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

Question Paper Code: U5701

B.E./B.Tech. DEGREE EXAMINATION, NOV 2024

Fifth Semester

Mechanical Engineering

21UME501- HEAT AND MASS TRANSFER

(Regulations 2021)

Duration: Three hours Maximum: 100 Marks

PART A - (10 x 1 = 10 Marks)

1. Following is critical radius of insulation for spheres CO1-U

   (Where h = convective heat transfer coefficient and k = thermal conductivity)

   (a) k/h (b) k/2h (c) 2k/h (d) 3k/h

2. Buoyantforce / Viscousforce = CO1- U

   (a) Weber number (b) Euler number

   (c) Schmidt number (d) Grashoff's number

3. If the Reynolds number is less than 2300 the flow is CO1- U

   (a) Turbulent (b) laminar (c) laminar turbulent (d) none of these

4. Weather is a example of..... CO1- U

   (a) Conduction current (b) Convection current

   (c) Radiation current (d) None of these

5. Heat transfer by radiation mainly depends upon CO1- U

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

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

6. The value of the wavelength for maximum emissive power is given by CO1- U

   (a) Wien's law (b) Planck's law (c) Stefan's law (d) Fourier's law

7. Baffles provided in heat exchangers for CO1- U

(a) to reduce heat transfer rate (b) to increase heat transfer rate

(c) to remove dirt (d) to reduce vibrations

8. In a condenser of a power plant, the steam condenser is at a temperature of 60^0CThe cooling water enters at 30^0C and leaves at 45^0C. The logarithmic mean temperature difference (LMTD) of the condenser is CO1- U

(a) 16.2^0C (b) 21.6^0C (c) 30^0C (d) 37.5^0C

9. The individual mass transfer co-efficient (moles/m2s) for absorption of a solute from a gas mixture into a liquid solvent are, KL = 4.5 and KG = 1.5. The slope of the equilibrium line is 3. Which of the following resistance (s) is (are) controlling? CO1- U

(a) Liquid Side (b) Gas Side

(c) Interfacial (d) Both Liquid and gas side

10. Dimension of mass diffusivity is the same as that of CO1- U

(a) Kinematic viscosity (b) Dynamic viscosity

(c) Surface tension (d) Pressure

PART – B (5 x 2= 10Marks)

11. Define fin efficiency and fin effectiveness. CO1 -U

12. What are the dimensionless parametsers used in forced convection? CO1 -U

13. Define emissivity. CO1 -U

14. What is meant by regenerators? CO4-Appf

15. State fick's law of diffusion. CO1 -U

PART – C (5 x 16= 80Marks)

16. (a) Hot air at a temperature of 40°C is flowing through steel pipe of 10 cm diameter. The pipe is covered with two layers of different insulating materials of thickness 4 cm and 3cm and their corresponding thermal conductivities are 0.1 and 0.32 W/mK. The inside and outside heat transfer coefficients are 50W/m^2K and 15 W/m^2K respectively. The outer temperature is at 10°C. Find the heat loss per meter length of pipe. CO2 -App (16)

Or

(b) An aluminium alloy fin of 7mm thick and 50mm long protrudes from a wall, which is maintained at 120 ^{0}C.the ambient air temperature is 22 ^{0}C.the heat transfer coefficient and conductivity of the fin material are 140 W/m2k. And 55 W/m^{2}k. Respectively. Determine temperature at the end of the fin, temperature at the middle of the fin, total heat transfer by the fin. CO2 -App (16)

17. (a) Air at 25^{0}C flows over s flat plate at a speed of 5 m/s and heated to 135^0 C.The plate is 3 m long and 1.5m wide. Calculate the local heat transfer coefficient at x=0.5 m and the heat transferred from the first 0.5 m of the plate. CO2- App (16)

Or

(b) Examine the heat transfer from a 60 W incandescent bulb at 115°C to ambient air at 25°C. Assume the bulb as a sphere of 50mm diameter. Also find the % of power lost by free convection. CO2- App (16)

18. (a) A black body of 1200cm^2 emits radiation at 1000 k. calculate the following.
1. Total rate of energy emission
2. Intensity of normal radiation
3. Wavelength of maximum monochromatic emissive power
4. Intensity of radiation along a direction along a direction at 60. To the normal CO2 -App (16)

Or

(b) Two large parallel planes at 800k and 600 k having emissivities of 0.5 and 0.8 respectively. A radiation shield having an emissivity of 0.1 on one side and an emissivity of 0.05 on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square meter with and without radiation shield. CO2 -App (16)

19. (a) In a counter flow double pipe heat exchanger, oil is cooled from 85^{o}C to 55^{o}C by water entering at 25^{o}C. the mass flow rate of oil is 9800 kg/h and specific heat of oil is 2000 j/kg k. the mass flow rate of water is 8000 kg/h and specific heat of water is 4180 j/kg k. determine the heat exchanger area and heat transfer rate for an overall heat transfer co-efficient of 280 w/m^2 k CO3 -App (16)

Or

(b) Water atmospheric pressure is to be boiled in polished copper pan. The diameter of the pan is 350mm and is kept at 115°C. Calculate the following (i) power of the burner (ii) rate of evaporation in kg/hr(iii) critical heat flux — CO3 -App — (16)

20. (a) A vessel contains a binary mixture of o2 and n2 with partial pressure in the ratio 0.21 and 0.79 at 20 ^{o}C. If the total pressure of the mixture is 1.1 bar, calculate the following: — CO3 -App — (16)

1. Molar concentration
2. Mass densities
3. Mass fractions
4. Molar fractions of each species

Or

(b) A vessel contains a binary mixture of O_2 and N_2 with partial pressure in the ratio 0.21 and 0.79 at 20 ^{o}C. If the total pressure of the mixture is 1.1 bar, calculate the following: — CO3 -App — (16)
(i)Molar concentration (ii) Mass densities (iii) Mass fractions (iv) Molar fractions of each species