[03 – 2113]

II/IV B.E. DEGREE EXAMINATION.

First Semester

Mechanical Engineering

ENGINEERING THERMODYNAMICS — I

(Common with Dual Degree Program in Mechanical Engineering)

(Effective from the admitted batch of 2006–2007)

Time : Three hours | Maximum : 70 marks

Question No. 1 is compulsory.

Answer any FOUR from the remaining.

All questions carry equal marks.

Use of "gas" tables is permitted.

1. Answer the following :

   (a) What is a path function?

   (b) What is meant by heterogeneous system?

   (c) State Zeorth law of thermodynamics.

   (d) Write the equation for universal gas constant.

   (e) Explain principle of increase of entropy.

   (f) Define irreversibility.

   (g) Discuss the significance of mean effective pressure.

7. (a) Derive the air standard efficiency of a Stiriling cycle.

(b) A certain quantity of air at a pressure of 1 bar and temperature 70°C, is compressed reversibly and adiabatically until the pressure is 7 bar in an Otto cycle engine. 460 kJ of heat per kg of air is now added at constant volume. Determine

(i) Compression ratio of the engine

(ii) temperature at the end of compression and

(iii) temperature at the end of heat addition.

Take for air : $C_p = 1$ kJ/kg - k and

$C_v = 0.707$ kJ/kg - k

8. (a) Draw the compressibility chart and explain its significance.

(b) Explain the performance of heat engines and reversed heat engines.

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2. (a) Explain various thermodynamic systems.

(b) The properties of a closed system charge following the relation between pressure and volume as $pV = 3.0$, where p is in bar, vis in m³. Calculate the work done when the pressure increases from 1.5 bar to 7.5 bar.

3. (a) With assumptions, derive steady flow energy equation.

(b) The properties of a system, during a reversible constant pressure non-flow process at p = 1.6 bar, changed from $V_1 = 0.3\,\text{m}^3/\text{kg}$, $t_1 = 20\,°\text{C}$ to $V_2 = 0.55\,\text{m}^3/\text{kg}$, $t_2 = 260\,°\text{C}$. The specific heat of the fluid is given by $C_p = \left(1.5 + \frac{75}{t + 45}\right)\text{kJ/kg}\,°\text{C}$, where t is in °C. Determine

(i) heat added/kg

(ii) work done/kg

(iii) change in interval energy/kg and

(iv) change in enthalpy/kg.

4. (a) What is throttling process? Explain by means of Joule Thompson porous plug experiment.

(b) A system contains 0.15 m^3 of a gas at a pressure of 3.8 bar and 150 °C. It is expanded adiabatically till the pressure falls to 1 bar. The gas is then heated at a constant pressure till its enthalpy increases by 70 kJ. Determine the total work done. Take $C_p = 1 \text{ kJ/kg-k}$ and $C_v = 0.714 \text{ kJ/kg-k}$.

5. (a) Derive the equation for charge of entropy of a gas for a general case.

(b) A heat pump working on a reversed Carnot cycle takes in energy from a reservoir maintained at 5°C and delivers it to another reservoir where temperature is 77°C. The heat pump derives power for its operation from a reversible engine operating within the higher and lower temperatures of 1077°C and 77°C. For 100 kJ/kg of energy supplied to reservoir at 77°C, estimate the energy taken from the reservoir at 1077°C.

6. (a) Explain the concept of availability in flow process.

(b) Using the first Maxwell equation, derive the remaining three.