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

Question Paper Code : 41401

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Fifth/Sixth/Seventh Semester
Mechanical Engineering
ME 6502 – HEAT AND MASS TRANSFER
(Common to Mechanical Engineering (Sandwich) Mechanical and Automation Engineering)
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

State clearly any assumption made with justification.
Use of standard HMT data book and steam tables are allowed.

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. What are the conditions needed to check for solving transient conduction problems using by Heisler charts ?
2. How do you select the thickness of insulation to prevent and support heat transfer ?
3. What is the thermal entry length for normal water flowing through a pipe of 5 mm radius if the Reynolds number is 2000 ?
4. A horizontal plate is insulated at one side and other side is not. Assume plate temperature is lesser than the surrounding air temperature. To support heat transfer, suggest the orientation of plate (i.e. facing up or down) with valid reason.
5. What is microheat exchanger ?
6. What are the effects of non-condensable gases in condenser ?
7. Two black square plates of size 1.0 m by 1.0 m are kept parallel to each other at the depth of 0.4 m. One plate is maintained at a temperature of 800°C and the other at 420°C. Find the net exchange of energy due to radiation between the two plates.

8. In Gas radiation, what is Beer's law ?

9. What is the significance of Lewis number ?

10. Compare the Reynolds analogy of heat transfer and mass transfer.

PART – B **(5×13=65 Marks)**

11. a) An electric motor casing has a diameter of 0.36m and length of 0.4 m. The casing is made from cast steel (k=60 W/m.K) and number of fins are installed over the entire length of motor casing to dissipate 400 J/s of heat into an ambient air whose heat transfer coefficient is 10 $W/m^2.K$. If each fin is 8 mm thick and 10 mm long, calculate the number of fins required to maintain the temperature difference between casing and surrounding air of 30°C. Use corrected fin length concept.

(OR)

b) A long cylinder of radius 15 cm initially at 30°C is exposed over the surface to gases at 600°C with a convective heat transfer coefficient of 65 $W/m^2.K$. Determine the temperature at the centre, mid radius and outside surface after 20 minutes. Also calculate the heat flow. Take, Density = 3550 kg/M^3, Specific heat = 586 J/kg.K, thermal conductivity = 19.5 W/m.K.

12. a) A 10 cm diameter sphere is maintained at 120°C. It is enclosed in a 12 cm diameter concentric spherical surface maintained at 100°C. The space between two spheres is filled with air at 200 kPa. Calculate the convective heat transfer rate from inner sphere.

(OR)

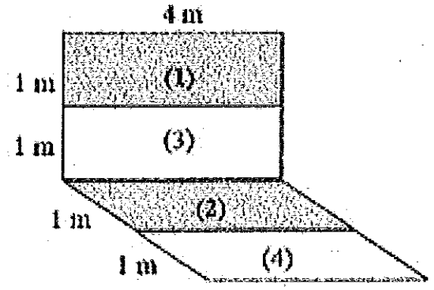
b) Consider a hot automotive engine, which can be approximated as a 0.5 m-high, 0.40 m-wide, and 0.8 m-long rectangular block. The bottom surface of the block is at a temperature of 100°C and has an emissivity of 0.95. The ambient air is at 20°C, and the road surface is at 25°C. Determine the rate of heat transfer from the bottom surface of the engine block by convection and radiation as the car travels at a velocity of 80 km/h. Assume the flow to be turbulent over the entire surface because of the constant agitation of the engine block.

13. a) A 4 kg/s product stream from a distillation column is to be cooled by a 3 kg/s water stream in a contra flow heat exchanger. The hot and cold stream inlet temperatures are 400 K and 300 K respectively and the area of the exchanger is 30 m^2. If the overall heat transfer coefficient is estimated to be 820 W/m^2K, determine the product stream outlet temperature, if its specific heat is 2500 J/kgK and the coolant (C_p=4.18 kJ/kg.K) outlet temperature.

(OR)

b) Saturated steam at 65°C condenses on horizontal cylinder of 0.2 m dia at 55°C. Determine the value of convection coefficient for i) single tube and ii) for a bank of tubes of 5 rows and 6 columns.

14. a) Determine the view factors between the rectangular surfaces shown in the figure.



(OR)

b) The net radiation from the surfaces of two parallel plates maintained at T1 and T_2 is to be reduced by 95%. Find the number of shields to be placed between the two surfaces to achieve this reduction in heat exchange assuming the emissivity of surface 1 as 0.8 and surface 2 as 0.5. Also assume the emissivity of the screens as 0.06.

15. a) i) Explain the physical mechanism of mass diffusion in a binary system. **(6)**

ii) Obtain the expression for steady state diffusion of gases and liquids through solids or plane membrane. **(7)**

(OR)

b) Derive the general mass diffusion equation and finally compare it with the heat conduction equation.

PART – C **(1×15=15 Marks)**

16. a) Air at 35°C and 1 atm. flows at a velocity of 60 m/s over a 0.5 m long flat plate. Calculate the mass transfer coefficient of water vapour in air. Neglect the concentration of vapour in air.

(OR)

b) In a particular solar collector, energy collected by placing a tube in collector and passing fluid through the tube. The arrangement resulting in a uniform heat flux of 2000 W/m^2 along the axis of the tube of diameter 60mm. Determine :

i) Length of the tube required to heat the water from 20°C to 80°C which flows at the rate of 0.01 kg/s.

ii) Surface temperature at the outlet of tube.
