

M.E. DEGREE EXAMINATIONS: DECEMBER 2008

First Semester

ENERGY ENGINEERING

P07EN101 Advanced Heat Transfer

Time: Three Hours

Maximum Marks: 100

Answer ALL Questions:-

(Use of HMT Data Book permitted)

Part A (20 X 1 = 20 Marks)

1. A perfect black body is one which
 - (a) Is black in colour
 - (b) reflects all heat
 - (c) transmits all heat radiations
 - (d) absorbs heat radiations of all wave lengths

2. Plank's law holds well for
 - (a) Black bodies
 - (b) polished bodies
 - (c) all colored bodies
 - (d) bodies under thermal equilibrium

3. Heat transfer takes place as per
 - (a) Zeroth law of thermodynamics
 - (b) First law of thermodynamics
 - (c) Second law of thermodynamics
 - (d) Kirchoff's law

4. Thermal conductivity of solid metals with rise in temperature normally
 - (a) Increases
 - (b) decreases
 - (c) remains constant
 - (d) unpredictable

5. A non dimensional number generally associated with natural convection heat transfer is
 - (a) Grashoff number
 - (b) Nusselt number
 - (c) Reynolds number
 - (d) Prandtl number

6. Which of the following property of air does not increase with rise in temperature?
 - (a) Thermal diffusivity
 - (b) Dynamic viscosity
 - (c) Density
 - (d) Kinematic viscosity

7. The value of Prandtl number for air is
 - (a) 0.1
 - (b) 0.3
 - (c) 0.5
 - (d) 0.7

8. The concept of overall coefficient of heat transfer is used in heat transfer of
 - (a) Conduction
 - (b) convection
 - (c) Conduction and convection
 - (d) conduction and radiation

9. In generator type heat exchanger, heat transfer takes place by
 - (a) Direct mixing of hot and cold fluids
 - (b) Flow of hot and cold fluids alternatively over a surface
 - (c) Complete separation between hot and cold fluids
 - (d) Generation of heat

10. Log mean temperature difference in case of counter flow compared parallel flow will be
 - (a) More
 - (b) less
 - (c) same
 - (d) depends on other factors

11. Heat is transferred by all three modes of transfer, viz., conduction, convection and radiation in
 - (a) Electric heater
 - (b) boiler
 - (c) steam condenser
 - (d) electric heater

12. Which of the following is a case of steady state heat transfer?
 (a) I.C. Engine (b) air preheater (c) air compressor (d) none of the above
13. If the bubbles formed on a submerged hot surface get absorbed in the mass of liquid, the process of boiling is termed as
 (a) Nucleate boiling (b) film boiling (c) pool boiling (d) all of the above
14. Drop wise condensation occurs on a
 (a) Glazed surface (b) smooth surface (c) oily surface (d) none of the above
15. $D_{BA} = D_{AB}$ in case of
 (a) stagnant diffusion (b) equimolar diffusion
 (c) both (a) and (b) (d) none of the above
16. The wavelength value for maximum emissive power is given by
 (a) Kirchoff's law (b) Stefan's law (c) Plank's law (d) Wien's law
17. Relaxation method was first introduced by
 (a) Euler (b) Prandtl (c) South well (d) Vonkarman
18. Fourier's law of heat conduction is valid for
 (a) One dimensional cases only (b) two dimensional cases only
 (c) three dimensional cases only (d) all of the above
19. Numerical analysis is used for solving problems involving
 (a) Complex geometries (b) complex boundary conditions
 (c) variable properties (d) all of the above
20. The heat transfer equation $\frac{\partial^2 t}{\partial x^2} + \frac{\partial^2 t}{\partial y^2} + \frac{\partial^2 t}{\partial z^2} = 0$
 is known as
 (a) Stefan-Boltzmaan equation (b) Grashoff equation
 (c) Lap lace equation (d) Fourier equation

Part B (5 X 16 = 80 marks)

21. a). Three 10 mm diameter rods, A, B and C protrude from a steam bath at 100°C to a length of 25 cm into the atmosphere at 20°C . The temperatures at the other ends are found to be 26.76°C for A, 32°C for B and 36.93°C for C. Neglecting the effects of radiation and assuming the surface film coefficient of heat transfer as $23\text{ W/m}^2\text{K}$. Evaluate their thermal conductivities. (16)

(OR)

- 21.b). (i) An enclosure measures 1.5 m X 1.7 m with a height of 2 m. The walls and ceiling are maintained at 250°C and the floor at 130°C . The walls and ceiling have an emissivity of 0.82 and the floor 0.7. Determine the net radiation to the floor (10)
- (ii) Explain what you mean by absorptivity, reflectivity and transmissivity. (6)

22.a). Air at atmospheric pressure and 100°C enters a tube of diameter 4 cm and length 2m with a velocity of 9 m/s. A 1KW electric heater is wound on the outer surface of the tube. Find

(i) mass flow rate of the air

(ii) the exit temperature of air and

(iii) Wall temperature at the outlet. Assume that the rate of heat absorption by air per unit area is uniform throughout the length of the tube. Take for air, $R=0.287$ KJ/kgK and $C_p=1.005$ KJ/kgK (16)

(OR)

22.b). Air flows with 30 m/s velocity through a tube of 2cm diameter and 1m length. The air intake temperature is 20°C , and its pressure is 101.3 KPa. The pressure loss in the tube is 8cm of water column. How much heat is transferred from the tube wall to the air when the wall is heated to a temp of 95°C ? (16)

23.a). (i) Estimate the power required to boil water in a copper pan 0.35 m in diameter. The pan is maintained at 120°C by an electric heater. What is the evaporation rate? Estimate the critical heat flux (10)

(ii) Explain about drop wise condensation (6)

(OR)

23.b). Water ($C_p=4.187$ KJ/kgK) is heated at the rate of 1.4 kg/s from 40°C to 70°C by an oil ($C_p=1.9$ KJ/kgK) entering at 110°C and leaving at 60°C in a counter flow heat exchanger. If $U_0 = 350$ W/m²K. Calculate the surface area required. Using the same entering fluid temperatures and the same oil flow rate, calculate the exit temperatures of oil and water and the rate of heat transfer, when the water flow rate is halved. (16)

24.a). Discuss the steps involved in the finite difference formulation using Crank-Nicolson method. (16)

(OR)

24.b). Discuss the steps involved in the relaxation method to solve two dimensional steady state conduction problems. (16)

25.a). i) Discuss the Fick's law of diffusion (6)

ii) Define Schmidt, Sherwood and Lewis numbers. What is the physical significance of each? (10)

(OR)

25.b). Explain about the heat transfer correlations used in I.C. Engines. (16)
