Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (R,S), MAY 2024
MECHANICAL ENGINEERING
(2020 SCHEME)

Course Code : 20MET302

Course Name: Heat and Mass Transfer

Max. Marks : 100 **Duration: 3 Hours**

Use of Heat and Mass Transfer data book and Steam table are permitted

PART A

(Answer all questions. Each question carries 3 marks)

1. State Fourier's law of heat conduction
2. How does transient heat transfer differ from steady state heat transfer?
3. Write short notes on Reynold's number (Re) and Prandtl number (Pr)
4. Define convection
5. Write down the relation for overall heat transfer coefficient in heat exchanger with fouling factor
6. What is meant by LMTD?
7. What is the use of radiation shield?
8. Explain perfect black body concept
9. Discuss the three modes of mass transfer.
10. What is the difference between mass concentration and molar concentration?

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Write down the general heat conduction equation in Cartesian coordinates. Reduce the equation for steady state one dimensional heat conduction across a plane wall without internal heat generation. (10)
    b) Distinguish between fin effectiveness and fin Efficiency? (4)

OR

12. a) A small electric heating application uses wire of 2mm diameter with 0.8mm thick insulation (k=0.12W/m°C). The heat transfer coefficient (h_o) on the insulated surface is 35W/m^2°C. Determine the critical thickness of insulation in this case and the percentage change in the heat transfer rate if the critical thickness is used, (10)

assuming the temperature difference between the surfaces of the wire and surrounding air remains unchanged.

b) Discuss Fourier's law of heat conduction (4)

MODULE II

13. a) Air at 25°C flows past a flat plate at 2.5 m/s. the plate measures 600 mm X 300 mm and is maintained at a uniform temperature at 95°C. Calculate the heat loss from the plate, if the air flows parallel to the 600 mm side. How this heat loss would be affected if the flow of air is made parallel to the 300 mm side. (8)

b) A vertical pipe 80 mm diameter and 2 m height is maintained at a constant temperature of 120^0C. The pipe is surrounded by still atmospheric air at 30^0C. Find heat loss by natural convection. (6)

OR

14. a) An incandescent bulb can be considered as a sphere of 0.06 m dia. The bulb surface is at 130°C. Air at 30°C flows over it with a velocity of 0.6 m/s. Determine the heat loss from the bulb surface. (8)

b) Explain hydrodynamic and thermal boundary layer for flow through flat plate with the help of neat sketches. (6)

MODULE III

15. a) Explain boiling (pool boiling) curve for water with the help of a neat sketch. (7)

b) In a double pipe heat exchanger hot water flows at a rate of 14 kg/s and gets cooled from 370K to 340K. At the same time 14 kg/s of cooling water at 303K enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^{2}K. Determine the effectiveness and the heat transfer area required, assuming two streams are in parallel flow. (7)
Assume the specific heat for the both the streams = 4.2 kJ/kgK.

OR

16. a) Derive an expression for LMTD of parallel flow heat exchanger. (10)

b) What is meant by shell and tube heat exchanger? (4)

MODULE IV

17. a) Derive an expression for the net radiation exchange between two black bodies. (7)

b) Calculate the radiation exchange per unit area between two parallel plates of temperature 500^0C and 50^0C. Emissivity of hot and cold plates are 0.9 and 0.7 respectively. Find the percentage reduction in heat transfer, if a radiation shield of emissivity 0.25 on both surface is placed in between the plates. (7)

OR

18. a) Two rectangular surfaces are perpendicular to each other with a common edge of 2 m. The horizontal plane is 2 m long and vertical plane is 3 m long. Vertical plane is at 1200 K and has an emissivity of 0.4. The horizontal plane is 291 K and has an emissivity of 0.3. Determine the net heat exchange between the planes. (7)

b) What is Wien's Displacement Law? Explain with the help of Planks distribution. (7)

MODULE V

19. a) State and explain Fick's law of molecular diffusion. Write its analogy with Fourier law. (7)

b) Explain steady state equimolar counter diffusion in liquids (7)

OR

20. a) Dry air at 30°C and 1 atm flows over a wet flat plate 600 mm long at a velocity of 50 m/s. Calculate the mass transfer co-efficient of water vapour in air at the end of the plate. Take the diffusion co-efficient of water vapour in air, D = 0.26 x 10^{-4} m^2/s (8)

b) Discuss the analogy between heat transfer and mass transfer (6)

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