CBCS SCHEME

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21MR62

Sixth Semester B.E. Degree Examination, June/July 2024
Marine Thermal Engineering

Time: 3 hrs. Max. Marks: 100

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use of HMT data hand book is allowed.
3. Use of refrigeration of psychometric chart is allowed.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. What are boundary and initial conditions? Explain briefly. **(06 Marks)**

b. An insulated container 3m long, 2.4m wide and 2.6m high consists of an insulating layer of 200mm thick cork, placed between an inner layer of 5mm thick aluminium and an outer layer of 5mm thick steel. The exposed surface of the aluminium is at –15°C when the outside atmosphere is at +25°C. Calculate :
i) The heat flow into the container per hour
ii) The interface temperatures between the work and the steel note K_{al} = 205w/mK, K_{corK} = 0.04w/mK, K_{steel} = 54w/mK outer surface heat transfer coefficient = 13w/m^{2}K. **(08 Marks)**

c. Derive an expression for critical thickness of insulation for a sphere. **(06 Marks)**

OR

2 a. Obtain an expression for temperature distribution and heat flow through a rectangular fin, when the end of the fin is insulated. **(10 Marks)**

b. Thin fins of bears whose K = 75w/mK are welded longitudinally on a 5cm diameter bars cylinder which stands vertically and is surrounded by air at 20°C. The heat transfer coefficient from metal surface to the air is 17w/m^{2}K. If 16 uniformly spaced fins are used each 0.8mm thick and extending 1.25cm from the cylinder, what is the rate of heat transfer from the cylinder per meter length to the air when the cylinder surface is maintained at 150°C? **(10 Marks)**

Module-2

3 a. Explain the following :
i) Grashaff number
ii) Prandtl number
iii) Sherwood number
iv) Schmidt number. **(08 Marks)**

b. Atmospheric air at 275K and free stream velocity 20m/s. flows over a flat plate of length 1.5m long maintained at 325K. Calculate :
i) The average heat transfer coefficient over the region where the boundary layer is laminar
ii) Find the average heat transfer over the entire length 1.5m of the plate
iii) Calculate the total heat transfer rate from the plate to the air over the length of 1.5m and width 1m assume transition occurs at a Raynold's number 2×10^5 take air properties at mean temperature of 300K. K = 0.026w/m°C, P_r = 0.708, $\gamma = 16.8 \times 10^{-6}$ m^2/s. $\mu = 1.98 \times 10^{-5}$kg/m^2. **(12 Marks)**

OR

4 a. With usual notation prove that $\frac{Nux}{Re_x Xp_r} = \frac{Cf_x}{2}$. **(10 Marks)**

b. Water at 30°C enters 1cm diameter tube with a velocity of 1m/s. The tube surface ins maintained at 90°C. Find the tube length required to heat water at 50°C. **(10 Marks)**

Module-3

5 a. For a black body enclosed in a hemispherical space, show that emissive power of black body is π times the intensity of radiation. **(10 Marks)**

b. Two parallel plates at $T_1 = 900K$ and $T_2 = 500K$ have emissivities $\varepsilon_1 = 0.6$ and $\varepsilon_2 = 0.9$ respectively. A radiation shield having an emissivity $\varepsilon_{31} = 0.15$ on one side and emissivity $\varepsilon_{32} = 0.06$ on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square meter with and without realization shield. **(10 Marks)**

OR

6 a. Derive an expression for effectiveness of counter flow heat exchanges. **(10 Marks)**

b. In a counter flow oil cooler, the oil flows with a velocity of 1.2m/cs through a single pass of 35 tubes. Each tube has a bore diameter of 15mm and wall thickness of 1.6mm. The oil enters at a temperature of 80°C and leaves at a temperature of 30°C. The fresh water coolant enters at a rate of 7 kg/s ad a temperature of 24°C. The overall heat transfer co-efficient is 2000w/m^{2}K, referenced to the tube outer surface area. Calculate the following :

i) The total mass flow rate of oil
ii) The outlet temperature of the water
iii) The logarithmic mean temperature difference
iv) The length of each tube for water ; specific heat capacity 412 kJ/kgK for oil specific heat capacity 2.0kJ/kgK, density 860 lg/m^3. **(10 Marks)**

Module-4

7 a. With a neat sketch explain the basic vapour compression refrigeration. **(10 Marks)**

b. In a F – 12 refrigerator, the Freon leaves the condenser as a saturated liquid at 20°C, the evaporator temperature is –10°C and the Freon leaves the evaporator as a vapour 0.97 dry, calculate :

i) The dryness fraction as the evaporator inlet
ii) The cooling effect per kg of refrigerant
iii)The volume flow of refrigerant entering the compressor if the mass flow is 0.1kg/s. **(10 Marks)**

OR

8 a. Write down the desirable properties of a refrigeration. **(06 Marks)**

b. Define the following with respect to :

i) Refrigerating effect
ii) Compressor work
iii) Capacity
iv) COP
v) Cooling load. **(10 Marks)**

c. Write a note on how refrigeration is done on a ship. **(04 Marks)**

Module-5

9 a. With a neat sketch, briefly describe air conditioning system. **(10 Marks)**

b. Define the following clearly

i) Specific humidity
ii) Relative humidity
iii) Degree of saturation
iv) Dew point temperature
v) Wet bulb temperature. **(10 Marks)**

OR

10 a. Write down psychometric properties of air comfort conditions. **(10 Marks)**

b. Write a note on :

i) Air circulation system
ii) Container cooling system
iii) Air cooler fans
iv) Air conditioning system in cargo ship. **(10 Marks)**

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