Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Examination January 2010

Subject code: 712101

Subject Name : Applied Thermodynamics and Heat Transfer

Date: 20 / 01 / 2010 **Time: 12.00 – 2.30 pm**

Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of molier chart and steam tables is permitted**

Q.1 **(a)** With usual notations derive an expression for principle of entropy increase. **06**

(b) State and explain concept of Exergy analysis and its application in power converting devices. **06**

Q.2 **(a)** State and explain the following : **06**

(1) Joule Thomson & Joule coefficient,
(2) Clapeyon equation
(3) Maxwell relation

(b) Obtain expression for change in internal energy of gas obeying vanderwaal's equation **06**

OR

(b) Determine h_{fg} of R-12 at -10 °C using both clapeyron equation and the clapeyron –clausius equation. Give the deviation in % , take $P_{sat\ at\ -5\ °C}$ =260.96 kPa, **06**

$P_{sat\ at\ -15°\ C}$ =182.60 kPa, $v_{g\ at\ -10\ C}$= 0.07665 m^3/kg,
$V_{f\ at\ -10\ °C}$= 0.000070 m^3/kg R=0.06876 KJ/Kg K
$h_{fg\ at\ -10°C}$=156.3 KJ/KgK

Q.3 **(a)** 0.5 kg of air executes a carnot power cycle having a thermal efficiency of 50 %. The heat transfer to the air during isothermal expansion is 40 KJ. At the beginning of the isothermal expansion the pressure is 7 bar and volume is 0.12 m^3. Determine the maximum and minimum temperature for the cycle in Kelvin, the volume at the end of isothermal expansion in m^3 , and work heat transfer for each of the four processes in kJ. **06**

(b) State and explain analytical method for solving dimensional heat conduction problems. **06**

OR

Q.3 **(a)** State and explain following terms: **06**

(1) Thermal capacity
(2) Specific heat
(3) Molecular heat

(b) Heat is generated at an interface between two slabs. One is steel K=36W/m K of 6 cm thick and other is brass K=70 W/m K, of 5cm thick. **06**

The temperatures of outer surfaces of steel slab and brass slab are maintained at 80 C and 40 C resply. The heat generation rate at the contact surface is 136 x 10^3 W/ m^2 , find heat flow through the outer surface of brass slab per m^2 and interface temperature, assume contact between the two slabs is perfect.

Q.4 **(a)** Brass wire of 0.5 mm diameter is annealed in an annealing furnace at a temperature of 500 °C. Find the time required for the wire to reach the temperature of 200 °C if the temperature of the wire before passing into furnace is **6**

30 °C, h=30 W/m^2 K, ρ=8600kg/m^3 Cp=0.4 KJ/kg K for brass assume length of wire 10 meters

(b) A refrigerated truck on highway is moving at speed of 90 Km/hr in a desert where air temperature is 70 °C. The body of the truck is considered as rectangular box 9m long, 3m wide, 2m high. Consider the boundary layer is turbulent over the whole surface and temperature at the surface is 10 °C. consider heat transfer on four surfaces of truck and neglect the heat transfer from front and back end. **06**

OR

Q.4 **(a)** State and explain the following : **06**

(1) Nusselt number (2) Reynold's number

(3) Prandlt number (4) Peclet number

(b) A thermos flask has a double walled bottle with a space between the walls evacuated. The bottle surfaces are silvered for emissivity of 0.05. If the ice at 0 °C is stirred in the flask find the rate of melting of ice in an ambient at 28 C take latent heat of ice 335 KJ/Kg and effective surface of flask as 460cm^2. **06**

Q.5 **(a)** State and explain the following : **06**

(1) Lambert's cosine law

(2) Diffuse surface

(3) Black body

(4) emissivity

(b) Air flows over a flat plate at velocity of 3m/s and ambient condition are the pressure is 760mm of Hg and the temperature is 15 °C. The plate is maintained at 85 °C. If the length of plate is 100 cm along the flow of air, find out heat lost by 50cm of the plate which is measured from the trailing edge. Plate width is 50 cm. the properties of air at mean temperature of 50 °C are ρ=1.093 kg/m^3 K=2.826 x 10^{-2} W/mK, ν= 17.95 x 10^{-6} m/sec, **06**

Use the correlation $Nu=0.664Re^{1/2} Pr^{1/3}$.

OR

Q.5 **(a)** Explain the fluid flow along a flat plate **06**

(1) Velocity distribution in hydrodynamic boundary layer

(2) Temperature distribution in thermal boundary layer

(3) Variation of local heat coefficient along the flow

(b) Derive necessary Von-Karman's expression for convection heat transfer. **06**

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