Register Number: ……

B.E. DEGREE EXAMINATIONS: APRIL/MAY 2012

Sixth Semester

MECHANICAL ENGINEERING

MEC118: Heat and Mass Transfer

(Use of HMT data book and Steam tables are permitted)

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

Answer ALL the Questions.

PARTA (10 x 1 = 10 Marks)

1. Transfer of heat by conduction does not occur if the

   a) bodies are kept in vacuum b) temperature difference between the bodies does not exist

   c) bodies are kept in water d) parts of the body does not have relative motion

2. Mention the Laplace's equation for steady state conduction.

   a) $\nabla^2 T + q/k = 0$ b) $\nabla^2 T - q/k = 0$ c) $\nabla^2 T = 0$ d) $\nabla^2 T + q = 0$

3. Among these which one is having low Prandtl number?

   a) Air b) Water c) Liquid metals d) Engine oil

4. Heat transfer rate in drop wise condensation is nearly _____ times higher than that of film wise condensation.

   a)7 b) 10 c) 5 d) 2

5. Which of the following is considered as the best compact heat exchanger ?

   a) Car radiators b) Glass ceramic gas turbine

   c) Human lungs d) Regenerator of Stirling engine

6. The thermal boundary layer thickness is thicker than the momentum boundary layer thickness, when Prandtl number is

   a) equal to 1 b) greater than 1 c) less than 1 d) Zero

7. In cross flow heat exchanger, two fluids move _____ to each other

   a) parallel b) opposite c) inclined d) perpendicular

8. For radiation between two large parallel plates of emissivities ε_1 and ε_2 , the effective emissivity is given by

   a) $(1/\varepsilon_1) + (1/\varepsilon_2)$ b) $\varepsilon_1 \varepsilon_2$ c. $\dfrac{1}{(1/\varepsilon_1)+ (1/\varepsilon_2) + 1}$ d. $\dfrac{1}{(1/\varepsilon_1)+ (1/\varepsilon_2) - 1}$

9. Which of the following represents Fick's first law

   a) dCA/dt = DAB.d2CA/dz2 b) g = KA dt/dx c) J = - μ dγ/dx d) JA = - DAB dCA/dz

10. The ratio of kinematic viscosity to mass diffusivity is known as

a) Schmidt number b) Lewis number c) Sherwood number d) Stanton number

PART B (10 x 2 = 20 Marks)

11. State Fourier's law of conduction.
12. What is meant by critical radius of insulation?
13. Define extended surfaces or fins and its applications.
14. Indicate the significance of boundary layer.
15. Define Hydrodynamic boundary layer and thermal boundary thickness.
16. What is meant by Effectiveness of the heat exchanger?
17. What is meant by Fouling factor?
18. What is the purpose of radiation shield?
19. Differentiate between natural convective and forced convective mass transfer?
20. What is meant by molecular diffusion?

PART C (5 x 14 = 70 Marks)

21. a) (i) Derive an expression general heat conduction equation in Cartesian coordinates. (7)

(ii) An aluminum alloy fin of 5mm thick and 40 mm long and 1m width protrudes from a wall. The base temperature is 420^{o}C and ambient air temperature is 25^{o}C. The heat transfer co-efficient between aluminum rod and environment is 25 W/m^{2}K. Calculate the heat loss from the fin material taking its thermal conductivity as 200 W/m-K. Also find efficiency of the fin. (7)

(OR)

b) (i) Explain the significance of Biot number in transient heat conduction. (4)

(ii) A 50 × 50 cm^{2} aluminum slab of 6mm thick is at 400^{o}C, initially and is suddenly immersed in water. So its surface temperature is lowered to 50^{o}C. Determine the time required for the slab to reach 120^{o}C by lumped heat analysis. Take heat transfer co -efficient h=100 w/m^{2}K. (10)

22. a) Air at 40^{0}C flows over a tube with a velocity of 30 m/s.The tube surface temperature is 120^{0}C. Calculate convective heat transfer co-efficient and amount of heat transfer for the following cases. Take length as 1m.

1. Tube could be square with a side of 6cm
2. Tube is circular cylinder of diameter 6cm.

(OR)

b) (i) Differentiate between free convection an forced convection. (4)

(ii) Water at 50^0C enters 50 mm diameter and 4 m long tube with a velocity of 0.8 m/s. The tube wall is maintained at a constant temperature of 90^0C. Determine the convective heat transfer coefficient and total amount heat transferred if exit temperature of water is 70^0C. (10)

23. a) A heating element cladded with metal is 8mm diameter and of emissivity is 0.92. The element is horizontally immersed in a water bath. The surface temperature of the metal is 260^0C under steady state boiling conditions. Calculate the power dissipation per unit length of the heater.

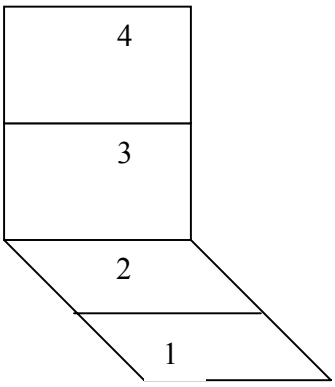
(OR)

b) A parallel flow heat exchanger has hot and cold water stream running thro' it, the flow rates are 10 and 25 kg/min respectively. Inlet temperatures are 75^0C and 25^0C on hot and cold side. The exit temperature on the hot side should not exceed 50^0C. Assume $h_i = h_o = 600$ W/m^2 K . Calculate the area of heat exchanger using € -NTU approach.

24. a) Emissivites of two large parallel plates maintained at T_1K and T_2 K are 0.6 and 0.6 respectively. Heat transfer is reduced by 75 times when a polished aluminum radiation shields of emissivity 0.04 are placed in between them. Calculate the number of shields required.

(OR)

b) The size of each square is 1 m × 1 m. Determine the view factor F_{1-4} for the figure shown



25. a) (i) Correlate mass transfer and heat transfer with suitable terms. (4)

(ii) The molecular weight of two components A and B are 24 and 48 respectively. The molecular weight a gas mixture is found to be 30. If the mass concentration of the mixture is 1.2 kg/m^3.

Determine the following (10)

(i) Density of component A and B

(ii) Molar fractions

(iii) Mass fractions

(iv) Total pressure if the temperature of the mixture is 290K

(OR)

b) Dry air at 20^0C [$\upsilon = 15.5 \times 10^{-6}$ m^2/s . D = 4.2×10^{-5} m^2/s,ρ=1.2 kg/m^3] flows over a flat plate of length 50 cm which is covered with a thin layer of water at a velocity of 1 m/s. Estimate the local mass transfer co efficient at a distance of 10 cm from the leading edge and average mass transfer co-efficient.

****