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

Question Paper Code: 56703

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2022

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 unit of overall coefficient of heat transfer is CO1- R

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

2. Heat is transferred by all three modes of transfer, viz. conduction, convection and radiation in CO1- R

   (a) Electric heater (b) Steam condenser (c) Boiler (d) Refrigerator condenser coils

3. $Nu = C\ Re^m\ Pr^n$ represents heat transfer under CO2- R

   (a) Forced Convection (b) Free convection

   (c) Combined convection (d) Conduction

4. The rate of energy transferred by convection to that by conduction is called CO2- R

   (a) Stanton number (b) Nusselt number (c) Biot number (d) Peclet number

5. By keeping constant area the heat transfer in counter flow heat exchanger is _____ than parallel flow heat exchanger. CO3- R

   (a) Higher (b) Lower (c) Same (d) None of these

6. The heat transfer rate of film wise condensation compared to drop wise condensation. CO3- R

   (a) Higher (b) Lower (c) Equal (d) Not able to predicted

7. The emissivity value of black body is equal to _____. CO4- R

(a) 0 (b) 1 (c) Negative (d) None of the above

8. According to Stefan Boltzmann law, the total radiation from a black body per second per unit area is directly proportional to the CO4- R

(a) Absolute temperature

(b) Square of the absolute temperature

(c) Cube of the obsolute temperature

(d) Fourth power of the obsolute temperature

9. The mass flux is proportional to _____. CO5- R

(a) Velocity gradient (b) Temperature gradient

(c) Concentration gradient (d) Pressure gradient

10. The molecular weight of Naphthalene is _____. CO5- R

(a) 74.08 (b) 128.16 (c) 28.02 (d) 157.02

PART – B (5 x 2= 10 Marks)

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

12. What are the dimensionless parameters used in forced convection? CO2- R

13. What are the types of heat exchangers? CO3- R

14. Define irradiation? CO4- R

15. What are the modes of mass transfer? CO5- R

PART – C (5 x 16= 80 Marks)

16. (a) A surface wall is made up of 3 layers one of fine brick, one of insulating brick and one of red brick. The inner and outer surface temperatures are 900˚C and 30˚C respectively. The respective thermal conductivity of the layers are 1.2, 0.14, and 0.9W/mK and the thickness of 20cm, 8 cm and 11 cm. Assuming close bonding of the layers at the interfaces. Find the heat loss per square meter and interface temperatures. CO1-Ana (16)

Or

(b) A rectangular aluminium fins of 0.5mm square and 12mm long are attached on a plane plate which is maintained at 80^{o} C. Surrounding air temperature is 22^{o}C. Calculate the number of fins required to generate $35x10^{-3}$ W of heat. Take k = 165W/mK and h = $10W/m^2K$. Assume no heat loss from the tip of the fin. CO1-Ana (16)

17. (a) Water flows inside a tube of 20mm diameter and 3 m long at a velocity of 0.03m/s. The water gets heated from 40^{o}C to 120^{o} C while passing through the tube. The tube wall is maintained at constant temperature of 160^{o} C. Find heat transfer. CO2-App (16)

Or

(b) Atmospheric air at 275K and a free stream velocity of 20m/s flows over a flat plate 1.5m long that is maintained at a uniform temperature of 325K. Calculate the average heat transfer coefficient over the region where the boundry layer is laminar, the average heat transfer coefficient over the entire length of the plate and the total heat transfer rate from the plate to the air over the length 1.5m and width 1m. assume transition occurs at $Re_c = 2x10^5$. 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^{0}C. Calculate the power input for boiling and the rate of evaporation. Take $C_{sf} = 0.0132$ CO3-App (16)

Or

(b) In a counter flow double pipe heat exchanger, water is heated from 25^{o} C to 65^{O}C by an oil with a specific heat of 1.45 KJ/Kg K and mass flow rate is 0.9Kg/s. the oil is cooled from 230^{O}c to 160^{O}C . If the overall heat transfer coefficient is $420W/m^2\ ^{O}C$, calculate the following. CO3-App (16)

1. The rate of heat transfer
2. The mass flow rate of water

The surface area of the heat exchanger

19. (a) The sun emits maximum radiation at λ=0.52μ. Assuming the sun to be a black body, calculate the surface temperature of the sun. also calculate the monochromatic emissive power of the suns surface. CO4-U (16)

Or

(b) Two black square plates of size 1 by 1m are placed parallel to each other at a distance of 0.4m. One plate is maintained at a temperature of 900^{o} C and to the other at 400^{o} C. Find the net heat exchange of energy due to radiation between two plates. CO4-U (16)

20. (a) Air at 10^{O} C with a velocity of 3m/s flows over a flat. plate. If the plate is 0.3m long, calculate the mass transfer coefficient. CO5-App (16)

Or

(b) A vessel contains binary mixture of O2 and N2 with partial pressures in the ratio 0.21 and 0.79 at 15C. The total pressure of the mixture is 1.1 bar. Calculate the following: CO5-App (16)

(1) Molar Concentrations
(2) Mass Densities
(3) Mass Fractions

Molar Fractions of each species