Code No: RR222102 **Set No.1**

II B.Tech. II Semester Regular Examinations, April/May -2005
ENGINEERING THERMODYNAMICS
(Aeronautical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What is thermodynamic equilibrium? Explain the significance of it in quasi-static process?
   (b) Identify the proper type of system in each case and explain the reason for your choice.
      i. Electric generator
      ii. Domestic tea kettle
      iii. Electric fan
      iv. A living human being.

2. A reciprocating air compressor installed in a fertilizer factory takes in air at 1 bar and 20^oC and delivers at 6 bar. Calculate the work done, heat transfer and change in internal energy per kg of air compressed if the compression follows:
   (a) isothermal
   (b) reversible adiabatic
   (c) polytrophic with index as 1.25. The changes in potential and kinetic energies may be neglected.

3. (a) Enunciate the two classical statements of second law of thermodynamics.
   (b) One kg of water is heated at a constant pressure of 0.7 MPa. The boiling point is 164.97^0C and the latent heat of evaporation is 2066.3 kJ/kg. If the initial temperature of water is 0^0C, find the increase in entropy of the water if the final state is dry saturated steam. Assume for liquid water $C_p = 4.2$ kJ/kgK.

4. (a) Using Maxwell's relations deduce the two Tds equations.
   (b) Derive the equation

$$\frac{(\partial V/\partial T)_s}{(\partial V/\partial T)_p} = \frac{1}{\gamma - 1}$$

5. Find the internal energy and enthalpy of unit mass of steam of a pressure of 7 bar
   (a) when its quality is 0.8,
   (b) when it is dry and saturated,
   (c) superheated, the degree of superheat being 65^0C. The specific heat of superheated steam at constant pressure is 2.1kJ/kg K.

6. One kilogram of moist air initially at a total pressure of 1 atm has a dry bulb temperature of 20^0C and a relative humidity of 60% and is contained in a closed rigid vessel. Determine the amount of heat that must be transferred to the moist air in order to increase the dry bulb temperature to 40^0C. Calculate the final pressure and final relative humidity of the mixture. Suppose that heat is transferred to the system from a heat source that has a temperature of 100^0C. Determine the total entropy change associated with this process.

7. (a) What do you mean by air standard cycles? What are the assumptions for air standard cycles.

   (b) An air standard Otto cycle has a compression ratio of 8. At the start of the compression process, the temperature is 26^0C and the pressure is 1 bar. If the maximum temperature of the cycle is 1080^0C calculate

      i. The heat supplied per kg of air

      ii. The network done per kg of air

      iii. The thermal efficiency of the cycle.

8. Air has a dry bulb temperature of 27^0C and a wet bulb temperature of 20^0C . If the barometer reads 1 bar, Calculate

   (a) the humidity ratio

   (b) the relative humidity

   (c) the dew point

   (d) the enthalpy of mixture per kg of dry air.

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1. (a) Explain with a neat sketch the working of constant volume gas thermometer.
   (b) The properties of a certain fluid are related as follows.
   u = 196 + 0.178t And pv = 0.287(t+273)
   Where u is specific internal energy (kJ/kg), t is in ^{0}C, p is pressure (KN/m^2) and v specific volume. For this fluid find Cv andCp.

2. Steam enters a steam condenser with an enthalpy of 2090kJ/kg and velocity of 510 m/s. The condensate leaves the condenser with an enthalpy of 209 kJ/kg and with a velocity of 10m/s. Determine the heat received by the cooling water per kg of steam condensed.

3. (a) What is absolute temperature scale? Develop this scale from Carnot theorem
   (b) A reversible engine during a cycle of operation interacts with three thermal reservoirs maintained at 200K,300K and 400K. It receives 5 MJ of heat from the reservoir at 400K and produces a net positive work of 840 kJ. Find the amount and direction of heat interaction with other reservoirs.

4. (a) Using Maxwell's relations deduce the two Tds equations.
   (b) Derive the equation

$$\frac{(\partial V/\partial T)_s}{(\partial V/\partial T)_p} = \frac{1}{\gamma - 1}$$

5. (a) Determine the equation of perfect gas pV = m RT from the kinetic energy of gases where.
   P = absolute pressure of gas in N/m^2
   V = Volume of gas in m^3
   m = mass of gas in Kg
   T = absolute temperature of gas in ^{0}K.

   (b) What is the difference between the Universal Constant and characteristic constant of a gas ? How many times is former bigger than the later?
   (c) Carbon dioxide at 25^0 C and 101.3 KPa has a density of $1.799Kg/m^3$. Determine
      i. The characterstic gas constant for CO_2
      ii. The molecular mass of CO_2 based on the gas constant.

6. A room of dimensions 5m x 3m x 3m contains an air water vapour mixture at 1 bar, 30^0C and 70% relative humidity. Calculate

   (a) Mass of air

   (b) Mass of Water Vapour

   (c) Also find the degree of saturation.

   The universal gas constant is 8.3143 KJ /Kg - Mole K and molecular mass of air and water vapour is 29 and 18 respectively.

7. (a) Derive the expression for mean effective pressure or Otto cycle.

   (b) A diesel engine has a compression ratio of 14 and cut off takes at 6% or the stroke. Find the air standard efficiency.

8. Two kg mole of Carbon di oxide at a pressure of 1.8 bar, 80^0C is mixed in a thermally insulated vessel with 3 kg-mole of Nitrogen is at equilibrium, Determine the final temperature and pressure and the change in entropy of the mixture.

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1. (a) Explain thermodynamic system, surroundings and universe, illustrate the same with examples.
   (b) Distinguish between closed system, open system and isolated system with suitable examples.

2. A small water pump is used in an irrigation system. The pump takes water in from a river at 10^0C, 100kpa at a rate of 5 kg/s. The exit line enters a pipe that goes up to an elevation 20m above the pump and river, where the water runs into an open channel. Assume the process is adiabatic and that the water stays at 10^0C. Find the required pump work.

3. (a) State and prove Carnot's theorems.
   (b) A cylinder-piston contains water at 200 kpa, 200^{o}C with a volume of 20 litres. The Piston is moved slowly, compressing the water to a Pressure of 800 kPa. The loading on the Piston is such that PV = C. Assume the room temperature as 20^{o}C and show that this process does not violate the second law of thermodynamics.

4. (a) Using Maxwell's relations deduce the two Tds equations.
   (b) Derive the equation

$$\frac{(\partial V/\partial T)_s}{(\partial V/\partial T)_p} = \frac{1}{\gamma - 1}$$

5. (a) What do you mean by a perfect gas? Give the equation of state of perfect gas.
   (b) Enunciate the Boyle's law and Charle's law and deduce the equation of a perfect gases.

6. The gravimetric analysis of a gaseous mixture is given in percentage as 18.92% CO_2, 1.39% CO, 3.71% O_2 and 75.98% N_2. Determine the volumetric analysis in percent. Also find the molecular weight of the mixture.

7. (a) Derive an expression for thermal efficiency of Atkinson cycle.
   (b) Find the air standard efficiency of Atkinson cycle if the compression ratio is 5 and pressure at the end of heat reception is 2.5 times that at the beginning. Take adiabatic index as 1.41.

8. Air at 25^0 C and 1 bar has a relative humidity of 50%. Using psychometric Chart, determine

(a) the partial pressure of steam

(b) the dew point

(c) the humidity ratio

(d) the wet bulb temperature.

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1. (a) Discuss the concept of continuum in thermodynamics.
   (b) What do you mean by property? Distinguish between intensive and extensive Properties.

2. (a) Two kg of air expands polytropically (n=1.25) from a pressure of 15 bar and temperature of 300^{o}C to a pressure of 1.5 bar, then heated at constant pressure to initial volume. Find
      i. Work done
      ii. Change in enthalpy
      iii. Heat transer.
   (b) Show that the heat transfer in polytropic process $\frac{\gamma-n}{\gamma-1}$ times of work

3. Ten grammes of water at 20^{0}C is converted to ice at -10^{0}C at constant atmospheric pressure. Assuming the specific heat of liquid water to remain constant at $4.2J/g^0$C and that of ice to be half of this value, and taking the latent heat of fusion of ice at 0^{0}C to be 335J/g, calculate the total entropy change of the system.

4. (a) Using Maxwell's relations deduce the two Tds equations.
   (b) Derive the equation

$$\frac{(\partial V/\partial T)_s}{(\partial V/\partial T)_p} = \frac{1}{\gamma - 1}$$

5. (a) Write a short note on Mollier chart.
   (b) A vessel having a capacity of $0.05m^3$ contains a mixture of saturated water and saturated steam at a temperature of 245^{0}C. The mass of the liquid present is 10 kg. Find the following:
      i. The pressure
      ii. The mass
      iii. The specific volume
      iv. The specific enthalpy
      v. The specific entropy, and
      vi. The specific internal energy.

6. A gas mixture in an engine cylinder has 12% CO2 , 11.2% O_2 and 76.5% N_2 by volume .The mixture at 1000^0C expands reversibly, according to $pV^{1.2}$ =constant to 7 times its initial volume. Determine the work done and heat transfer per unit mass of the mixture. the average c_p values for CO_2, O_2 and N_2 are 1.27 kJ/kgK , 1.11 kJ/kgK and 1.196 kJ/kgK respectively.

7. An air standard limited pressure cycle has a compression ratio of 15 and compression begins at 0.1Mpa, 40^0c. The maximum pressure is limited to 6Mpa and the heat added is 1.675MJ/Kg. Compute

   (a) The heat supplied at constant volume per Kg of air.

   (b) The heat supplied at constant pressure per kg of air.

   (c) The work done per Kg of air

   (d) The cycle efficiency.

   (e) The temperature at the end of the constant volume heating process.

   (f) The cut off ratio and

   (g) The mean effective pressure of the cycle.

8. (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.

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