3E1413

Roll No. : _____ Total Printed Pages : 4

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B.Tech. (Sem. III) (Main/Back) Examination, February - 2010
(Common for Mech., P. & I. & Automobile Engg.)
(3AE3 Engineering Thermodynamics)

Time : **3** Hours] [Total Marks : **80**
[Min. Passing Marks : **24**

*Attempt overall **five** questions in all. Schematic diagrams must be shown wherever necessary. Any data you feel missing may be assumed and stated clearly.*

Use of following supporting material is permitted during examination.

(Mentioned in form No. 205)

1. **Steam tables** 2. **Mollier Chart**

1 (a) Derive an expression for the work done and heat supplied in a polytropic process. 8

(b) A closed system has 2 kg of air initially at a pressure of 5 bar and temperature 227°C, expands reversibly to a pressure of 2 bar following the law $pv^{1.25}$ = constant. Assuming air as an ideal gas, determine the work done and heat transferred. 8

OR

1 (a) A mass of air initially at 227°C temperature and 700 K Pa pressure occupies 0.025 m^3 space. The air is expanded at a constant pressure till volume becomes 0.10 m^3. A polytropic expansion process with n=1.5 is then carried out followed by a constant temperature process which completes the cycle. All processes are reversible. Sketch the cycle on p-v plane and find :

(i) heat rejected in the cycle in kJ and

(ii) efficiency of the cycle. 8

(b) Define the term property. State the differences between intensive, extensive and specific properties of a thermodynamic system. Give few examples for each.

8

2 (a) What is a thermal energy reservoir?

2

(b) State the limitations of first law of thermodynamics.

6

(c) An engine operating on a Carnot cycle works within the temperature limits of 600 K and 300 K. If the engine receives 200 kJ of heat, evaluate the work done and thermal efficiency of the engine.

8

OR

2 (a) Discuss the consequence of combined first law and second law of Thermodynamics.

6

(b) State and prove Clausius statement.

10

3 (a) What does the Joule-Thomson coefficient represent?

4

(b) Show that the Joule-Thomson coefficient of an ideal gas is zero.

6

(c) Show that $C_p - C_v = R$ for an ideal gas.

6

OR

3 A piston-cylinder device contains 0.05 kg of steam at 1 MPa and 300°C. The steam now expands to a final state of 200 kPa and 150°C, doing work. Heat losses from the system to the surroundings are estimated to be 2 kJ during this process. Assuming the surroundings to be at $T_o = 25°C$ and $P_o = 100$ kPa, determine :

(a) the availability of the steam at the initial and the final states,

(b) the reversible work and

(c) the irreversibility.

16

4 (a) Compare Otto, Diesel and Dual cycle with p-v and T-s diagrams. 6

(b) An engine working on air standard Diesel cycle the compression ratio is 16. At the beginning of isentropic compression the conditions are 1 bar pressure and 288 K temperature. Heat is added at constant pressure till temperature reaches 1500 K. Calculate :

(i) cut-off ratio

(ii) heat supplied

(iii) cycle efficiency, and

(iv) mean effective pressure. 10

OR

4 (a) Derive the expression for air standard efficiency of Otto cycle. 2

(b) Enlist four assumptions made in the analysis of Air standard cycles. 4

(c) A four stroke engine working on Otto cycle has a swept volume of 0.1 m^3. The compression ratio is 7 and condition at the start of the cycle, 1 bar pressure and 360 K temperature. The heat addition at constant volume is 100 kJ per cycle. Find, Air Standard Efficiency, Mean Effective Pressure, Peak Pressure and Temperature of the cycle. 10

5 (a) Define sensible heat and dry saturated steam. 4

(b) Find the enthalpy and entropy of steam when the pressure is 2 MPa and the specific volume is 0.09 m^3/kg. Use steam table only. 4

(c) Find out specific volume, dryness fraction and specific internal energy of steam at 7 bar pressure and specific enthalpy of 2600 kJ/kg by using Mollier chart only. 8

OR

5 (a) Explain the following terms as applied to steam :

(i) Saturated steam

(ii) Dryness fraction

(iii) Triple point, and

(iv) Total enthalpy of dry and saturated steam. 4

(b) Define critical point and explain its significance. State critical point temperature and pressure for water vapour. 4

(c) A spherical shell of diameter 50 cm contains steam at a pressure of 40 bar and 0.85 dryness fraction. Calculate the mass of water and steam. 8
