Code No: NR210304 **NR**

II B.Tech I Semester Supplementary Examinations, November 2006
THERMODYNAMICS
(Common to Mechanical Engineering and Aeronautical Engineering)
Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain with a neat sketch the working principle of a constant volume gas thermometer.
   (b) Explain the concept of temperature and equality of temperature. [8+8]

2. (a) Prove that for a constant pressure non flow process the change in enthalpy equal to heat transfer.
   (b) Derive the steady state flow energy equation and explain the perpetual motion machine of first kind. [8+8]

3. (a) Draw neatly the sequences of operation of Carnot engine on p-v and T-s diagrams. Show that the entropy change during the cycle is zero
   (b) A Carnot engine operates between 1000K and 300K. the change in entropy of the source is 0.6 kJ/K. Find the heat added and the net work output.
   (c) CO2 gas is contained in 1.0 m3 tank initially at 1.2 bar and 300 K. The temperature is increased by 400K by
      i. stirring with a paddle wheel and
      ii. heat supply from a reservoir. Find the initial and final availabilities of the gas. Which method of heating is better from the thermodynamic point of view?

   [6+4+6]

4. Starting from first law and using second law derive the Gibb's equations and hence deduce the Maxwell's relations [16]

5. (a) The specific volume of H_2 at 100^0C is $1m^3$/kg.
      i. Determine the pressure exerted by H_2 using Van der Wall's equation.
      ii. Compare the result obtained considering H_2 as ideal gas. The values of Van der Walls constant 'a' and 'b' are 25105 $Nm^4/(kg-mol)^2$ and $0.0262m^3$/kg-mol.
   (b) Determine for CO_2
      i. the reduced pressure at 100 bar, compressibility factor Z=0.71,
      ii. reduced pressure at 30^0C, Z = 0.98. The critical pressure p_c = 73.9 bar, and the critical temperature T_c = 304.2 K.

   [8+8]

6. (a) A gas mixture consists of 5 kmol of hydrogen and 5 kmol of nitrogen. Determine the mass of each gas and the gas constant of the mixture.

   (b) Air is considered to be a mixture of 78% nitrogen and 22% oxygen by volume if the small amounts of argon and carbon oxide present in the mixture are neglected. Treating nitrogen and oxygen in air are to be the ideal gases, find the gas constant C_P and C_V for air at 25^0C. [6+10]

7. The gravimetric composition of a liquid fuel is 0.86 kg carbon, 0.163 kg hydrogen and 0.01 kg ash. What is the mass ratio of air to liquid fuel required?
   The fuel is burnt with air and the products of combustion are sampled to determine the volumetric composition of carbon monoxide and carbon dioxide present, the result being 1% CO and 10% CO_2. assume that the hydrogen has burned completely and the remaining undetermined products are water vapour, excess oxygen and nitrogen. Calculate the actual air fuel mass ratio. Also find the mean isobaric specific heat capacity of the product. [16]

8. Steam enters the high pressure turbine of a steam power plant which operates on the ideal reheat Rankine cycle at 6MPa and 450^0C and leaves as saturated vapor. Steam is then reheated to 400^0C before it expands to a pressure of 7.5kPa. Heat is transferred to the steam in the boiler at a rate of 4x104kJ/s. Steam is cooled in the condenser by the cooling water from a nearby river, which enters the condenser at 15^0C. Show the cycle on a T-s diagram with respect to saturation lines, and determine the pressure at which reheating takes place, the net power output, the thermal efficiency and the minimum mass flow rate of the cooling water required. [16]

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