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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (R), MAY 2023

(2020 SCHEME)

Course Code : 20MET384

Course Name: Heat Transfer

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

Use of HMT data book is permitted

PART A

(Answer all questions. Each question carries 3 marks)

1. Define Newton's law of cooling.
2. How thermal conductivity of a material defined. List the factors on which it depends.
3. Define critical thickness of insulation and mention its significance.
4. How thermal conductivity of gases varies with temperature?
5. Differentiate natural and forced convection citing example.
6. Define Reynold's number and Prandtl number. Mention its significance.
7. Define the function of a heat exchanger. List any two examples.
8. Sketch the temperature distribution over length for a parallel and counter flow heat exchanger.
9. Explain Kirchoff's law of radiation.
10. Define total emissive power and monochromatic emissive power.

PART B

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

MODULE I

11. a) The inner surface of a plane brick wall is at 40°C and the outer surface is at 20°C. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 250mm thick. The thermal conductivity of the brick is 0.52W/m°C. (4)

    b) Derive the general three dimensional steady state heat conduction equation in Cartesian coordinate system. (10)

OR

12. a) Determine heat transfer by convection over a surface of 0.75m^2 if the surface is at 200°C and the fluid is at 80°C. The value of convective heat transfer coefficient is 25W/m^2°C. (4)

b) Derive the general three dimensional steady state heat conduction equation in Cylindrical coordinate system. (10)

MODULE II

13. a) Derive an expression for critical thickness of insulation for sphere. (4)

b) The temperature at the inner and outer surfaces of a boiler wall made of 20 mm thick steel and covered with an insulating material of 5 mm thickness are 300^{0}C and 50^{0}C respectively. If the thermal conductivities of steel and insulating material are 58W/m^{0}C and 0.116 W/m^{0}C respectively, determine the rate of flow through the boiler wall. (10)

OR

14. a) Derive an expression for one dimensional heat transfer along radial direction, through a hollow cylindrical surface of radius r_1 and r_2, thermal conductivity K and length L. (6)

b) A spherical container holding a cryogenic fluid at – 140°C and having an outer diameter of 0.4 m is insulated with three layers each of 50 mm thick insulation of K_1 = 0.02, K_2 = 0.06 and K_3 = 0.16 W/mK (starting from inside). The outside is exposed to air at 30°C with h = 15 W/m^{2}K. Determine the heat gain. (8)

MODULE III

15. a) Define thermal boundary layer thickness and sketch the formation of thermal boundary during the flow of warm fluid over a cool plate. (4)

b) Explain (i) Reynolds Number (ii) Prandtl Number (iii) Nusselt Number (iv) Grashoff Number (10)

OR

16. a) Define momentum thickness and energy thickness (4)

b) The velocity distribution in the boundary layer is given by

$$\frac{u}{U} = \frac{3}{2}\frac{y}{\sigma} - \frac{1}{2}\frac{y^2}{\sigma^2}$$ (10)

Note: σ is the boundary layer thickness.

Calculate the following
(i)Ratio of displacement thickness to boundary layer thickness
(ii) Ratio of momentum thickness to boundary layer thickness

MODULE IV

17. a) Derive an expression for LMTD of parallel flow heat exchanger. (4)
b) Define NTU for a heat exchanger. (10)

OR

18. a) How do you define NTU of a heat exchanger? When is it used? (4)
b) With a neat sketch explain the shell and tube heat exchangers. (10)

MODULE V

19. a) Explain the concept of a black body. (4)
b) Two parallel discs of 1m diameter face each other. The distance between them is 1m. The temperatures are 300°C and 80°C with emissivity value of 0.2 and 0.6 respectively. Determine heat exchange by radiation. (10)

OR

20. a) Two parallel rectangular surfaces 1m x 2m are opposite to each other at a distance of 4m. The surfaces are black and at 100°C and 200°C. Calculate the heat exchange by radiation between the two surfaces. (4)
b) Explain (i) Radiation shield (ii) Shape factor (iii) Absorptivity (iv) Reflectivity (v) Transmissivity (10)

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