CBCS Scheme

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15MR33

Third Semester B.E. Degree Examination, Dec.2017/Jan.2018
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing one full question from each module.***
2. ***Use of thermodynamic data hand book permitted.***

Module-1

1 a. Define the following: (i) Open, closed and isolated systems (ii) Intensive and extensive properties. **(06 Marks)**

b. With necessary equations, explain the methods of temperature measurements using, (i) two fixed points and (ii) Single fixed point. **(04 Marks)**

c. A platinum wire is used in a resistance thermometer. The resistance was found to be 10 ohm and 16 ohm at ice point and steam point respectively. At Sulpur's boiling point 444.6°C, the resistance was 30 ohm. Find the resistance of wire at 500°C, if the resistance is given by, $R = R_0(1 + aT + bT^2)$ where R_0, a and b are constant and T is temperature. **(06 Marks)**

OR

2 a. At the beginning of compression stroke in a two-cylinder internal combustion engine, the air is at atmospheric pressure. The compression reduces the volume to 20% of initial volume. The bore and stroke of each cylinder is 0.15 m and 0.25 m compression is done polytropically with an index of compression of 1.2. If 500 compression strokes take place per minute, determine the power absorbed. **(08 Marks)**

b. Derive the expressions for, (i) Electrical work and (ii) Shaft work. **(06 Marks)**

c. State the sign convention followed for (i) work and (ii) heat transfer. **(02 Marks)**

Module-2

3 a. Write the SFEE for, (i) Steam turbine (ii) Condenser (iii) Centrifugal compressor (iv) Water turbine. **(08 Marks)**

b. Air flows steadily a the rate of 0.5 kg/s through an air compressor, entering with a velocity of 7 m/s, pressure 1 bar and specific volume 0.95 m^3/kg . Corresponding values at the exit are 5 m/s, 7 bar and 0.19 m^3/kg. The specific internal energy increases by 90 kJ/kg due to compression. Cooling water absorbs 58 kW heat from the air. Compute the power needed for compression and diameters of outlet and inlet. **(08 Marks)**

OR

4 a. A household fridge interior is maintained at 2°C. Whenever the door is opened, it introduces 420 kJ of heat, making negligible change in interior temperature. The door is opened 20 times a day. The refrigerator operates at 25% of the ideal COP. The atmosphere is at 30°C. The cost of electricity is ₹ 4 per unit. What is the monthly bill of fridge? What is the heat rejected to surroundings? **(08 Marks)**

b. State and prove Carnot's theorem by conducting a thought experiment. **(08 Marks)**

Module-3

5 a. Define (i) Clausius inequality (ii) Entropy principle (iii) Available energy (iv) Unavailable energy and (v) Irreversibility. **(10 Marks)**

b. 2 kg of nitrogen at 1.5 bar, 300 K is compressed polytropically until its volume becomes 20% of original volume. The index of compression is 1.3, and C_P = 1.04 KJ/kgK. Calculate the change in entropy due to compression. **(06 Marks)**

OR

6 a. Define the following:
(i) Subcooled liquid (ii) Saturated liquid (iii) Saturated vapour
(iv) Superheated vapour and (v) Dryness fraction **(05 Marks)**

b. Steam at 15 bar, 300°C expands isentropically in a turbine to 0.4 bar. Determine the ideal work output of turbine per kg of steam, using Mollies chart. **(05 Marks)**

c. Steam flows in a pipeline at 15 bar. After expanding to 1 bar in a throttling calorimeter, the temperature is 120°C. Determine the quality of steam in the pipeline. Use steam tables for the properties. **(06 Marks)**

Module-4

7 a. Derive Maxwell's relations. **(08 Marks)**

b. Derive Clausius-Clayperon equation. **(08 Marks)**

OR

8 a. Define the following : (i) ideal gas (ii) enthalpy (iii) specific heat at constant volume, (iv) specific heat at constant pressure (v) perfect gas (vi) Gibb's function. **(06 Marks)**

b. 1 kg of air is compressed reversibly and adiabatically from 80 kPa, 60°C to 4 bar. It is then expanded at constant pressure to the original volume. Sketch the processes on p-v plane. Compute heat transfer and work for the whole path. **(10 Marks)**

Module-5

9 a. Derive (i) Dalton's law of partial pressure (ii) Amagat's law of partial volumes. **(08 Marks)**

b. A mixture of ideal gases consists of 3 kg nitrogen and 5 kg carbon dioxide at 300 kPa and 20°C. Calculate partial pressures and equivalent gas constant. **(08 Marks)**

OR

10 a. What are the limitations of ideal gas equation? Discuss how Vander Waal's, Redlich Kwong and Beattie-Bridgemass's equations account for real gas behavior. **(10 Marks)**

b. Using generalized compressibility chart, determine the density of steam in a super critical boiler at 442 bar and 440°C. **(06 Marks)**

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