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

Question Paper Code: 46702

B.E. / B.Tech. DEGREE EXAMINATION, APRIL 2019

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. Three fins of equal length and diameter but made of aluminium, brass and cast-iron are heated to 200^{o} 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. ……. Number can be used for convective heat transfer

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

4. The convection heat transfer coefficient is laminar flow over a flat plate

(a) increase with the distance
(b) increase if a higher viscosity fluid is used
(c) increase if a denser fluid is used
(d) decrease with increase in free stream velocity

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. Define thermal contact resistance.

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) 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. (16)

Or

(b) (Nichrome, having a resistivity of 100μΩ-cm is to be used as a heating element in a electric heater. The wire used is 2 mm diameter and other design feature include.
Current flow =25 A
Surrounding air temperature=20°C
'K' for Nichrome wire=17.5 W/mK
Surface heat transfer coefficient=46.5 W/m^2K

Calculate rate of heat flow for one meter long heater, and also the temperature at the surface and the central line of Nichrome wire. (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 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 ^{o}C. The plate is 60 cm wide and 45 cm long. Assuming a transition Reynolds number $4x10^5$. Calculate the average heat transfer and friction coefficients for the laminar and turbulent region of 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^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) 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/m^{2}K. 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) 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 $\varepsilon_1=\varepsilon_2 - \varepsilon_2 = 0.005$. Also find the heat loss per m length of the composite cylinder. (16)

Or

(b) Two very large parallel plates are maintained at uniform temperature of T_1 = 1000 *K*, T_2 = 800 *K* and have emissivity of $\varepsilon_1=\varepsilon_2 = 0.2$ respectively. It desired to reduce the net rate of radiation heat transfer between the two plants to one-fifth by placing thin aluminum sheets with an emissivity of 0.15. Determine numbers of sheets that need to be inserted. (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) Dry air at 27*º C* and 1 bar flows over a wet plate of 50 *cm* at 50 *m/sec*. Calculate the mass transfer coefficient of water vapour in air at the end of the plate. (16)
