Roll No .....

AU/IP/IEM/ME/AE/PR - 304

B.E. III Semester Examination, December 2014

Thermodynamics

Time : Three Hours

Maximum Marks : 70

Note: i) Answer five questions. In each question part A, B, C is compulsory and D part has internal choice.

ii) All parts of each questions are to be attempted at one place.

iii) All questions carry equal marks, out of which part A and B (Max.50 words) carry 2 marks, part C (Max.100 words) carry 3 marks, part D (Max.400 words) carry 7 marks.

iv) Except numericals, Derivation, Design and Drawing etc.

Unit - I

1. a) What is meant by thermodynamic equilibrium?
   b) What is an ideal gas? How does it differ from a perfect gas?
   c) State and derive characteristic gas equation.
   d) A high altitude chamber, the volume of which is 30 m^3, is put into operation by reducing the pressure from 1.013 bar to 0.35 bar and temperature from 27°C to 5°C. How many kg of air must be removed from the chamber during the process? Express this mass as volume measured at 1.013 bar and 27°C. Take R = 287 J/kg K for air.

   OR

   3 kg of air kept at an absolute pressure of 100 kPa and temperature of 300 K is compressed polytropically until the pressure and temperature become 1500 kPa and 500K respectively. Evaluate the polytropic exponent, the final volume, the work of compression and the heat interaction.

Unit - II

2. a) What is a heat engine? Write characteristic features of a heat engine.
   b) Define thermal efficiency of a heat engine.
   c) Show that COP of a heat pump is greater than COP of a refrigerator by unity.
   d) Three real heat engines have the same thermal efficiency and are connected in series. The first engine absorbs 2400 kJ of heat from a thermal reservoir at 1250 K and the third engine rejects its waste of 300 kJ to a sink at 150 K. Determine the work output from each engine.

   OR

   A lump of steel of mass 8 kg at 1000 K is dropped in 80 kg of oil at 300 K. Make calculations for the entropy change of steel, the oil and the universe. Take specific heats of steel and oil a 0.5 kJ/kg K and 3.5 kJ/kg K, respectively.

Unit - III

3. a) Define compressibility and explain its significance.
   b) What is a real gas? How does it differ from an ideal gas?

c) Derive Van der Waal's equation in terms of reduced parameters.

d) 5 kg of carbon dioxide occupies 1.5 m^3 at 300 K. Determine the pressure exerted by CO_2 gas using Van der Waal's equation. How this result would compare with the one obtained by treating CO_2 as an ideal gas. The constants a and b appearing in Van der Waal's equation have the values $a = 3.6285 \times 10^5$ Nm/(kg mol)^2 and $b = 0.0423$ m^3/kg mol.

OR

Derive the first and second T ds equations and set up the expression for the difference in heat capacities C_p and C_v. State the significance of this expression.

Unit - IV

4. a) What is a pure substance?

b) What information do you get from a Mollier Chart?

c) Describe the process of formation of steam and give its graphical representation.

d) Calculate the internal energy of 0.3 m^3 of steam at 4 bar and 0.95 dryness. If this steam is superheated at constant pressure through 30°C, determine the heat added and change in internal energy.

OR

The following data were obtained in a test on a combined separating and throttling calorimeter: Pressure of steam sample = 15 bar, pressure of steam at exit = 1 bar, temperature of steam at exit = 150°C, discharge from separating calorimeter = 0.5 kg/min, discharge from throttling calorimeter = 10 kg/min.

Determine the dryness fraction of the sample steam.

Unit - V

5. a) What is a cycle? What is the difference between ideal and actual cycle?

b) Enumerate all the four processes of the Carnot cycle and draw its P-V diagram.

c) Derive an expression for the efficiency of Otto cycle.

d) The stroke and cylinder diameter of a compression ignition engine are 250 mm and 150 mm respectively. If the clearance volume is 0.0004 m^3 and fuel injection takes place at constant pressure for 5 per cent of the stroke, determine the efficiency of the engine. Assume the engine working on the diesel cycle.

OR

Given that air consists of 21% oxygen and 79% nitrogen by volume. Determine:

i) The moles of nitrogen per mole of oxygen.

ii) The partial pressure of oxygen and nitrogen if the total pressure is 1 atm.

iii) The kg of nitrogen per kg of mixture.

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