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Vellore Institute of Technology

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School of Mechanical Engineering

Continuous Assessment Test – II, March 2020, Winter Semester 2019-20

B.Tech Mechanical with spl in Automotive Engineering (BME, BMA, BEM)

Course Code :MEE2038
Course Name :Thermal and Heat Transfer
Slot/Batch :A1 + TA1

Duration :90 minutes
Max. Marks :50
Faculty :Prof. T.Vijayakumar

Open Notebook Examination

- Only handwritten notes is permitted
- Assume suitable data if required
- Avoid irrelevant answers
- Make your sketches neatly with pencil
- Answer all the questions
- Use of refrigerant table book is permitted

1. A plane wall of fireclay brick of thickness ***25 cm*** is having temperatures of ***1350° C*** and ***50° C*** on its two sides. The thermal conductivity of the fireclay brick is a function of temperature, $k = 0.838(1+0.0007T)$, ***W/mK***. Calculate the temperature distribution through the wall and the temperature at the mid-plane. Also find the rate of heat flow? (10) (CO-5)

2. A boiler furnace has the effective dimensions ***4 m x 3 m x 3 m*** high. The walls are constructed from an inner firebrick wall ***25 cm*** thick (***k=0.4 W/mK***), a layer of ceramic blanket insulation (***k=0.2 W/mK***), ***8 cm*** thick and a steel protective layer(***k= 54 W/mK***), ***2 mm*** thick. The inside temperature of the firebrick layer was measured as ***600° C*** and the temperature of the outside of insulation as ***60° C***. determine the rate of heat loss through the vertical walls of the furnace. Also calculate the temperature drop across the steel layer. (10) (CO-5)

3. An ammonia ice plant operates between condenser temperature of $35°C$ and an evaporator temperature of $-15°C$. It produces 5 tons of ice per day from water at $25°C$ to ice $-5°C$. The NH_3 enters the compressor as dry saturated vapor and leaves the condenser as saturated liquid. Determine (i)

Thecapacity of the refrigerating plant. (ii) Mass flow of the refrigerant (iii) Discharge temperature of NH_3 from the compressor. (iv) Power of the compressor motor if the isentropic efficiency of the compressor is 85% and the mechanical efficiency of the compressor is ***90%*** (v) COP of the system. Take latent heat of ice = ***335 kJ/kg***. Specific heat of ice = ***1.94 kJ/kgK***. Specific heat of water = ***4.2 kJ/kg-K.*** Use the following properties of NH_3

Saturation Temp °C	Enthalpy kJ/kg		Entropy kJ/kg-K		Specific heat kJ/kg-K	
	h_f	h_g	s_f	s_g	$LiqC_{pf}$	$VapC_{pg}$
-15	112.3	1426	0.457	5.549	-	-
35	347.5	1471	1.282	4.930	4.6	2.8

(15) (CO-3)

4. A plane wall of thickness $2L = 40\ mm$ and thermal conductivity $k = 5\ W/mK$ experiences uniform volumetric heat generation at a rate of q, while convection heat transfer occurs at both of its surfaces $(x = -L, +L)$, each of which is exposed to a fluid of temperature $T_\infty = 20^\circ C$. Under steady state conditions, the temperature distribution in the wall is of the form

$$T(x) = a + bx + cx^2$$

Where $a = 82^\circ C$, $b = -210^\circ C/m$, $c = -2x10^4{}^\circ C/m^2$ and x is in meters. The origin of the x coordinate is at the mid-plane of the wall.

a. Sketch the temperature distribution inside the plane wall along the x axis
b. What is the volumetric rate of heat generation in the wall?
c. What are the convection coefficients for the outer surfaces of the plane wall?

(15) (CO-5)