Reg. No. : | | | | | | | | | | |

Question Paper Code: 46702

B.E. / B.Tech. DEGREE EXAMINATION, NOV 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. A satellite in space exchanges heat with surroundings essentially essentially by

   (a) conduction (b) convection
   (c) radiation (d) conduction and convection put together

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. ……. Number can be used for convective heat transfer

   (a) Mach (b) Frodue (c) Nusselt (d) None of the above

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. Molecular weight of O_2 is

(a) 77 (b) 28 (c) 40 (d) 32

PART - B (5 x 2 = 10 Marks)

11. What are the factors affecting thermal conductivity?

12. Define Reynolds number.

13. Distinguish LMTD and NTU Method.

14. What is emissive power?

15. Define Scherwood Number.

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) A large plane wall 40 *cm* thick and 8 m^2 area is heated from one side and temperature distribution at a certain time instant is approximately prescribed by the relation $t = 80 - 60X + 12X^2 + 25X^2 - 20X^4$ where temperature t is in degree celsius and the distance X is in meters. Make calculations for the

(i) heat energy stored in the wall in unit time

(ii) rate of temperature change at 20 *cm* distance from the side being heated and

(iii) location where the rate of heating or cooling is maximum

For the wall material, thermal conductivity $k = 6$ *W/mk* and thermal diffusivity $\alpha = 0.02$ m^2/hr. (16)

17. (a) Air at 40^0C flows over a tube with a velocity of 30 m/s. the tube surface temperature is 120^0C, Calculate the rate of heat transfer for the following cases

(i) Tube could be a square with a side of 6 cm.

(ii) Tube is circular cylinder of diameter 6cm (16)

Or

(b) A thin 80cm long and 8cm wide horizontal plate is maintained at a temperature of 130^0C in large tank full of water at 70^0C. Estimate the rate of heat input into the plate Necessary to maintain the temperature of 130^0C. (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^2K and tube water side heat transfer coefficient is 200 W/m^2K, 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 500^o C, 300^o 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) Dry air at 27^{0}C and 1 atm flows over a wet plate 50 cm long at a velocity of 50m/s.Calculate the mass transfer coefficient of water vapour in the air at the end of the plate. D = 0.26 cm^2/s. (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)