Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 713904N **Date: 06-01-2014**

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 meaning of terms available energy and unavailable energy with suitable examples. **07**

(b) Derive the Nusselt theory of laminar flow film condensation on a vertical plate. **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) Nitrogen is to be stored at 15 MPa and 300K in a steel cylinder of 0.5 m^3 capacity. The cylinder is protected against excessive pressure by a fusible plug which would melt and allow the gas to escape if the temperature rises too high. Make calculations for mass of oxygen which the cylinder will hold at the designed condition. Also determine the temperature at which fusible plug must melt in order to limit the pressure in the cylinder to 16 MPa. **07**

OR

(b) Two storage tanks are connected and their contents mixed. Tank A initially contains 5kg of nitrogen gas at 150°C and 150KPa. Tank B initially contains 2 kg of oxygen gas at 100°C and75 KPa. Can either gas be treated as an ideal gas? If both tanks eventually cool to room temperature (20°C) after mixing, what will the final pressure be at equilibrium? **07**

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

(b) An exterior wall of a house may be approximated by a 0.1 m layer of common brick (k= 0.7 W/m^0C), followed by a 0.04 m layer of gypsum plaster (k= 0.48 W/m^0C). What thickness of loosely packed rockwool insulation (k= 0.065 W/m^0C) should be added to reduce the heat loss or gain through wall by 80% ?

OR

Q.3 **(a)** Write a short note on Reactive mixtures. **07**

(b) A furnace wall has the inside surface temperature of 1100^0C, while the ambient air temperature is 25^0C.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, and (c) the temperature of the outside surface of the wall. **07**

Q.4 **(a)** Define 'boiling'. Explain briefly physical mechanism of boiling. **06**

(b) A vertical plate in the form of fin is 500mm in height and is exposed to steam at atmospheric pressure. If the surface of the plate is maintained at 60^0C, calculate (i) the film thickness at trailing edge of the film(ii) the overall heat transfer co-efficient (iii) the heat transfer rate (iv) the condense mass flow rate **08**

OR

Q.4 **(a)** Derive the expression of effectiveness for counter flow heat exchanger. **07**

Q.4 **(b)** Water at atmospheric pressure is to be boiled in polished copper pan. The diameter of the pan is 300 mm and is kept at 120^0C. 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/Kg K, n=1,C_{sl}= 0.013 **07**

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

(b) In a double pipe heat exchanger, hot water flows at a rate of 40000 kg/h and gets cooled from 90^0C to 60^0C. At the same time 40000Kg/h of cooling water at 25^0C enters the heat exchanger. The overall heat transfer co-efficient remains constant at 2270 W/m^2K.Determine the heat transfer area required and the effectiveness, assuming parallel flow streams. Assume Cp = 4.2 KJ/KgK for both the streams. **07**

OR

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

(b) Determine the heat loss by radiation per meter length of 80mm diameter pipe at 300^0C when (i) located in a large room with red brick walls at a temp. of 27^0C and (ii) enclosed in a 160 mm diameter red conduit at a temp. of 27^0C. Also Calculate % reduction in heat flow. Take $\varepsilon_{(pipe)}$=0.79 $\varepsilon_{(conduit)}$=0.93 **07**

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