Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2014

Subject code: 713904N **Date: 24-06-2014**

Subject Name: Advanced Thermal Engineering

Time: 02:30 pm - 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of Steam table is permitted.**

Q.1 **(a)** Explain meaning of terms available energy and unavailable energy with suitable examples. **07**

(b) Differentiate between Film wise and Drop wise condensation. **07**

Q.2 **(a)** Derive General heat conduction equation in Cartesian co-ordinates. Also find the equation for temperature distribution for one dimensional steady flow conditions. **07**

(b) It is desired to compress one mole of air (ideal gas with ɔ = 1.4) from 1 bar and 27^0C to 10 bar to 1 bar and 27^0C. For this purpose compare the work to be done for the following processes (a)Isothermal compression(b)Constant volume heating followed by a constant pressure compression and (c)Adiabatic compression ($PV^ɔ$ = C) followed by constant volume cooling. **07**

OR

(b) A square plate heater (15 * 15) is inserted between two slabs. Slab is 2 cm thick (k = 50 W/m^0C) and slab B is 1 cm thick (k = 0.2 W/m^0C). The outside heat transfer coefficients on side A and side B are 200 W/m^2 ^{0}Cand 50 W/m^2 ^{0}C respectively. The temperature of surrounding air is 25 ^{0}C. If rating of heater is 1 kW, find: (a) Maximum temperature in the system (b) Outer surface temperature of two slabs. Draw the equivalent electrical circuit also. **07**

Q.3 **(a)** Using Gibbs relations derive Maxwell relations **07**

(b) A furnace wall has the inside surface temperatureof1100^{0}C, while the ambient air temperature is 250C.The wall consists of 125 mm thick refractory bricks (k=1.6 W/mK), 125 mm thick firebricks (k=0.3 W/mK) and 12 mm thick plaster (k=0.14 W/mK). There is an air gap which offers a thermal resistance of 0.16 K/W. The heat transfer coefficient on the outside wall to the air is 17 W/m^2K. Find (a) The rate of heat loss per unit area of wall surface, (b) the interface temperatures throughout the wall (c) the temperature of the outside surface of the wall. **07**

OR

Q.3 **(a)** Explain thermal insulation and derive the equation for the critical thickness of insulation of pipe. **07**

(b) A refrigerant suction line having outer diameter 30 mm is required to be thermally insulated. The outside air film coefficient of heat transfer is 12 $W/m^2\ ^0C$. The thermal conductivity of insulation is 0.3 W/m^0C. (a) Determine whether the insulation will be effective or not; (b) Estimate the maximum value of thermal conductivity of insulating material to reduce heat transfer (c) Determine the thickness of cork insulation to reduce the heat transfer to 22 percent if the thermal conductivity of cork is 0.038 W/m^0C. **07**

Q.4 **(a)** Explain with net sketch different regimes of boiling. **07**

(b) A vertical plate is maintained at 80^0C. It is exposed to saturated steam at atmospheric pressure. If the plate height is 40 cm, Calculate: (1) The film thickness at the bottom of the plate (2) Avg. heat transfer co-efficient using McAdams relation (3) Rate of heat transfer and condensate flow rate.(4) Check whether flow is laminar or not. **07**

OR

Q.4 **(a)** Derive the expression for NTU for the counter flow heat exchangers. **07**

(b) Water at atmospheric pressure is to be boiled in polished copper pan. The diameter of the pan is 350 mm and is kept at 115^0C. Calculate (i) power of the burner (ii) Rate of evaporation in Kg/h (iii) Critical heat flux for these conditions. Take: C_{pl} = 4220 J/KgK, n=1,C_{si}= 0.013 **07**

Q.5 **(a)** Write a short note on Gas radiation. **07**

(b) A thermocouple indicates a temperature of 800^0C when placed in a pipeline where a hot gas is flowing at 870^0C. If the convective heat transfer co-efficient between thermocouple and gas is 50 $W/m^2\ ^0C$, Find the duct wall temperature. $\mathring{U}$(thermocouple) =0.55. **07**

OR

Q.5 **(a)** Derive the expression for the radiant heat exchange between the two non-black bodies. **07**

(b) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperature on the hot and cold sides is 75^0C and 20^0C respectively. The exit temperature of hot water is 45^0C. If the individual heat transfer co-efficient on both sides are 650 $W/m^2\ ^0C$, calculate the area of the heat exchanger. C_p=4.187 KJ/kgK **07**

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