Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. IST Semester–Remedial Examination – July- 2011

Subject code: 711101

Subject Name: Advanced thermodynamics and Heat Transfer

Date:07/07/2011 **Time: 10:30 am – 01:00 pm**

Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Students are allowed to use their own charts & tables.**

Q.1 **(a)** What is law of corresponding state? Explain Van Der Waal's equation as law of corresponding state. **06**

(b) Derive the equation for heat transferred and maximum temperature available for a cylinder with uniform internal heat generation in one dimension. **06**

Q.2 **(a)** Air expands through a turbine from 500 kPa, 520°C to 100 kPa, 300°C. During the expansion 10 kJ/kg of heat is lost to the surroundings which is at 98kPa, 20°C. Neglecting the K.E. and P.E. changes, determine per kg/s of air (1) the decrease in availability, (b) the maximum work and (3) the irreversibility. For air, take c_p = 1.005 kJ/kg-K, h = c_pT. **06**

(b) Define (i) compressibility factor (ii) reduced co-ordinates. Also With neat sketch explain general compressibility chart. **06**

OR

(b) Explain in detail different types of Phase Equilibrium diagram on p-T surface, h-s surfaces, T-s surfaces. **06**

Q.3 **(a)** Define Gibbs & Helm Holtz free energy and Derive Maxwell relations for internal energy (u), enthalpy (h), Gibbs energy (g) and Helm Holtz energy (f). **06**

(b) Define unsteady flow process. Explain bottle filling and emptying processes. **06**

OR

Q.3 **(a)** State Kelvin statement for second law and with neat sketch prove that for cyclic process $\int \delta Q/T \leq 0$ **06**

(b) During summer to cool water for drinking purpose 1 kg of ice at -2°C is mixed with 5 kg of water at 27°C in an insulated container which is subjected to atmospheric pressure of 1 bar. Calculate the temperature of the mixture and the change in entropy for the spontaneous process. Assume specific heat of ice as 2.093 kJ/kg – K and the latent heat of ice as 335 kJ/kg. take Cp of water as 4.18 kJ/kg-K. **06**

Q.4 **(a)** Explain the relaxation technique to solve the heat transfer problem on two-dimensional steady state conduction with neat sketch. **06**

(b) A 6 mm thick stainless steel plate (ρ=7800 kg/s/m3, c= 460 J/kg-K, k = 55W/m°C) is used to form the nose section of missile. It is held initially at a uniform temperature of 30°C. When the missile enters the denser layers of the atmosphere at a very high velocity the **06**

effective temperature of air surrounding the nose region attains the value 2150°C; the surface convective heat transfer co-efficient is estimated as 3395 $W/m^2\ {}^oC$. If the maximum metal temperature is not to exceed 1100°C. Determine: (i) maximum permissible time in these surrounding (ii) Inside surface temperature under these conditions.

OR

Q.4 **(a)** Derive the Von Karman momentum equation for boundary layer flow. **06**

(b) Derive the equation for Reynold's analogy between fluid friction & Newton's Law of Viscosity. **06**

Q.5 **(a)** State Lambert's cosine law. **06**

Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 2500°C :

(i)Monochromatic emissive power at 1.2 μm length,

(ii)Wavelength at which the emission is maximum, (iii) Maximum emissive power, (iv) total emissive power.

Take $C_1 = 0.3742 \times 10^{-15}\ Wm^4/m^2$ & $C_2 = 1.4388 \times 10^{-2}$ mK

(b) Derive the equation for interchange factor f_{1-2} from surface 1 to 2 for a two infinite parallel plates. **06**

Where

$$f_{1-2} = \frac{1}{1/\varepsilon_1 + 1/\varepsilon_2 - 1}$$

with usual notations.

OR

Q.5 **(a)** Define fin efficiency, fin effectiveness, overall effectiveness, Biot number, eddy diffusivities ε_M and ε_H. **05**

(b) A plane wall is provided with rectangular fin (k = 150W/mK) having profile area 0.9 cm^2. The ambient condition is 26°C and unit surface conductance is $50 W/m^2K$. If the fin base temperature is maintained at 200°C, calculate the maximum heat dissipated by fins per unit width of the fin. **07**

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