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AU/IP/IEM/ME–304

B. E. (Third Semester) EXAMINATION, Dec., 2011

(Grading/Non-Grading System)

(Common for AU, IP/IEM & ME Engg. Branch)

THERMODYNAMICS

Time : Three Hours

Maximum Marks : { *100 (Non–Grading)* / *70 (Grading)*

Note : All questions are compulsory. Internal choice is given with all the questions. All questions carry equal marks. Steam table and Mollier charts are allowed in Exam.

1. A perfect gas expands such that its pressure varies in linear relationship with volume :

$$P = a\,V + b$$

where '*a*' and '*b*' are constants.

If the initial and final states of the gas are 4 bar/0·1 m^3 and 2 bar/0·2 m^3, determine :

(a) heat interactions

(b) work interactions

Or

A certain mass of gas in a closed system is undergoing polytropic expansion in accordance with the expression PV^n = constant. Show that the ratio :

$$\Delta Q : \Delta u : \Delta w :: (v - h) : (h - 1) : (v - 1)$$

P. T. O.

where : ΔQ is the heat rejected.

Δu is the gain in internal energy.

Δw is the work done.

2. (a) Distinguish between reversible and irreversible processes.

(b) Are all natural processes irreversible ? Cite *two* examples of real processes that can reasonably be regarded as close to reversible processes.

(c) Why can heat not be converted into work ?

(d) Describe an imaginary process that violates both first law and second law of thermodynamics.

Or

A heat engine, a heat pump and a refrigerator receive 500 kJ of heat each, but they reject 250 kJ, 600 kJ and 700 kJ of heat respectively. Determine :

(a) The efficiency of heat engine

(b) COP of heat pump

(c) COP of the refrigerator

3. Prove that :

(a) $a = \frac{RT_c}{8P_c}$ (b) $b = \frac{27}{64}\frac{R^2T_c^2}{P_c}$

where 'a' and 'b' are van der Waals constants, k is characteristic gas constant. T_c, P_c are temperature and pressure at critical points.

Or

(a) What is compressibility factor 'z' ? What is the physical significance of this factor ?

(b) What is the principle of corresponding states ?

(c) What is the significance of two constants that appear in the van der Waals equation ?

4. 1 ton of ice at − 5°C is heated to produce steam at 300°C. The entire process is carried out at 1·0132 bar i. e. 1 atm. pressure. Calculate the entropy changes in all possible stages.

Or

A steam sample at 2 MPa has a specific volume of 0·09 m^3/kg. Determine the dryness fraction of the steam. Also calculate the specific enthalpy and specific entropy of the sample.

5. Half kg helium and half kg nitrogen are mixed in a mixing chamber at 293 K and 100 kPa of total pressure. Calculate the :

   (a) Mole fraction of the components

   (b) Volume of the mixture

   (c) Volume fraction of the components

   (d) Partial pressures of the components

Or

For an air standard dual cycle, the following data are available :

Air intake at 1 bar and 323 K.

Maximum pressure is 70 bar.

Heat addition at constant pressure = Heat addition at constant volume.

Determine :

(a) Pressure and temperatures at all the points of the cycle

(b) Code efficiency

(c) MEP