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**Reg. No. :**

**Question Paper Code: 46072**

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2017

Sixth Semester

Mechanical Engineering

14UME602- HEAT AND MASS TRANSFER

(Regulation 2014)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The conduction heat diffuses in a material when the material has:.

(i) High thermal conductivity (ii)Low density

(iii)High specific heat (iv)High viscosity

(a) i) and ii) (b) ii) and iii) (c) iii) and iv) (d) iv) and i)

2. Three fins of equal length and diameter but made of aluminium, brass and cast-iron are

heated to 200o C at one end. If the fins dissipate heat to the surrounding air at 25 o C the

temperature at the free end will be least in case of

(a) Aluminium fin (b) Brass fin

(c) Cast-iron fin (d) Each fin will have the same temperature at the free end

3. A dimensionless number that connects the link between velocity flow field and the

temperature field is

(a) Nusselt number (b) Prandtl number (c) Reynolds number (d) Grashof number

4. The characteristic length for computing Grashof number in the case of horizontal

cylinder is

(a) The length of the cylinder (b) The diameter of the cylinder

(c) The perimeter of the cylinder (d) The radius of the cylinder

5. In a two-fluid heat exchanger, the inlet and outlet temperatures of the hot fluid are 65 o C and 40 o C respectively. For the cold fluid, these are 15 o C and 43 o C. The heat exchanger is a

(a) Parallel flow heat exchanger (b) Counter heat exchanger

(c) Mixed heat exchanger (d) Phase-change heat exchanger

6. In a shall and tube arrangement, the fluid that can be said to be mixed the\_\_\_\_\_side

fluid.

(a)Shell side (b) Shell& tube (c) Tube side (d) None of the above

7. If a body is at 200 K, the wave length at which the body emits maximum amount of

radiation is.

(a) 1.45 µm (b) 1.45 cm (c) 0.345 cm (d) 0.345 µm

8. For a hemispherical furnace with a flat circular base of diameter D, the view factor from

the dome to its base is

(a) 0.5 (b) 1.0 (c) 0 (d) 0.32

9. Eddy diffusion takes place when fluids are in

(a) Laminar motion (b) Turbulent motion

(c) Uniform motion (d) Unsteady motion

10. The dimensionless number related to mass transfer is

(a) Prandtl Number (b) Nusselt Number

(c) Sherwood Number (d) Reynolds number

PART - B (5 x 2 = 10 Marks)

11. Define fourier law of heat conduction.

12. What is Hydrodynamic boundary layer?

13. Distinguish LMTD and NTU Method.

14. Deifne Stefan bollzman law.

15. Define Schmidt Number and specify its significance.

PART - C (5 x 16 = 80 Marks)

16. (a) The boiler furnace has the effective dimensions 4m×3m×3m high. The walls are constructed from and inner firebrick wall 25 cm thick (k=0.4 W/mK), a layer of ceramic blanket insulation (k=0.2 W/mK) 8 cm thick and a steel protective layer (k=54 W/mK) 2mm thick. The insulated temperature of the firebrick layer was measured as 600°C and the temperature of outside insulation as 60°C. Determine the rate heat loss through the vertical walls of the furnace. Also calculate temperature drop across the steel layer.

(16)

Or

(b) (i) A rod of 12mm dia is used as fin of length 0.08m.The material conductivity is

15.5W/mk.The convection co efficient is 25W/m2K. Compare the heat flow if the

same volume is used for two of fins same length.Assuming shortfin end insulated. (10)

(ii) One end long rod 1cm dia having a thermal conductivity of 45W/mk is placed in

a furnace.The rod is exposed to air at 300c over it is surface and the correction

coefficient is estimated at 35W/m2K.If the temperature is send as 2650c at a

distance of 39.3mm from the furnace end,determine the base temperature of the

rod. (6)

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17. (a) A vertical plate 0.25 m high is maintained at a temperature of 70 ⁰C in a still

atmosphere of air at 25⁰C. Compute the boundary layer thickness at the trailing

edge of the plate. What would be the boundary layer thickness if this plate were

placed in an air stream flowing at a velocity of 5 m/s over the plate? (16)

Or

(b) A plate at 90 o C is located parallel to an air stream flowing at a speed of 75 m/s. The temperature of air is 0 oC. The plate is 60 cm wide and 45 cm long. Assuming a transition Reynolds number 4x105. Calculate the average heat transfer and friction coefficients for the laminar and turbulent region of the plate. (16)

18. (a) Exhaust gases flowing through the tubular heat exchanger at the rate of 0.4 kg/s are

cooled from 450 o C to 150 o C by water initially at 15 o C. The specific heats of

exhaust gases and water may be taken as 1.13 and 4.19 kJ/kg/ o C respectively and

the overall heat transfer coefficient from gases to water is 140 W/m2/ o C. Calculate

the surface area required for the following cases i) parallel flow ii) counter flow,

when the cooling water flow rate is 0.5 kg/s. (16)

Or

(b) In a shell and tube heat exchanger with 8 tube passes through the shell, hot engine

oil available at 160 o C flows through the shell and water through the tubes. Water at

the rate of 2.5 Kg/s is heated from 15 o C to 85 o C and there are 10 tube per pass.

The diameter of each tube is 2.5 cm and the average convection coefficient

ho=400 W/m2K. Determine the flow rate of oil if its exit temperature to be

100 o C. Also compute the length of the tubes. (16)

19. (a) A double-walled spherical vessel used for storing liquid oxygen consists of an

inner sphere of 30 cm diameter and an outer sphere of 36 cm diameter. Both the

surfaces are covered with a paint of emissivity 0.5. The temperature of liquid

oxygen stored is -183o C where as the temperature of the outer sphere is 20o C.

Calculate the radiation heat transfer through the walls into the vessel and the rate of

evaporation of liquid oxygen if its latent heat of vaporizations is 213.54kJ/kg. (16)

Or

(b) Two parallel plates 2mx1m are placed 1m apart. The temperature and the emissivity

of the plates are respectively 500o C, 300o C, 0.8 and 0.5. Calculate the net radiant

heat exchange between them. If a third plate of a same size, but with an emissivity

of 0.6 is introduced between the two plates, find the temperature of the third plate

and the heat gained by the colder plate. (16)

20. (a) (i) H2 diffuses through 10 mm thick steel wall. The concentration of H2 in the

steel at the inner surface is 1 K mol/m3 while its concentration at the outer

surface is negligible. If the binary diffusion coefficient of H2 in s teel is

0.26x10-12 m2/s. What is the diffusion flux for H2 through the steel? (10)

(ii) In a gas mixture consisting of Hydrogen and Oxygen. Hydrogen moves with

a velocity of 1m/s and its mole fraction is 0.2. Calculate the mass and molar

average velocity. (6) Or

(b) (i)Breifly explain the ficks law of diffusion. (6)

(ii) A tank contains a mixture of CO2 and N2 in the mole proportions of 0.2 and 0.8 at 1bar and 290K.It is connected by a duck of sectional area 0.1m2 to another tank containing a mixture of CO2 and N2 in the molar propotion of 0.8 and 0.2.The duct is 0.5m long. Find the diffusion rates of CO2 and N2. D=0.16X 10-4 m2/s. (10)