DEPARTMENT OF MECHANICAL ENGINEERING

ME8693HEAT AND MASS TRANSFER

MODEL EXAM

PART A (10x2=20)

1. State Newton's law of cooling or convection law.
2. Define critical thickness of insulation with its significance
3. Define Reynolds number (Re) &Prandtl number (Pr).
4. Define boundary layer thickness.
5. Give the merits of dropwise condensation.
6. Summerize the term Recuperators.
7. Illustrate Stefan boltzmann law.
8. Compare black body with grey body.
9. List the modes of mass transfer.
10. Define Sherwood Number.

PART B (5x13=65)

11. a.) A hollow cylinder 5 cm inner diameter and 10 cm outer diameter has inner surface temperature of 200°C and outer surface temperature of 100°C. Determine heat flow through the cylinder per meter length. Also determine the temperature of the point half way between the inner and outer surfaces. Take K=1 W/mK.

(Or)

b.) An aluminium fin of 5 mm thick and 40 mm long protrudes from a wall. The base temperature is 420°C and ambient air temperature is 25°C. The heat transfer coefficient between aluminium rod and environment is 25 W/m2K. Calculate the heat loss from the fin of material taking its thermal conductivity as 200 W/mK.

12. a.)Air at 25°C at the atmospheric pressure is flowing over a flat plate at 3 m/s. If the plate is 1 m wide and the temperature Tw = 75°C. Calculate the following at a location of 1 m from leading edge.
    a) Hydrodynamic boundary layer thickness
    b) Local friction coefficient
    c) Thermal boundary layer thickness
    d) Local heat transfer coefficient

(or)

b.) Water flows inside a tube of 20 mm diameter and 3 m long flows at a velocity of 0.03 m/s. The water gets heated from 40° C to 120° C while passing through the tube. The tube wall is maintained at constant temperature of 160° C. Find heat transfer rate.

13. **a.)** Water is to be boiled at atmospheric pressure in a polished copper pan by means of an electric heater. The diameter of the pan is 0.38 m and is kept at 115° C. calculate the following:

(i) Power required to boil the water.

(ii) Rate of evaporation.

(iii) Critical heat flux.

(Or)

b.) In a counter flow double pipe heat exchanger, oil is cooled from 85˚C to 55˚C by water entering at 25˚C. The mass flow rate of oil is 9,800 kg/h and specific heat f oil is 2000 J/kg K. The mass flow rate of water is 8,000 kg/h and specific heat of water is 4180 J/kg K. Determine the heat exchanger area and heat transfer rate for an overall heat transfer co-efficient of 280 W/m2 K.

14. a.) A black body at 3000 K emits radiation. Calculate the following.

i) Monochromatic emissive power at 1 μm wave length.

ii) Wave length at which emission is maximum.

iii) Maximum emissive power.

iv) Total emissive power.

v) Calculate the total emissive of the furnace if it is assumed as a real surface having emissivity equal to 0.85.

(Or)

b.) Two large parallel plates are maintained at a temperature of 900 K and 500 K respectively. Each plate has an area of 6 m2. 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.

15. a.) A vessel contains a binary mixture of O2 and N2 with partial pressures in the ratio 0.21 and 0.79 at 20 ◦C. If the total pressure of the mixture is 1.1 bar, calculate the following.

i) Molar concentrations.

ii) Mass densities.

iii) Mass fractions.

iv) Molar fractions of each species.

(or)

b.) Two large tanks, maintained at the same temperature and pressure are connected by a circular 0.15 m diameter direct, which is 3 m in length. One tank contains a uniform mixture of 60 mole % ammonia and 40 mole % air and the other tank contains a uniform mixture of 20 mole % ammonia and 80 mole % air. The system is at 273 K and 1.013 x 105 pa. Determine the rate of ammonia transfer between two tanks. Assuming a steady state mass transfer.

PART C (1x15=15)

16. a.) A furnace wall consists of three layers. The inner layer is 10 cm thickness is made of fire brick (k=1.04 W/mK). The intermediate layer of 25 cm thickness is made of masonry brick (k=0.69 W/mK) followed by a 5 cm thick concrete wall (k=1.37 W/mK). When the furnace is in continuous operation the inner surface of the furnace is at at 800°C while the outer concrete surface is at 50°C . Calculate the rate of heat loss per unit area of the wall, the temperature at the interface of the firebrick and masonry brick and the temperature at the interface of the masonry brick and concrete.

(or)

b.) Air at 20°C at atmospheric pressure flows over a flat plate at a velocity of 3 m/s. If the plate is 1 m wide and 80°C, Calculate the following at x = 300 mm.

(i) Hydrodynamic boundary layer thickness
(ii) Thermal boundary layer thickness
(iii) Local friction co-efficient
(iv) Average friction co-efficient
(v) Local heat transfer co-efficient
(vi) Average heat transfer co-efficient
(vii) Heat Transfer
(viii) Total drag force on the plate