Code No.: **83102** **MR18**

MALLA REDDY ENGINEERING COLLEGE (AUTONOMOUS)

(Affiliated to JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD)
Gundlapochampally (H), Maisammaguda (V), Medchal (M), Medchal-Malkajgiri (Dist), Hyderabad

M. Tech. I SEMESTER SUPPLEMENTARY END EXAMINATIONS, MAY-2019

Subject: **Process Heat and Mass Transfer**

Branch: **Thermal Engineering**

Time: 3 hours **Max. Marks: 70**

PART – A

Answer **ALL** questions of the following **5x4Marks=20 Marks**

1. Define efficiency, effectiveness of fin and when they are maximum?
2. Define displacement thickness and energy thickness
3. How heat exchangers are classified.
4. Write briefly about the various discretization schemes
5. State Fick's law of diffusion and from that deduce the units of diffusion coefficient.

PART-B

Answer **ALL** questions of the following **5x10Marks=50Marks**

1. A very long copper rod 20 mm in diameter extends horizontally from a plane heated wall maintained at 100°C. The surface of the rod is exposed to an air environment at 20°C.with convective heat transfer is 8.5 W/m^2-K. Workout the heat loss if thermal conductivity of copper is 400 W/m-K. Further estimate how long the rod to be in order to be considered infinite.

OR

2. Two parallel plates of size 1.0 × 1.0 m spaced 0.5 m apart are located in large room, the walls of which are maintained at a temperature of 300 K and plate is maintained at temperature of 1173 K and other at 673 K. The emissivities of the plates are 02 and 0.5 respectively. If the plates exchange heat between themselves and surroundings, find net heat transfer to each plate and to the room. Consider only the plate surfaces facing each other.
3. Air at 100 kPa and 27°C enters a 5.0 mm diameter smooth tube with a velocity of 3.0 m/s. The length of the tube is 0.1 m. A constant heat flux is imposed on the tube wall. Calculate the heat transfer if the exit bulk temperature is 77°C. Also calculate the exit wall temperature and value of heat transfer coefficient at exit.

OR

4. Air at 100 kPa and 27°C enters a 5.0 mm diameter smooth tube with a velocity of 3.0 m/s. The length of the tube is 0.1 m. A constant wall temperature is imposed on the tube wall. Calculate the heat transfer if the exit bulk temperature is 77°C. Also calculate the exit wall temperature and value of heat transfer coefficient at exit.

5. A copper pan of 350 mm diameter contains water and its bottom surface is maintained at 115°C by an electric heater. Calculate the power required to boil water in this pan and the rate at which water evaporates from the pan due to its boiling process. Also make calculations for the heat flux for these conditions.

OR

6. A counter-flow heat exchanger is used to cool 2000 kg/h of oil with specific heat is 2.5 kJ/kg-K from 105°C to 30°C by the use of water entering at 15°C, if the overall heat transfer coefficient is required to be 1.5 kW/m^2-K, make calculations for water flow rate, the surface area required and effectiveness of heat exchanger. Presume that outlet temperature of water does not exceed 80°C. Use NTU-effectiveness approach
7. The block is 1 m square. The left face is maintained at 100°C and the top face is maintained at 500°C while other faces are exposed to an environment at 100°C with convective heat transfer coefficient of 20 W/m^{2}°C and thermal conductivity of block is 30 W/m°C. Determine nodal equations at corner nodes from fundamentals of numerical heat transfer method

OR

8. The rectangular fin of length 80 mm and height 20 mm has base maintained at 300° C and is exposed to convection environment of heat transfer coefficient, 40 W/m^{2}°C and temperature 20°C. Determine nodal equations at different nodes from fundamentals of numerical heat transfer method
9. 9.a. Hydrogen gas at 27°C and 2..0 bar flows through a rubber tubing of 10 mm inside radius and 20 mm outside radius. The diffusivity of hydrogen through rubber is stated to be 0.75×10^{-4} m^2/h and the solubility of hydrogen is 0.052 m^3 of hydrogen per m^3 of rubber at 1 atmosphere. If the gas constant for hydrogen is 4240 J/kg-K and the concentration of hydrogen at the outer surface of tubing is negligible, calculate the diffusion flux rate of hydrogen per metre length of rubber tubing.

OR

10. An open tank 6 m in diameter contains 1 mm deep layer of benzene (molecular weight =78) at its bottom. The vapor pressure of benzene in the tank is 13.15 kN/m^2. The diffusion takes place through a stagnant air film 2.5 mm thick. The system is operating at 1.013 kN/m^2 atmosphere and 20°C and under these conditions the diffusivity of benzene is 8.0×10^{-6} m^2/s. Assuming the density of benzene as 880 kg/m^3, calculate the time taken for the entire benzene to evaporate.