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

Question Paper Code: R5701

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2025

Fifth Semester

Mechanical Engineering

R21UME501 – HEAT MASS TRANSFER

(Regulations R2021)

(Steam tables and HMT data book can be Provided)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. Drop-wise condensation normally occurs for CO1- U

   (a) Coated surface (b) Oily surface

   (c) Rough surface (d) All of the above

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

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

5. The radiation emitted by a black body is known as CO1- U

   (a) Black radiation (b) Full radiation (c) Total radiation (d) All of these

6. 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

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. For the same inlet and outlet temperatures of hot and cold fluids, the Log Mean Temperature Difference (LMTD) is CO1- U

(a) Greater for parallel flow heat exchanger than for counter flow heat exchanger

(b) Greater for counter flow heat exchanger than for parallel flow heat exchanger.

(c) Same for both parallel and counter flow heat exchangers.

(d) Depends on the properties of fluid.

9. Universal gas constant value is CO1- U

(a) 8.314 J/kg K (b) 8314 J/kg K (c) 8314 KJ/kg K (d) All of these

10. In case of unsaturated air CO1- U

(a) Dew point < wet bulb temperature (b) Wet bulb temperature < dry bulb temperature

(c) Both (a) and (b) (d) Neither (a) not (b)

PART – B (5 x 2= 10 Marks)

11. Explain about heat transfer. CO1- U

12. Define prandtl number (P_r). CO1- U

13. An electrical heated plate dissipates heat by convection at a rate of 8000 w/m^2 into the ambient air at 25^{o}C. If the surface of the hot plate is at 125^{o}C, calculate the heat transfer coefficient for convection between the plate and air. CO1- U

14. Difference between counter flow and cross flow heat exchanger. CO1- U

15. Difference between counter flow and cross flow heat exchanger. 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) A steel pipe of 120mm ID & 140mm OD with thermal conductivity of 55W/mK. It is covered with two layers insulated each having a thickness of 55 mm. The thermal Conduction of the first insulated material is 0.11 W/mK & That of second is 0.11 W/mK. The temperature of the inside tube surface is 240°C & that of outside surface of the insulation is 60°C. Calculate the loss of heat per Meter length of pipe and the interface temperature between the two layers of Insulation. CO2 -App (16)

17. (a) Air at 20^0 C at atmospheric pressure flows over a flat plate a velocity of 3.5 m/s.If the plate is 0.5 m wide and 60^0C, Calculate the following at x=0.4m.Hydrodynamic boundary layer thickness, Thermal boundary layer thickness, Local friction coefficient, Average friction coefficient, Heat transfer 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 50 mm diameter. Also find the % of power lost by free convection. CO2- App (16)

18. (a) A Black body at 3000 K emits radiation. Calculate the following CO2 -App (16)
1. monochromatic emissive power at 1 μm wave length
2.wave length at which emission is maximum
3.maximum emissive power
4. total emissive power

Or

(b) Two large parallel plates with ε = 0.5 each, are maintained at different temperature and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage of reduction in net radiative heat transfer CO2 -App (16)

19. (a) In a double pipe heat exchanger, hot fluid with a specific heat of 2300 J/Kg enters at 380 ^{o}C and leaves at 300 ^{o}C. Cold fluids enters at 25 ^{o}C and leaves at 210 ^{o} C. calculate the heat exchanger area required for counter flow and what would be the percentage of increase is area if fluid flows were parallel.
Take overall heat transfer co-efficient is 750 W/m^2 and mass flow rate of hot fluid is 1 kg/s CO3 -App (16)

Or

(b) Water is boiled at the rate of 24 Kg/h in a polished copper pan, 300mm in diameter, at atmospheric pressure. Assuming nucleate boiling conditions, calculate the temperature of the bottom surface of the pan — CO3 -App — (16)

20. (a) Estimate the diffusion rate of water from the bottom of a test tube 10mm in diameter and 15cm long into dry atmospheric air at 25 ^{o}C. diffusion co-efficient of water into air is 0.255 x 10^{-4} m^2/s — CO3 -App — (16)

Or

(b) Air at 20 ^{o}C and atmospheric pressure, containing small quantities of iodine flows with a velocity of 4 m/s inside a 4 cm inner diameter tube. Determine the mass transfer Co-efficient. Assume D_{ab} = 0.75 x 10^{-5} m^2/s — CO3 -App — (16)