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

Question Paper Code : 42843

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Fourth/Sixth Semester
Mechanical Engineering
ME 2251 : HEAT AND MASS TRANSFER
(Common to Mechanical Engineering (Sandwich) and Mechanical and Automation Engineering)
(Regulations 2008)
(Also common to PTME 2251 – Heat and Mass Transfer for B.E. (Part-Time) Fourth Semester Mechanical Engineering – Regulation 2009)

Time : Three Hours | Maximum : 100 Marks

State Clearly any Assumption made with Justification.
(Use of Approved HMT data book/Steam table is allowed)

Answer ALL questions.

PART – A (10×2=20 Marks)

1. An important property of matter is defined by Fourier's law. What is it ? What is its physical significance ?
2. What is thermal time constant ?
3. How Prandtl number is defined ? Why it is important for convection heat transfer ?
4. What is free convection heat transfer ?
5. What is recuperative type heat exchanger ? Give example.
6. How effectiveness of a heat exchanger is defined ?
7. What is thermal radiation ?
8. What is 'irradiation' and 'radiosity' ?.
9. Name and define the law of governing for diffusion mass transfer.
10. What is the significance when Schmidt number is equal to unity ?

PART – B (5×16=80 Marks)

11. a) It is desired to increase the heat dissipated over the surface of an electronic device of spherical shape of 5 mm radius exposed to convection with $h = 10\ W/(m^2K)$ by encasing it in a transparent spherical sheath of conductivity 0.04 W/(m-K). Determine the diameter of the sheath for maximum heat flow. For a temperature drop of 120°C from device surface determine the heat flow for bare and sheathed device.

(OR)

b) i) A long rod 12 mm square section made of low carbon steel protrudes into air at 35 °C from a furnace wall at 200 °C. The convective heat transfer coefficient is estimated at 22 $W/(m^2K)$. The conductivity of the material is 51.9 W/mK. Determine the location from the wall at which the temperature will be 60°C. Also calculate the temperature at 80 mm from base. **(10)**

ii) For the above case, consider the fin to be 80 mm long and end face convection also exists. Determine the end temperature. **(6)**

12 .a) Air at 273 K at 75 m/s flows over a plate having 45 cm length 62 cm wide. The plate is maintained at 90°C temperature. Assuming the transition of boundary layer takes place at critical Reynolds number of 5×10^5, find the average values of friction coefficient and heat transfer coefficient for the full length of the plate. Also get energy dissipation from the plate.

(OR)

b) Banks of plates are used to dissipate the heat from a transformer. The plates are 0.6 m high and 0.18 m wide. The plate surface is at 80°C and the air is at 40°C. Determine the distance between the plates so that the boundary layers do not interfere. Also calculate the number of plates required to dissipate 2 kW.

13. a) What is flow boiling ? With a neat sketch explain the various stages exist in flow boiling process.

(OR)

b) A cross flow heat exchanger with both fluids unmixed is used to heat water flowing at a rate of 20 kg/s from 25°C to 75°C using gases available at 300°C to be cooled to 180°C. The overall heat transfer coefficient has a value of 95 $W/(m^2K)$. Determine the area required. Also find the gas flow rate. Assume for gas, C_p = 1005 J/(kg-K).

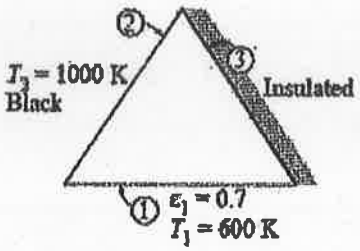
14. a) Two large plates are maintained at a temperature of 900 K and 500 K respectively. Each plate has area of $6m^2$. Compare the net heat exchange between the plates for the following cases.

i) Both plates are black

ii) Plates have an emissivity of 0.5.

(OR)

b) A furnace is shaped like a long equilateral triangular duct, as shown in Figure. The width of each side is 1 m. The base surface has an emissivity of 0.7 and is maintained at a uniform temperature of 600 K. The heated left-side surface closely approximates a blackbody at 1000 K. The right-side surface is well insulated. Determine the rate at which heat must be supplied to the heated side externally per unit length of the duct in order to maintain these operating conditions.



15. a) i) Determine the mole fraction of air dissolved in water at the surface of a lake whose temperature is 17°C. Take the atmospheric pressure at lake level to be 92 kPa. (8)

ii) Consider a nickel plate that is in contact with hydrogen gas at 358 K and 300 kPa. Determine the molar and mass density of hydrogen in the nickel at the interface. (8)

(OR)

b) The partial pressure of diffusing vapour over a surface under steady state of mass transfer was measured and plotted against height above the surface. At the surface the partial pressure was 0.1 bar and in the free stream the partial pressure was 0.02 bar. The tangent to the concentration profile at the surface meets the x-axis at 2.2 mm. Determine the convective mass transfer coefficient $D = 28.8 \times 10^{-6}$ m^2/s.
