Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject code: 712101N Date: 05/07/2012

Subject Name: Applied Thermodynamics & Heat Transfer

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.**

Q.1 **(a)** Derive the expression for the availability associated with the fluid stream from open system in steady state condition in the following form **07**

$$\psi = (h - h_0) - T_0 (s - s_0) + \frac{V^2}{2} + gz$$

(b) A 5 kg iron block initially at 350°C is quenched in an insulated tank which contains 100 kg water at 30°C. Assuming no loss of water during evaporation and surroundings are at 20°C and 100 kPa, determine the availability of the combined system at initial and final state. **07**

Q.2 **(a)** Using the Maxwell relations, determine a relation for $(\partial s/\partial v)_T$ for a gas whose equation of state is given by $\left(P - \frac{a}{v^2}\right)(v - b) = RT$ **07**

(b) Using the Clapeyron equation, estimate the value of the enthalpy of vaporization of refrigerant -12 and compare it with the tabulated value. **07**

OR

(b) If the entropy and internal energy are the function of temperature and volume then for a perfect gas obeying $pv = RT$, show that c_v is a function of temperature only. **07**

Q.3 **(a)** Explain the concept of Phase equilibrium for single component system. **07**

(b) In absorption refrigeration system, a two phase equilibrium mixture of liquid ammonia (NH_3) and water (H_2O) is at 40°C. If the composition of the liquid phase is 70 percent NH_3 and 30 percent H_2O by mole numbers, determine the composition of the vapour phase of this mixture. **07**

OR

Q.3 **(a)** For the plane wall having thickness 2L exposed to convective environment with same temperature at both surfaces, show that the maximum temperature in the wall is given by **07**

$$T_{max} = \frac{g_0 L^2}{8k} + \frac{g_0 L}{2h} + T_a$$

Where T_a is the environment temperature, h is convective heat transfer coefficient, k is thermal conductivity of wall, g_0 is heat generation per unit volume

(b) A plane wall of fireclay brick, 25 mm thick is having temperatures 1350°C and 50°C on two sides. The thermal conductivity of fireclay varies as $k = 0.838(1 + 0007T)$ where T in degree Celsius. Calculate the heat loss per square meter through the wall. **07**

Q.4 **(a)** If a thin and long fin, insulated at its tip is used, show that the heat transfer from the fin is given by **07**

$$Q_{fin} = \sqrt{hPkA_c}\,(T_0 - T_\infty)\tanh mL$$

(b) A slab of aluminum 10 cm thick is initially at temperature of 500°C. It is suddenly immersed in a liquid bath at 100°C resulting in a heat transfer coefficient of 1200 W/m^{2}K. Determine the temperature at the centre line and surface 1 min after the immersion. Take the following properties for aluminum **07**

$\alpha = 8.4\times10^{-5}$ m/s $\quad k = 215$ W/mK

ρ=2700 kg/m^3 $\quad$ C=0.9 kJ/kgK

OR

Q.4 **(a)** Explain the Reynolds analogy for turbulent flow over a flat plate. **07**

(b) In a particular solar collector, energy collected by placing a tube at the focal line of parabolic collector and passing fluid through the tube. The arrangement resulting in uniform flux of 2000 W/m^2 along the axis of the tube of diameter 60 mm. Determine **07**

1. Length of the tube required to heat the water from 20°C to 80°C which flows at a rate of 0.01 kg/s
2. Surface temperature at the outlet at the tube

Take the properties of water

$\mu = 352\times10^{-6}$ Ns/m^2 $\quad C_p = 4187$ J/kgK

$k_f = 0.67$ W/mK $\quad$ Pr = 2.2

Q.5 **(a)** Explain the following term in relation with natural convection heat transfer including its physical significance **07**

1. Buoyancy force
2. Volumetric expansion coefficient
3. Grashof number

(b) What is black body? What are its properties? Explain the concept of total and spectral emissive power of black body. **07**

OR

Q.5 **(a)** Explain the Kirchhoff's law and Lambert law of radiation. **07**

(b) In an isothermal enclosure at uniform temperature two small surfaces A and B are placed. The irradiation to the surface by the enclosure is 6200 W/m^2. The absorption rates by the surfaces A and B are 5500 W/m^2 and 620 W/m^2. When steady state is reached, calculate the following **07**

(i) What are the heat fluxes to each surface?
(ii) What is the temperature of each surface?
(iii) Absorptivity of each surfaces
(iv) Emissive power of each surface
(v) Emissivity of each surface

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