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

Question Paper Code: U5701

B.E./B.Tech. DEGREE EXAMINATION, NOV 2023

Fifth Semester

Mechanical Engineering

21UME501 – HEAT AND MASS TRANSFER

(Regulations 2021)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The rate of heat transfer is said to be constant if temperature CO1- U

   (a) decreases (b) increases (c) become zero (d)none of the above

2. The Nusselt number is a function of CO1- U

   (a) Prandtl Number (b) Grashoff's Number

   (c) Prandtl Number And Grashoff's Number (d) Mach Number

3. ……. Number can be used for convective heat transfer CO1- U

   (a) Mach (b) Frodue (c) Nusselt (d) None of the above

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

   (a) Conduction current (b) Convection current

   (c) Radiation current (d) None of these

5. Emissivity of a white polished body in comparison to a black body is CO1- U

   (a) Higher (b) Lower (c) Same (d) Depends upon the shape of body

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. Drop wise condensation occurs on asurface CO1- U

   (a) oily (b) smooth (c) glazed (d) coated

8. The multi-pass heat exchangers used for CO1- U

(a) To obtain high heat transfer coefficient (b) to reduce pressure drop

(c) to get a compact unit (d) all of the above

9. Diffusion coefficient unit is CO1- U

(a) m (b) m/s (c) s (d) m^2/s

10. ……. Number can be used for convective mass transfer CO1- U

(a) Mach (b) Sherwood (c) Nusseh (d) None of the above

PART – B (5 x 2= 10Marks)

11. Explain Fourier's Law of heat conduction. CO1- U

12. Describe Newton's law of cooling. CO1- U

13. Explain Wien's distribution law.. CO1- U

14. Explain Film wise condensation and Drop wise condensation. CO1- U

15. Discuss Fick's law of diffusion. Give its expression. CO1- U

PART – C (5 x 16= 80Marks)

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 850°C and 65°C respectively. The respective co-efficient of thermal conductivity of the layers are 1.05, 0.15 and 0.85W/mK and the thickness of 250mm, 120 mm and200 mm. Assuming close bonding of the layers at the interfaces. Find the heat loss per square meter and interface temperatures. CO1-App (16)

Or

(b) A heating unit made in the form of a cylinder is 6mm diameter & 1.2m long. It is provided with 20 longitudinal fins 3mm thick which protrude 50mm from the surface of the cylinder. The temperature at the base of the fin is 800^O C. The ambient temperature is 250^OC. The film heat transfer co-efficient from the cylinder and fins to the surrounding air is 10 W/m^2k. Calculate the rate of heat transfer from the finned wall to the surrounding. Take k= 90W/mk. CO2-App (16)

17. (a) Atmospheric air at 275 K and a free stream velocity of 20 m/s flows over a flat plate 1.5 m long that is maintained at a uniform temperature of 325 K. Calculate the average heat transfer coefficient over the region where the boundary 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 1.5 m and width 1 m. Assume transition occurs at Re = 2 x $l0^5$. 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) Calculate the following for an industrial furnace in the form of blackbody and emitting radiation at 2500°C CO2 -App (16)

i) Monochromatic emissive power at 1.2 μm length

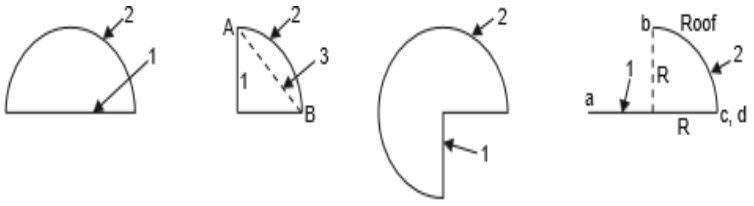
ii) Wave length at which the emission is maximum

Maximum emissive power Total emissive power, and total emissive power of the furnace if it is assumed as a real surface with emissivity equal to 0.9.

Or

(b) Determine the shape factor F1–2 and F2–1 for the following cases shown in Fig CO2 -App (16)

Also find F2–2.



(a) Hemisphere (b) Long duct (c) Long duct (d) Long roof

19. (a) The outer surface of the vertical tube, which is 1 m long and has an outer diameter of 80 mm, is exposed to saturated steam at atmospheric pressure and is maintained at 50°C by the flow of cool water through the tube. What is the rate of heat transfer to coolant and what is the rate at which the steam is condensed at the surface. CO3 -App (16)

Or

(b) Hot exhaust gases which enter the cross flow heat exchanger at 300°C and leaves at 100°C are used to heat water at a flow rate of 1 kg/s from 35°C to 125°C. The specific heat of the gas is 1000 J/ kg K. And the overall heat transfer coefficient based on the gas side surface is 100 W/m^2K. Find the required gas side surface area using the NTU method and LMTD method — CO3 -App — (16)

20. (a) A vessel contains binary mixture of O_2 and N_2 with partial pressure in the ratio of 0.21 and 0.79 at 15^{o}C. The total partial pressure of the mixture is 1.1 bar. Calculate the following, Molar concentrations Mass densities Mass fractions & Molar fraction of each species. — CO3- App — (16)

Or

(b) Air at 20^{0}C(D=4.166*10-5 m^2/sec) flows over a tray length = 320mm and width = 420mm full of water with a velocity of 2.8m/sec. the total pressure of moving air is 1 atm pressure and partial pressure of water present in the air is 0.0068 bar. If the temperature on the water surface is 15^{0}C. Calculate the evaporation rate of water. — CO3- App — (16)