Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject code: 713904N **Date: 05-12-2014**

Subject Name: Advanced Thermal Engineering

Time: 10:30 am - 01:00 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 compressibility factor and compressibility chart. 07

(b) Differentiate between boiling and condensation. 07

Q.2 (a) Derive General heat conduction equation in Cartesian co-ordinates. 07

(b) It is desired to charge 15 Kg of ethane at 300 K into a cylinder of volume 0.08 m^3.Determine the pressure to which the cylinder is to be charged. Further if 20 Kg of ethane is charged into a cylinder of capacity of 0.15 m^3 and the cylinder is held at a pressure of 15 MPa, determine the temperature of the gas in the cylinder. Assume that ethane behaves like an ideal gas. 07

OR

(b) Two reversible heat engines A and B are arranged in series. Engine A rejects heat directly to engine B. A receives 200 kJ at a temperature of 421^0C from hot source while engine B is in communication with a cold sink at a temperature of 50^0C. If the work output of A is twice that of B, find(a) intermediate temperature between A and B,(b) efficiency of each engine and(c) heat rejected to the sink. 07

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

(b) The composite wall of an oven consists of three materials, two of which are of known thermal conductivity, k_A = 20 W/mK and kc = 50 W/mK and known thickness, L_A = 0.3 m and Lc = 0.15 m. The third material, B, which is sandwiched between materials A and C, is of known thickness, L_B = 0.15 m, but unknown thermal conductivity k_B. Under steady state conditions, measurements reveal an outer surface temperature of 20°C, an inner surface temperature of 600°C, and oven air temperature of 800°C. The inside convection coefficient h is known to be 25 W/m^2K. What is the value of k_B?

OR

Q.3 (a) Write a short note on stoichiometry. 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) Give a brief note on (i) Film condensation (ii) Drop-wise condensation 07

(b) Water is boiled at atmospheric pressure by horizontal polished copper heating element of diameter 5 mm having emissivity 0.05 immersed in water. If the 07

surface temp. of heating wire is 350^0C,determine rate of heat transfer from wire to water per unit length of wire and heat transfer co-efficient.

OR

Q.4	(a)	Derive the expression of effectiveness by NTU method for parallel flow heat exchanger.	07
Q.4	(b)	A vertical plate 340mm high and 400mm wide, at 40^0C is exposed to saturated steam at 1atm. Calculate: (i) film thickness at bottom of the plate (ii) the maximum velocity at the bottom of the plate (iii) the total flux to the plate.	07
Q.5	(a)	Write a short note on Gas radiation.	07
	(b)	The tubes (k = 106 W/m^{0}C) of a single pass condenser are of 30mm outside diameter and 25mm inside diameter. The condenser is required to handle 20000 kg/hr of dry saturated steam at 50^0C. The inlet and outlet temp. of water are 15^0 and 25^0C resp. If the avg. velocity of water in each tube is 2.5m/s and steam side heat transfer co-efficient is 5150 W/m^2 ^{0}C, calculate outside tube area. Use Nu= 0.023 $Re^{0.8}$ $Pr^{0.3}$.	07

OR

Q.5	(a)	Derive the expression for the radiant heat exchange between the two non-black infinite long parallel plates.	07
	(b)	A thermocouple indicates a temp. of 850^0C when placed in a pipe line where a hot gas is flowing at 920^0C. If the convective heat transfer co-efficient between the thermocouple and gas is 57 W/m^2 ^{0}C, find the duct wall temp. Take ε =0.5.	07

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