Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E –Ist SEMESTER–EXAMINATION – JULY- 2012

Subject code: 713904N Date: 11/07/2012

Subject Name: Advanced Thermal Engineering

Time: 2:30 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 tables/refrigerant tables is permitted**

Q.1 **(a)** Explain compressibility factor and generalized compressibility charts with its application. **07**

(b) Derive the equation for laminar film condensation on a vertical plate. **07**

Q.2 **(a)** An 80 liters vessel contains 4 kg of refrigerant 134a at a pressure of 160 kPa. Determine (i) temperature of the refrigerant
(ii) quality of the refrigerant
(iii) enthalpy of refrigerant and
(iv) the volume occupied by the vapour phase and the liquid phase. **07**

(b) Two vessels A & B, both containing nitrogen, are connected by a valve which is opened to allow contents to mix and achieve an equilibrium temperature of 27^0C. Before mixing, the gases are in following condition **07**

	Vessel A	vessel B
Pressure in Mpa	1.5	0.6
Temperature	50^0C	20^0 C
Contents	0.5 kg mol	2.5 kg

Calculate final equilibrium pressure and the amount of heat transferred to the surroundings if the vessel had been perfectly insulated. Calculate final temperature and pressure which would have been reached.(assume $\gamma = 1.4$)

OR

(b) A reversible heat engine operates between 2 reservoirs at temperature of 600^0C and 40^0 C. The engine drives a reversible refrigerator which operates between reservoirs at temperature 40^0 C and -20^0 C.The heat transfer to the heat engine is 2000 kJ. And net work output of combined engine refrigerator plant is 360 kJ. **07**

(i) Evaluate heat transfer to the refrigerant and the net heat transfer to reservoir at 40^0 C

(ii) Reconsider (i) given that the efficiency af the heat engine and C.O.P of refrigerator are each 40 % of their maximum possible values.

Q.3 **(a)** Using Maxwell relations derive clausius clapeyron equation. **07**

(b) The hot combustion gases at 150^0C flow through a hollow cylindrical pipe of 10 cm inner diameter and 12 cm outer diameter. The pipe is lovated in a space at 30^0C and the thermal conductivity of the pipe material is 200 W/mK. Neglecting surface heat transfer coefficients, calculate the heat loss through the pipe per unit length and the temperature at a point halfway eween the inner and outer surface. What should be the surface area normal to the direction of heat flow so that the heat transfer through the pipe can be determined by considering material of the pipe as a plane wall of the same thickness? **07**

OR

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

(b) A typical wall for a house is constructed as shown in FIG 1. Calculate overall heat transfer coefficient and R value of the wall. **07**

Q.4 **(a)** Differentiate between Dropwise and film type condensation. **07**

(b) Vertical flat plate in the form of fin is 600m in height is exposed to steam at atmospheric pressure. If surface of the plate is maintained at 60^0C, calculate (1) the film thickness at the trailing edge of the film (2) the overall heat transfer co-efficient (3) the heat transfer rate. Take ρ_v=0.596 Kg/m^3, t_{sat} = 100^0C, ρ_l =971.8 Kg/m^3, k= 67.413x10^{-2}W/m^{0}C, μ = 355.3 x 10^{-6}Ns/m^2 **07**

OR

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

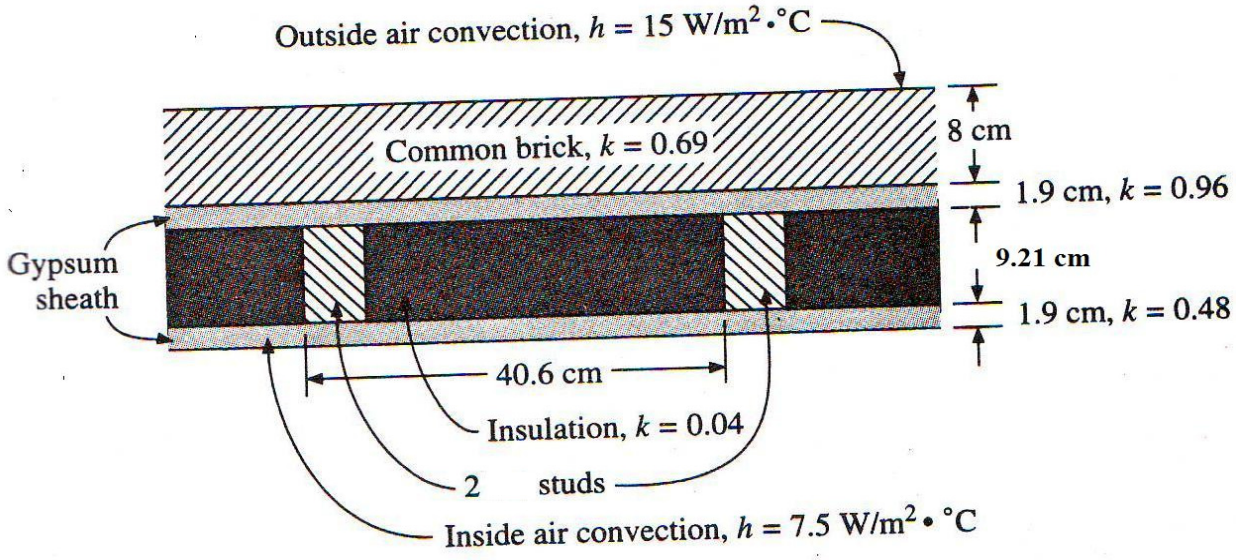
Q.5 **(a)** Write a short note on Gas radiation. **07**

(b) Three hollow thin walled cylinders having diameter 100mm, 200mm and 3000mm are arranged concentrically. The temperature of the innermost and outermost cylinder surfaces are 100K and 300K respectively. Assuming vacuum between the annular spaces, find the steady state temperature attained by the cylinder surface having diameter of 200mm. Take $\varepsilon_1=\varepsilon_2=\varepsilon_3$=0.05 **07**

OR

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

(b) The flow rates of hot and cold water streams running through parallel flow heat exchanger are 0.2 Kg/s and 0.5Kg/s respectively. The inlet temperatures on the hot and cold sides are 75^0C and 20^0C respectively. The exit temperature of hot water is 45^0C.If the individual heat transfer co-efficient on both the sides are 650 W/m^2 ^{0}C. Calculate the area of heat exchanger. **07**



Actual dimensions of stud = 4.1 X 9.21 cm^2
Thermal conductivity of stud = 0.1 W/m^0 C

FIG 1

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