CBCS SCHEME

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21MR62

Sixth Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025
Marine Thermal Engineering

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain the modes of heat transfer with governing laws. **(10 Marks)**

b. Derive general heat conduction equation in Cartesian coordinates. **(10 Marks)**

OR

2 a. Explain the boundary conditions of heat transfer. **(10 Marks)**

b. A steel rod of diameter D = 2cm, L = 25cm and thermal conductivity K = 50W/m-K is exposed to ambient air at T_∞ = 20°C with a heat transfer co-efficient h = 64W/m^2K. If one end of the rod is maintained at a temperature of 120°C, calculate the heat loss from the rod considering it as i) Long fin ii) Insulated end. **(10 Marks)**

Module-2

3 a. With a neat sketch, explain velocity boundary layer and thermal boundary layer. **(10 Marks)**

b. A vertical cylinder 1.5m high and 180mm in diameter is at 100°C in atmospheric temperature of 20°C. Calculate heat loss by free convection. Properties of air at mean temperature as p = 1.06 kg/m^3, v = 18.97 × 10^{-6} m^2/s, c_p = 1.004 kJ/kg°C and K = 0.1042 kJ/mh°C. **(10 Marks)**

OR

4 a. Explain the following dimensionless numbers and their physical significance.

i) Reynolds number (Re)
ii) Prandtl number (Pr)
iii) Nusselt number (Nu)
iv) Stanton number (st) **(10 Marks)**

b. Air at atmospheric pressure and 40°C flows with a velocity of U = 5 m/s over a 2 m long flat plate whose surface is kept at a uniform temperature of 120°C. Determine the average heat transfer coefficient over the 2 m length of the plate. Also find out the rate of heat transfer between the plate and the air per 1 m width of the plate.
Given [at 80°C v = 2:107 × 10^{-5} m^2/s, k = 0.03025 W/mK, pr = 0.6965] **(10 Marks)**

Module-3

5 a. Define heat exchanger and write the classifications. **(05 Marks)**

b. Explain fouling factor in heat exchangers. **(05 Marks)**

c. Exhaust gases flowing through a heat exchanger at the rate of kg/min are cooled from 400°C to 120°C by water initially at 10°C. Specific heat of gases may be taken as 1.13 kJ/kg-K and $U = 502.3 \frac{kJ}{m^2 - hr - k}$. If water flow rate is 25 kg/min. Calculate the surface area needed for parallel flow heat exchanger. **(10 Marks)**

OR

6 a. Explain the concept of black body. **(05 Marks)**

b. Explain Stefan-Boltzman law and Wein's displacement law. **(05 Marks)**

c. Determine the heat lost by radiation per meter length of 8 cm diameter pipe at 300°C if i) Enclosed in a 16 cm diameter red brick duct at a temperature of 27°C ii) Located in a large room with walls at a temperature of 27°C. $\in$(steel pipe) = 0.79, $\in$(brick conduct) = 0.93. **(10 Marks)**

Module-4

7 a. With help of a neat sketch explain vapour compression refrigeration. **(10 Marks)**

b. A carnot refrigerator requires 1.3 kW per tonne of refrigeration to maintain a region at low temperature of -38°C. Determine:

i) COP of carnot refrigerator

ii) Higher temperature of cycle

iii) Heat delivered and COP when this device is used as heat pump. **(10 Marks)**

OR

8 a. Explain the desirable properties of refrigerant. **(10 Marks)**

b. A refrigeration machine is required to produce i.e at 0°C from water at 20°C. The machine has a condenser temperature of 298K while the evaporator temperature is 268 K. The relative efficiency of the machine is 50% and 6 kg of Freon – 12 refrigerant is circulated through the system per minute. The refrigerant enters the compressor with a dryness fraction of 0.6 specific heat of water is 4.187 kJ/kg K and the latent heat of Ice is 335 kJ/kg. Calculate the amount of ice produced in 24 hrs. The table of properties of freon-12 is given below.

Temperature K	Liquid heat kJ/kg	Latent heat kJ/kg	Entropy of liquid kJ/kg
298	59.7	138.0	0.2232
268	31.4	154.0	0.1251

(10 Marks)

Module-5

9 a. Explain: i) Specific humidity ii) Relative humidity iii) Degree of saturation iv) DPT v) DBT. **(10 Marks)**

b. The atmospheric conditions are : 20°C and specific humidity of 0.0095 kg/kg of air. Calculate: i) Partial pressure of vapour ii) Relative humidity iii) Dew point temperature. **(10 Marks)**

OR

10 a. With a neat sketch explain hot and humid outdoor conditions. **(10 Marks)**

b. The air supplied to a room of a building in winter is to be at 17°C and have a relative humidity of 60%. If the pressure is 1.01325 bar find : i) Specific humidity ii) Dew point temperature. **(10 Marks)**

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