Reg. No. :

Question Paper Code : X10709

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2021
Sixth/Eighth Semester
Mechanical Engineering
ME 8693 – HEAT AND MASS TRANSFER
(Common to Mechanical Engineering (Sandwich))
(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. When do you recommend fins ?
2. What is the use of lumped analysis ?
3. State the use of Dittus-Boelter equation. Also write its expression.
4. Define Hydrodynamic boundary layer.
5. Distinguish between drop wise and film-wise condensation.
6. Compare the temperature profile for parallel flow and counter flow heat exchanger.
7. Distinguish between black body and gray body.
8. What are surface and space resistance in radiation heat transfer ?
9. Define mass and molar concentration.
10. Give an example of transient mass transfer similar to heat transfer in semi infinite body.

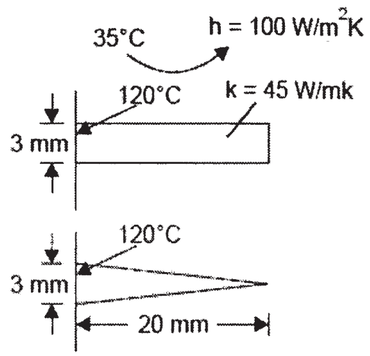
PART – B **(5×13=65 Marks)**

11. a) i) A furnace wall consists of 200 mm layer of refractory bricks, 6 mm layer of steel plate and 100 mm layer of insulation bricks. The maximum temperature of the wall is 150°C on the furnace side and the minimum temperature is 40°C on the outermost side of the wall. An accurate energy balance over the furnace shows that the heat loss from the wall is 400 W/m^2. It is known

that there is a thin layer of air between the layers of refractory bricks and steel plate. Thermal conductivities for the three layers are 1.52,45 and 0.138 W/m°C respectively. Find the temperature of the outer surface of the steel plate.

(OR)

b) Determine the heat flow for (i) rectangular fins and (ii) triangular fin of 20 mm length and 3 mm base thickness. Thermal conductivity = 45 W/m K. Convection coefficient = 100 W/m^{2}K, base temperature = 120°C surrounding fluid temperature = 35°C. Determine also the fin effectiveness.



12. a) Air at 27°C and atmosphere pressure flows over a flat with a velocity of 2 m/s. Estimate (a) the boundary layer thickness at a distance of 20 cm and 40 cm from the leading edge of the plate and (b) the mass flow that enters the boundary layers between x = 20 cm and x = 40 cm . Take μ of air at 27°C as 1.85×l 0^{-5}kg/m.s. Assume unit depth in z-directions. If the plate is heated over its entire length to a temperature of 60°C, calculate the heat transfer in (c) the first 20 cm of the plate and (d) the first 40 cm of the plate. (e) Compute the drag force exerted on the first 40 cm of the plate. Properties of air at 316.5 K are γ = 17.36×10^{-6}m^2/s, k = 0.02749 W/m K, pr = 0.7 and Cp=1.006 kJ/kg K.

(OR)

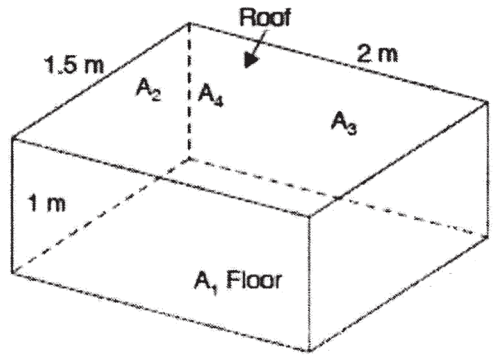
b) Icebergs 1 km long by 0.8 km wide and 0.3 km thick at 0°C are proposed to be towed to arid regions for obtaining supply of fresh water. If the average water temperature is 10°C and if the iceberg is to travel at 1.2 km/hour, determine the thickness of ice melted per hour. The latent heat of ice is 334 kJ/kg. Assume that the iceberg is towed along the 1 km direction.

13. a) Saturated steam at a temperature of 65°C condenses on a vertical surface at 55°C. Determine the thickness of the condensate film at locations 0.2, 0.4, 0.6, 0.8, 1 m from the top. Also determine the condensate flow, the film Reynolds number, and the local and average values of convective heat transfer coefficients at these locations.

(OR)

b) Derive the LMTD expression for counter flow heat exchanger with suitable assumptions.

14. a) Determine the shape factor from the floor of a furnace of 1m × 2m × 1.5m size to the side surfaces and to the roof.



(OR)

b) A furnace in the form of a cube of 2 m side has gas in it at 1500 K. The analysis of gas is 16% CO_2, 10% H_20 and the rest are non radiating gases. Determine the emissivity of the gas body. The total pressure is 1 atm.

15. a) A well is 40 m deep and 9 m diameter and the atmospheric temperature is 25°C. The air at the top is having a relative humidity of 50%. Determine the rate of diffusion of water vapour through the well. Take $D = 2.58 \times 10^{-5}$ m^2/s.

(OR)

b) Air at 25°C and 20% RH flows through a pipe of 25 mm ID with a velocity of 5.2 m/s. The inside surface is constantly wetted with water and a thin water film is maintained throughout. Determine the water evaporated per m^2 surface area.

PART – C **(1×15=15 Marks)**

16. a) A spherical electronic device of 10 mm diameter generates 1 W. It is exposed to air at 20°C with a convection coefficient of 20 W/m^2K. Find the surface temperature. The heat transfer consultant advices to enclose it in a glass like material of k = 1.4 W/mK, to a thickness of 5 mm all around to reduce the temperature. Investigate the problem and also find the thickness to obtain 50°C surface temperature.

(OR)

b) Wind blows at 20 kmph parallel to the wall of adjacent rooms. The first room extends to 10 m and the next one to 5 m. The wall is 3.2 m high. The room inside is at 20°C and the ambient air is at 40°C. The walls are 25 cm thick and the conductivity of the material is 1.2 W/mK. On the inside convection coefficient has a value of 6 W/m^2 K. Determine the heat gain through the walls of each room.