Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Regular Examination January / February 2011

Subject code: 711101N

Subject Name: Advanced Thermodynamics and Heat Transfer

Date: 31 /01 /2011 **Time: 02.30 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, Mollier chart is permitted**

Q.1 (a) Show that the transfer of heat through a finite temperature difference is irreversible. **07**

(b) A fluid undergoes a reversible adiabatic compression from 0.5MPa, 0.2m^3 to 0.05 m^3 according to the law $pv^{1.3}$=C. Determine the change in enthalpy, internal energy, entropy, heat transfer and work transfer during the process. **07**

Q.2

(a) Write brief notes on Fugacity, Exergy. **07**

(b) Derive an expression for minimum isothermal system boundary temperature required by 2nd law of thermodynamics as an incompressible material is heated or cooled from a temperature T_1 to temperature T_2 in a closed system with constant heat flux. **07**

OR

(b) A heat engine is working between the starting temperature limits of T_1 and T_2 of two bodies. Working fluid flows at rate of m' Kg/sec and specific heat at constant pressure as C_p, determine the maximum obtainable work from engine. **07**

Q.3

(a) Explain second law analysis of steady flow system with suitable examples. **07**

(b) In a steam turbine the steam enters at 50 bar, 600°C and 150m/s and leaves as saturated vapour at 0.1 bar, 50m/s. During expansion work of 1000 KJ/Kg is delivered. Determine the inlet steam availability, exit steam availability and irreversibility. Take dead state temperature as 15°C. **07**

OR

Q.3 (a) Describe Chemical potential of ideal gas with suitable example. **07**

(b) An adiabatic cylinder of volume 10 m^3 is divided into two compartments A and B each of volume 6m^3 and 4m^3 respectively, by a thin sliding partition. Initially the compartment A is filled with air at 6 bar and 600K.while there is vacuum in the compartment B. Air expands and fills both the compartments. Calculate the loss in available energy. Assume atmosphere is 1 bar and 300K. **07**

Q.4

(a) With usual notations derive generalized two dimensional steady state heat conduction equation in semi-infinite plate when two boundaries are at zero temperature. **07**

(b) A large cast iron ingot (K=48.5 W/mk, α=0.06m^2/hr) at 700°C is taken out from the furnace and its one surface is suddenly exposed and maintained at 50°C Calculate **07**

1. The time required to reach the temperature 300°C at a depth of 4cm from the surface.

2. Instantaneous heat flow rate at depth of 4cm and on surface after half an hour.

OR

Q. 4 (a) A 2.5 cm diameter rod of 36 cm length connects two heat sources maintained at 127°C and 227°C resply. The curved surface of rod is losing heat to the surrounding air at 27°C. The heat transfer coefficient is 10W/m^2 C. Calculate the loss of heat from the rod if it is made of (1) Copper(k=335W/m °C), (2) Steel (K=40 W/m°C) **07**

(b) A long cylindrical heater 2.5cm in diameter is maintained at 660 °C and has surface emissivity of 0.8. The heater is located in a large room whose walls are at 27°C. How much will the radiant transfer from the heater be reduced if it is surrounded by a 30cm diameter radiation shield of aluminum having an emissivity of 0.2? What is the temperature of shield? **07**

Q.5

(a) With usual notations derive Von-Karman expression for convective heat transfer. **07**

(b) Explain following laws: Lambert's cosine law, Stefan bolt'z man law, plank's law, wein's displacement law. **07**

OR

Q.5 (a) Explain the following **07**

1. Displacement thickness
2. Momentum thickness
3. Energy thickness

(b) A shape of a cavity is frustum having 30 cm and 60 cm diameters and 75cm height is maintained at 500°C. Find the heat loss from the cavity when smaller diameter is at bottom. Also calculate percentage change in heat loss if the bigger diameter is at the bottom. Assume cavity is a black body. **07**

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