Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –I Examination Feb. - 2012

Subject code: 713904N **Date: 21/02/2012**
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 tables/refrigerant tables is permitted.**

Q.1 **(a)** Define "Condensation". Differentiate between Film & Dropwise condensation **07**

(b) Explain compressibility factor and generalized compressibility charts with its application. **07**

Q.2 **(a)** Explain meaning of terms available energy and unavailable energy with suitable examples. **07**

(b) Derive General heat conduction equation in Cartesian coordinates. **07**

OR

(b) A reversible heat pump is required to maintain a temperature of 0^0 C in a refrigerator while rejecting heat to the surroundings at 300 D. If heat removed rate from the refrigerator is 25 kW, determine the coefficient of performance of the machine and the work input required. **07**

Proceed to determine the overall C.O.P of the system if the power required to run the machine is developed by a reversible engine which operates between higher and lower temperature limits of 650 K and 300 K respectively.

Q.3 **(a)** What is the importance of Maxwell relations in thermodynamics? **07**

(b) A homogeneous wall of area A and thickness δ has left and right hand surface temperatures of 0^0C and 40^0C respectively. Determine the temperature at the centre of the wall. **07**

(i) How much material must be added and to which side of the wall if the temperature at the centre is to be raised by 5 ^{0}C ?

(ii) How much material must be removed and from which side of the wall if the temperature at the centre is to be lowered by 5 ^{0}C ?

Express your answers in terms of δ. Presume that surface temperatures remain same before and after the alterations.

OR

Q.3 **(a)** A plane wall is a composite of three materials a,b and c. The wall of material generates heat at a rate of 2 X 10^6 W/m^2. The other details are : **07**

L_a = 5 cm ; L_b =3 cm ;L_c = 1.5 cm ;

k_a = 190 W/mK ; k_b = 150 W/mK and k_c = 50 W/mK.

The inner surface of material 'a' is well insulated and outer surface of material 'c' is cooled by water stream with tw = 50^0C and h = 2000^0 W/m$^{2\ 0}$ C.

The wall materials of 'b' and 'c' have no heat generation. Determine the temperature of insulated surface and temperature of cooled surface.

(b) A 3 cm diameter pipe at 100^0C is losing heat at the rate of 100 W per metre length to the surrounding ir at 20^0C. This is to be reduced to a minimum value by providing insulation. The following insulation materials are available : **07**

Insulation A:

Quantity = 3.15 X 10^{-3} m^3 per metre length of pipe

Thermal conductivity = 5 W/m-deg

Insulation B:

Quantity = 4 X 10^{-3} m^3 per metre length of pipe

Thermal conductivity = 1 W/m-deg.

Examine the position of better insulating layer relative to the pipe. What percentage saving in heat dissipation results from that arrangement ?

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

(b) A vertical cooling fin approximating a flat plate 400mm in height is exposed to saturated steam at atmospheric pressure. The fin is maintained at temperature of 90^0C. Estimate (i) thickness of the film at the bottom of the fin (ii) Overall heat transfer co-efficient (iii) Heat transfer rate using McAdam's co-relation. Take: t_{sat} = 100^0C, ρ_l=965.3 Kg/m^3, k_l= 0.68 W/m^0C, μ_l = 3.153 x 10^{-4}Ns/m^2 **07**

OR

Q.4 **(a)** Derive the expression for effectiveness by NTU method for the parallel 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,ρ_v= 958.4Kg/m^3, μ_l=279x10^{-6} N-s/m^2, Pr_l=1.75, σ =58.9x10^{-3} **07**

Q.5 **(a)** Derive the expression for the radiant heat exchange between two gray surfaces using definition of irradiation and radiosity. **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 the thermocouple and gas is 60 W/m^2,find the duct wall temperature Take 'ε'of thermocouple = 0.5 **07**

OR

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

(b) An oil cooler for a lubrication system has to cool 1000Kg/h of oil (c_p=2.09 KJ/Kg^{0}C) from 80^0C to 400C by using a cooling water flow of 1000kg/h at 30^0C. Give your choice for a parallel or counter flow heat exchanger, with reason. Calculate the surface area of the heat exchanger if overall heat transfer co0efficient is 24 W/m^2 ^{0}C. Take c_p of water = 4.18 KJ/Kg^{0}C **07**

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