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Question Paper Code: 46702A

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2018

Sixth Semester

Mechanical Engineering

14UME602 - HEAT AND MASS TRANSFER

(Regulation 2014)

(HMT tables, Steam table, Mollier chart and Psychometric chart are permitted)

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. Fins are made as thin as possible to

   (a) reduce the total weight
   (b) accommodate more number of fins
   (c) increase the which for the same profile area
   (d) improve the flow of coolant around the fin

3. The free convection heat transfer is significantly affected by

   (a) Reynolds number (b) Grashoff number
   (c) Prandtl number (d) Stanton 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. The steam condenser in a thermal power plant is heat exchanger of the type

(a) direct contact (b) regenerator

(c) recuperator (d) none of these

6. In a heat exchanger with one fluid evaporating or condensing, the surface area required is least in

(a) parallel flow (b) counter flow

(c) cross flow (d) all the above

7. What is the basic equation of radiation from which all other equations of radiation equations can be derived

(a) Stefan-Boltzman equation (b) Plancks equation

(c) Wiens equation (d) Rayleigh-Jeans formula

8. A radiation shield should

(a) Have high transmissivity

(b) absorb all the radiations

(c) Have high reflective power

(d) partly absorb and partly transmit the incident radiation

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. What are the factors affecting thermal conductivity?

12. What is Hydrodynamic boundary layer?

13. Distinguish LMTD and NTU Method.

14. What is emissive power?

15. State Ficks first law of diffusion.

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/m^2K. 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 30^0c over it is surface and the correction coefficient is estimated at 35W/m^2K.If the temperature is send as 265^0c at a distance of 39.3mm from the furnace end,determine the base temperature of the rod. (6)

17. (a) Air at 8 *KN/m*^{2} and 242º *C* flows over a flat plate of 0.3 *m* wide and 1 *m* long at a velocity of 8 *m/sec*. If the plate is maintained at a temperature of 75º *C*. Estimate the heat to be removed continuously from the plate. (16)

Or

(b) A vertical plate *L* = 5 *m* high and *w* = 1.5 *m* wide has one of its surface insulated. The other surface maintained at a uniform temperature 400 *K* is exposed to quiescent atmospheric air at 300 *k*. Calculate the total rate of heat loss from the plate. (16)

18. (a) Air at 120º *C* is cooled to 50º *C* by passing through the counter flow that exchanger tubes of 12 *mm* ID surrounded by water which enters the cooler at 10º *C* and leaves at 25º *C*. Find the LMTD. If the air velocity in the tube is limited to 6 *m/s*, find the length of the tube required. Tube inside heat transfer coefficient is 65 *W/m*^{2}*K* and tube water side heat transfer coefficient is 200 *W/m*^{2}*K*, density of air = 2.85 *kg/m*^{3}, for air *Cp* = 1.005 *KJ/KgK*. (16)

Or

(b) An air craft counter flow heat exchanger for liquid metal and air is designed and got the following temperatures. T_1 = 800º *C*, T_2 = 500º *C*, t_1 = 300º *C* and t_2 = 700º *C*. The flow rate of air is 110 *kg/*s and Cp_c - 1100 *J/Kgk* and average flow rate of the metal is 160 *kg/s* and Cp_h = 800 *J/Kgk*. the overall heat transfer coefficient based on air side area is 610 W/m^2K. Find the area required for the above mentioned heat transfer use NTU method. (16)

19. (a) Three cylinders of thin wall 150 *mm*, 200 *mm* and 250 *mm* in diameters are arranged concentrically. The temperature of the surfaces of 150 *mm* diameter cylinder and 250 *mm* diameter cylinder are maintained at 800 *k* and 200 *k* respectively. Assuming vacuum between the annular spaces, find out the steady state temperature attained by the surfaces of the cylinder whose diameter is 200 *mm*. Take $\varepsilon_1=\varepsilon_2$ - ε_2 = 0.005. Also find the heat loss per m length of the composite cylinder. (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) A vessel contains binary mixture of O_2 and N_2 with partial pressure in the ratio 0.21 and 0.79 at 15º *C*. The total pressure of the mixture is 1.1 bar. Calculate the following

(i) Molar concentrations
(ii) Mass densities
(iii) Mass factions and
(iv) Molar fractions of each species. (16)

Or

(b) A tank contains a mixture of CO_2 and N_2 in the mole proportions of 0.2 and 0.8 at 1bar and 290K.It is connected by a duck of sectional area 0.1m^2 to another tank containing a mixture of CO_2 and N_2 in the molar propotion of 0.8 and 0.2.The duct is 0.5m long. Find the diffusion rates of CO_2 and N_2. D=0.16X 10^{-4} m^2/s. (16)