is Schmidt Number?. CO5- R

PART – C (5 x 16= 80Marks)

16. (a) The wall of an oven consists of 3 layers of brick. Inside one is built of 20 cm of fire bricks surrounded by 10 cm of insulating brick and outside layer is binding bricks of 12 cm thick. The oven operates at 900°C, such that the outside surface of the oven is maintained at 60°C. Calculate: (i) The heat loss per m^2 in surface. (ii)The interfacial temperature. Given the thermal conductivity of fire brick, insulting brick and binding are 1.2, 0.26 and 0.68 respectively in W/m°C CO1-App (16)

Or

(b) A wire of 6 mm diameter with 2 mm thick insulation (K = 0.11 W/mK). If the convective heat transfer co-efficient between the insulating surface and air is 25 W/m^2L, find the critical thickness of insulation. And also find the percentage of change in the heat transfer rate if the critical radius is used. CO1-App (16)

17. (a) Air at 20^0C at atmospheric pressure flows over a flat plate at a velocity of 3.5 m/s. If the plate is 0.5 m wide and at 60^0C , Calculate the following at x =0.4 m. (i) boundary layer thickness (ii) local friction coefficient (iii) average friction coefficient (iv) shearing stress due to friction (v) thermal boundary layer thickness (vi) local convective heat transfer coefficient (vii) average heat transfer coefficient (viii) rate of heat transfer — CO2- App — (16)

Or

(b) A thin 100 cm long and 10 cm wide horizontal plate is maintained at a uniform temperature of 150°C in a large tank full of water at 75°C. Estimate the rate of heat to be supplied to the plate to maintain constant plate temperature as heat is dissipated from either side of plate. — CO2- App — (16)

18. (a) An aluminum pan of 15 cm diameter is used to boil water and the water depth at the time of boiling is 2.5 cm. The pan is placed on an electric stove and the heating element raises the temperature of the pan to 110^0C. Calculate the power input for boiling and the rate of evaporation. Take C_{sf} = 0.0132. — CO3- App — (16)

Or

(b) A condenser is to designed to condense 600 kg/h of dry saturated steam at a pressure of 0.12 bar. A square array of 400 tubes, each of 8 mm diameter is to be used. The tube surface is maintained at 30°C. Calculate the heat transfer coefficient and the length of each tube. — CO3- App — (16)

19. (a) Assuming sun to be black body emitting radiation at 6000 K at a mean distance of 12×10^{10} m from the earth. The diameter of the sun is 1.5×10^9 m and that of the earth is 13.2×10^6 m. Calculation the following. — CO4- Ana — (16)
    1. Total energy emitted by the sun.
    2. The emission received per m^2 just outside the earth's atmosphere.
    3. The total energy received by the earth if no radiation is blocked by the earth's atmosphere.
    4. The energy received by a 2 × 2 m solar collector whose normal is inclined at 45° to the sun. The energy loss through the atmosphere is 50% and the diffuse radiation is 20% of direct radiation.

Or

(b) Two large parallel plates having emissivity's of 0.4 and 0.7 are maintained at a temperature of 600 K and 900 K respectively. A radiation shield having an emissivity of 0.05 on both sides is placed between two plats. Calculate (i) temperature of shield, (ii) ratio of heat transfer rate without shield to with shield — CO4- Ana — (16)

20. (a) Hydrogen gases at 3 bar and 1 bar are separated by a plastic membrane having thickness 0.25 mm. the binary diffusion coefficient of hydrogen in the plastic is 9.1×10^{-3} m^2/s. The solubility of hydrogen in the membrane is 2.1×10^{-3} kg-mole/m^3bar. An uniform temperature condition of 20° is assumed. — CO5- App — (16)

Calculate the following

1. Molar concentration of hydrogen on both sides
2. Molar flux of hydrogen
3. Mass flux of hydrogen

Or

(b) Dry air at 20^0C (ρ=1.2 Kg/$m^{3,}$ ν=15 x 10^{-6} m^2/s, D=4.2 x 10^{-5} m^2/s) flows over a flat plate of length 50cm which is covered with a thin layer of water at a velocity of 1 m/s. Estimate the total mass transfer coefficient at a distance of 10cm from the leading edge and the average mass transfer coefficient. — CO5- App — (16)