B.E., DEGREE EXAMINATIONS: APRIL/MAY 2014

(Regulation 2009)

Sixth Semester

MECHANICAL ENGINEERING

MEC118: Heat and Mass Transfer

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

Answer ALL Questions:-

PART A (10x1=10 Marks)

1. In a slab under steady state condition if the thermal conductivity increases along the thickness , the temperature gradient aling the direction will become

    (a) Steeper   (b) flatter

    (c) Will depend up on the heat flow   (d) will remain constant.

2. An increase in convection coefficient over a fin will

    (a) Increase effectiveness   (b) Decrease effectiveness

    (c) Does not influence effectiveness   (d) Influences only the fin efficiency

3. Heating or cooling of a road surface can be analysed using

    (a) Lumped parameter model   (b) infinite slab model

    (c) semi infinite slab model   (d) boundary model

4. Heat transfer rate

    (a) Will be higher in turbulent flow   (b) will be lower in turbulent flow

    (c) will depend only on the fluid   (d) will depend only on viscosity

5. The boundary layer thickness in laminar flow over a flat plate, is propotional to

    (a) x   (b) $x^{0.5}$

    (c) $x^{-0.5}$ (d) x^{-1}

6. In pipe flow,the average convection coefficient

    (a) will be higher in rough pipe.   (b) will be higher in smooth pipe.

    (c) roughness affects only pressure drop & not the convection co-efficient.   (d) only Reynolds and Prandtl number influence the convection and not the roughness.

7. When one of the fluid is condensing the best flow arrangement is

    (a) counter flow   (b) parallel flow

    (c) cross flow   (d) are all equal

8. Thermodynamically the type which leads to lower loss in availability is

    (a) parallel flow   (b) counter flow

    (c) cross flow   (d) shell and tube

9. A radiation shield should have

    (a) high emissivity   (b) high absorptivity

    (c) high reflectivity   (d) high emissive power

10. The flow direction is immaterial in the case of heat exchange from

    (a) wet or saturated steam to water   (b) water to gas

    (c) oil to water   (d) oil to gas

PART - B (10 x 2 = 20 Marks)

11. State newton's law of cooling.

12. Confer the mechanism of heat conduction in solids.

13. What is the physical meaning of fourier number?

14. Draw the velocity and temperature profiles for free convection of a hot vertical plate.

15. Delineate about the burnout point.

16. Define NTU of a heat exchanger. Is it correct to say that, larger the NTU, larger the heat exchanger will be?

17. What is a black body?

18. What does the view factor represent? When the view factor from a surface to itself is not zero?

19. State the Fick's law of diffusion.

20. What do you understand by steady state molecular diffusion?

PART C (5 x 14 = 70 Marks)

21. a) A steel tube of 5 cm id, 7.6 cm OD and k = 15 w/mk is covered with an insulation of thickness,2 cm and thermal conductivity, 0.2 w/mk . A hot gas at 330°c and h = 400 w/m^2 k flows inside the tube . The outer surface of the insulation is exposed to cold air at 30 c with h = 60 w/m^{2}k. Assuming a tube length of 10 m ,find the heat loss from the tube to the air . Also find, across which layer the largest temperature drop occurs.

(OR)

b) Obtain an expression for the temperature profile of an infinitely long fin of uniform cross section from basic principles and hence calculate the heat transfer by fin.

22. a) (i) Explain the thermal and velocity boundary layer for flow over a horizontal flat plate. (7)

(ii) Engine oil (k = 0. 14 w/mk , v = 80 x 10 $^{-6}$ m^2/s) flows with a mean velocity 0.2 (7) m/s inside a 1:25 cm diameter tube which is electrically heated at the wall at a uniform rate of 2.45 kw/m^2 . The heat transfer is taking place in the fully developed region. Calculate the temperature difference between the tube wall surface and the mean flow temperature.

(OR)

b) Cylindrical cans of 150 mm length and 65 mm diameter are to be cooled from an initial temperature of 20°c by exposing them to atmospheric air at a temperature of 1°c and a pressure of 1 bar. Find the cooling rates when the cans are kept in (i) horizontal position (ii) vertical position.

23. a) Explain briefly the various regimes of pool boiling of water at atmospheric pressure.

(OR)

b) A heat exchanger is designed to cool 8.7 kg/s of alcohol (c$_p$ = 3.84 kj/kg k) from 75°c with cooling water entering the tube side at 15 c and a flow rate of 9.6 kg /s . the overall heat transfer coefficient based on the outer surface of the tube is 500 w/m^{2}k .find the heat transfer area for the following flow arrangements:

(i) One shell pass and two tube passes

(ii) Cross-flow, both fluids unmixed.

24. a) Explain briefly the following:

(i) Thermal radiation

(ii) Specular and diffuse reflection

(iii) Reciprocity rule and summation rule.

(OR)

b) A truncated cone has top and bottom diameters of 10 cm and 20 cm and a height of 10 cm. Estimate the shape factor between the top surface and the side and also the shape factor between the side and itself.

25. a) (i) Explicate briefly the similarities between heat transfer and mass transfer. (7)

(ii) The composition of dry atmospheric air on a molar basis is 78.1 % N$_2$, 20.9 % (7) O$_2$ and 1% Ar. Neglecting the other constituents , find the mass fractions of the constituents of air.

(OR)

b) Consider air inside a tube of surface area 0.5 cm^2 and wall thickness 10 mm. The pressure of air drops from 2.2 bar to 2.18 bar in 6 days. The solubility of air in the rubber is 0.072 m^3 of rubber at 1 bar. Determine the diffusivity of air in rubber at the operating temperature of 300 k if the volume of air in the tube is 0.028 m^3.

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