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Question Paper Code : 57562

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fifth Semester

Mechanical Engineering

ME 6502 – HEAT AND MASS TRANSFER

(Regulations 2013)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. What are various modes of heat transfer ? Give examples.
2. What is lumped capacitance analysis ?
3. Differentiate free and forced convection.
4. Differentiate Hydrodynamic and thermal boundary layer.
5. What is black body radiation ?
6. Define Emissive power and monochromatic emissivity.
7. What are the assumptions made in Nusselt theory of condensation ?
8. What is fouling and how does it affect the rate of heat transfer ?
9. Define Fick's law.
10. Diffusivity of ammonia in air at temperature 30 °C and pressure 1 atm. is 0.228 cm^2/sec. Find the diffusivity of ammonia in cm^2/sec in air at temperature 50°C and pressure 1.1 atm.

PART – B (5 × 16 = 80 Marks)

11. (a) Write short notes on :

(i) Heat transfer with extended surfaces **(3)**

(ii) critical radius of insulation **(3)**

(iii) A flat furnace wall is constructed of 114 mm layer of sil-o-gel brick with a thermal conductivity of 0.138 W/m°C backed by a 229 mm layer of common brick of conductivity 1.38 W/m°C . The temperature of inner face of the wall is 760°C and that of the outer face is 76.6°C. (a) What is the heat loss through composite wall ? (b) What is the temperature of interface between refractory brick and common brick ? **(10)**

OR

(b) (i) A plane wall 10 cm thick generates heat at the rate of 4×10^4 W/m^3, when electric current is passed through it. The conductive heat transfer coefficient between each phase of wall and ambient air is 50W/m^2°C. The thermal conductivity of wall is 15 W/ m °C (a) Derive the temperature profile for given slab, (b) Determine the surface temperature, (c) The maximum temperature in the wall. **(10)**

(ii) What is the significance of Heisler charts in transient heat conduction ? **(6)**

12. (a) (i) Explain about three-layer model for internal convection in tubular flow. **(8)**

(ii) A fluid of kinematic viscosity equal to 15×10^{-6} m^2/s flows with an average velocity of 10 m/s in a square duct of 0.08 × 0.08 m cross section. What is the Reynolds number based on the hydraulic diameter ? Is the flow laminar or turbulent ? What is the Nusselt number if the flow is fully developed and the Prandtl Number is 0.7 . **(8)**

OR

(b) (i) Explain about thermal boundary layer flow past a flat plate. **(6)**

(ii) Consider flow of air at atmospheric pressure and 300 K parallel to a flat plate 2 m long. The velocity of air far away from the plate is 10 m/sec. The plate surface is held at a constant temperature of 400 K. Determine the heat transfer coefficient at the trailing edge of the plate using the Colburn analogy ? Data : Properties at film temperature are: Density 0.995 kg/m^3, kinematic viscosity 20.92 × 10^{-6} m^2/s, thermal conductivity 0.03 W m^{-1} K^{-1} . Prandtl number 0.7 **(10)**

13. (a) (i) Hot water enters a counter flow heat exchanger at 95°C. This hot water is used to heat a cool stream of water from 8 to 40° C. The flow rate of the cool water is 1 .2 kg/s, and that of the hot water is 2.7 kg/s. The overall heat-transfer coefficient is 850 W/m^2°C. What is the area of the heat exchanger and its effectiveness ? **(10)**

(ii) Name and brief the different types of heat exchangers. **(6)**

OR

(b) (i) A hot stream is cooled from 120°C to 30°C while the cold stream temperature changes from 20 to 60°C. Find out the LMTD for both counter current and co-current phenomenon. Justify how counter current is effective than co-current ? **(6)**

(ii) What is flow boiling and pool boiling ? Describe how heat transfer coefficient varies in regimes of pool boiling. **(10)**

14. (a) (i) Determine an expression for heat transfer rate by using electrical analogy (i) without any shield between 2 parallel plates (ii) with shield in between 2 parallel plates. **(16)**

OR

(b) (i) What is view factor and shape factor ? (5)

(ii) State laws of blackbody radiation ? (5)

(iii) Two large parallel plates are at temperatures $T_1 = 500$ K and $T_2 = 300$ K. Their emissivities are $\varepsilon_1 = 0.85$ and $\varepsilon_2 = 0.90$. What is the radiant flux between the plates ? (6)

15. (a) (i) Derive an expression for mass flux in steady state molecular diffusion
(a) A through non diffusing B.

(b) Equimolar Counter Diffusion (8)

(ii) NH_3 gas (A) diffuses through N_2 (B) under steady state condition with non-diffusing N_2. The total pressure is 101.325 k Pa and temperature is 298 K. The diffusion thickness is 0.15 m the partial pressure of NH_3 at one point is 1.5×10^4 Pa and at the other point is 5×10^3 Pa. The D_{AB} for mixture at 1 atm and 298 K is $2.3 * 10^{-5}$ m^2 /sec. (a) Calculate flux of NH_3. (A through non diffusing B). Calculate flux for equimolal counter diffusion. (8)

OR

(b) (i) Write a note on convective mass transfer coefficients for liquids and gases. (8)

(ii) Give a brief description on heat, momentum and mass transfer analogies. (8)
