SATHYABAMA UNIVERSITY

(Established under section 3 of UGC Act,1956)

Course & Branch :B.E - AERO

Title of the Paper :Heat Transfer — Max. Marks :80

Sub. Code :526603/626603 — Time : 3 Hours

Date :27/04/2010 — Session :FN

PART - A (10 x 2 = 20)

Answer ALL the Questions

1. What is Fourier's law of heat conduction?

2. What is critical thickness of insulation?

3. Mention the importance of Biot Number.

4. Define Nusselt and Prandtl number.

5. State Kirchhoff's Law of Radiation.

6. Define absorptivity, reflectivity and transmissivity.

7. Expand LMTD and NTU.

8. Differentiate between parallel and counter flow heat exchanger.

9. What is meant by Mach number?

10. Define the term propulsive efficiency.

PART – B (5 x 12 = 60)

Answer All the Questions

11. (a) Derive general heat conduction equation in Cartesian coordinates.

(b) An exterior wall of a house may be approximated by a 0.1m layer of common brick (K = 0.7 W/m°C) followed by a 0.04m layer of gypsum plaster (K = 0.48 W/m°C). What thickness of loosely packed rock wool insulation (K=0.065 W/m°C) should be added to reduce the heat loss or (gain) through the wall by 80%?

(or)

12. The temperature distribution across a large concrete slab (K = 1.2W/m°C, $\propto$ = 1.77 x 10^{-3} m^2/hr) 500mm thick heated from one side as measured by thermocouples approximates to the relation:

$$T = 60 - 50x + 12x^2 + 20x^3 - 15x^4$$

Where ‘t’ is in °C and x is in meters. Considering an area of 5 m^2 compute:

(a) The heat entering and leaving the slab in unit time.

(b) The heat energy stored in unit time.

(c) The rate of temperature change at both sides of the slab, and

(d) The point where the rate of heating or cooling is maximum.

13. Air stream of 30°C moves with a velocity of 0.3 m/s across a 100W electric bulb at 130°C. If the bulb is approximated by a 0.06m diameter sphere, estimate the rate and the percentage lost due to convection alone.

(or)

14. (a) Air at 8 kN/m^2 and 242°C flows over a flat plate of 0.3m wide and l m long at a velocity of 8m/s. If the plate is maintained at a temperature of 78°C, estimate the heat to be removed continuously from the plate.

(b) A 0.30 m long glass plate at 77°C is hung vertically in air at 27°C. Calculate the boundary layer thickness at the trailing edge and the average Nusselt number of the plate.

15. In a counter-flow double pipe heat exchanger, water is heated from 25°C to 65°C by an oil with a specific heat of 1.45kJ/kg K and mass flow rate of 0.9kg/sec. The oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 W/m^2 °C, calculate the following:
(a) The rate of heat transfer
(b) The mass rate flow of water
(c) The surface area of the heat exchanger.

(or)

16. (a) Explain how heat exchangers are classified.
(b) A counter flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500 kg/h. The steam enters the heat exchanger at 180°C and leaves at 130°C. The inlet and exit temperatures of water are 30°C and 80°C respectively. If U=814 W/m^2°C, calculate the heat transfer area. What would be the increase in area if the fluid flows were parallel?

17. Two parallel plates of size 1.0m x 1.0m spaced 0.5m apart are located in a very large room, the walls of which are maintained at a temperature of 27°C. One plate is maintained at a temperature of 900°C and the other at 400°C. Their emissivities are 0.2 and 0.5 respectively. If the plates exchange heat between themselves and surroundings, find the net heat transfer to each plate and to the room. Consider only the plate surfaces facing each other.

(or)

18. (a) Define Stefan-Boltzmann law.
(b) Calculate the net radiant heat exchange per m^2 area for a large parallel plates at a temperature of 427°C and 27°C respectively. $\in$ (hot plate) = 0.9 and $\in$(cold plate) = 0.6. If a polished aluminium shield is placed, between them, find the percentage reduction in heat transfer, $\in$ (shield) = 0.4

19. A theoretical gas turbine receives air at 1 bar and 27°C. The maximum allowable temperature is 727°C. The pressure ratio is 5 to 1. Determine per kg of air the work of compressor, the work of turbine and the net work. Also, determine the thermal efficiency of the cycle. If the mass flow rate of air is 5 kg/s, what is the power output?

(or)

20. A 1.75 m dia. Propeller of an aeroplane discharges 350 m^3/s of air at a flight speed of 360 km/h in still air of density 1.225 kg/m^3. Calculate

(a) thrust and

(b) propulsive efficiency.