Code : 021307

B.Tech 3rd Semester Examination, 2016

Thermodynamics

Time : 3 hours   Full Marks : 70

Instructions :

(i) There are *Nine Questions in this Paper*

(ii) *Attempt Five questions in all.*

(iii) *Question No. 1 is Compulsory.*

(iv) The marks are indicated in the right hand margin.

---

1. Multiple choice question (do any seven):   2×7=14

   (i) The difference between the pressure of fluid and the pressure of atmosphere is called as

   (a) Barometric pressure

   (b) Absolute pressure

   (c) Gauge Pressure

   (d) None of these

   (ii) Which of the following sets has all properties as point functions?

   (a) Entropy, enthalpy, work

   (b) Pressure, temperature, heat

   (c) Heat, work, enthalpy

   (d) Temperature, enthalpy, internal energy

   (iii) Which of the following sets has all open systems?

   (a) Boiler, gas turbine, compressor, condenser

   (b) Pump, thermo-flask, refrigerator, petrol engine

   (c) Window air conditioner, scooter engine, thermometer, diesel engine

   (d) Jet engine, gas engine, pressure cooker, steam turbine

   (iv) The elastic work (δW) per unit volume required for stretching a wire of length is given by the expression

   (a) $-\dfrac{\sigma}{d\varepsilon}$

   (b) $-\sigma d\varepsilon$

   (c) $-\sigma - d\varepsilon$

   (d) None of the above

   (v) The thermometric property of electrical resistance thermometer is

   (a) Current

   (b) Potential difference

   (c) Magnetic

   (d) Resistance

   (vi) The internal energy for a perfect gas is expressed as

Code : 021307   2

P.T.O.

(a) $\dfrac{\partial u}{\partial v} = c$

(b) $\dfrac{\partial u}{\partial v} = 0$

(c) $\dfrac{\partial u}{\partial v} < 0$

(d) $\dfrac{\partial u}{\partial v} > 0$

(vii) The following amount of heat transfer occurs during a cycle comprising of four processes.

$$120 \text{ kJ}, -20\text{kJ}, 16 \text{ kJ}, \text{ and } 24 \text{ kJ}$$

(a) 100 kJ

(b) 120 kJ

(c) 130 kJ

(d) 140 kJ ✓

(viii) The Van der waals equation of state for real gases may by given by

(a) $p = \dfrac{RT}{v+b} + \dfrac{a}{v^2}$

(b) $p = \dfrac{RT}{v-b} - \dfrac{a}{v^2}$

(c) $p = \dfrac{RT}{v^2} + \dfrac{a}{v^2}$

Code : 021307   3   P.T.O.

(d) ✓ $p = \dfrac{RT}{v+b} - \dfrac{a}{v^2}$

(ix) Select the correct relation

(a) Tds=dU+pdV

(b) dH=Tds+Vdp

(c) Tds=$C_p$dt−Vdp

(d) All of these

2. (a) Describe Thermodynamic Equilibrium and Quasi-stati process.   4+4

(b) An air standard dual cycle has a compression ratio of 16 and compression begins at 1 bar, 50°C. The maximun pressure is 70 bar. The heat transferred to air at constan pressure is equal to that at constant volume. Estimate (a) the pressure and temperatures at the cardinal points of the cycle, (b) the cycle efficiency (Given: for air $\gamma = 1.4$, $C_v = 0.718$ kJ/kg K, and $C_p = 1.005$ kJ/kg K).   6

3. (a) What are the four processes which constitute the Carnot cycle. A Carnot cycle operates between 0°C and 100°C. Determine thermal efficiency, if it operates as a heat engine and COPs if it operates as Heat pump and Refrigerator.
   5

(b) Describe Rankine Cycle? Define quality and dryness fraction of steam.   5+4

Code : 021307   4

4. (a) Describe and Diesel Cycle. akubihar.com 5

(b) A steam power plant operates on a simple ideal Rankine cycle between the pressure limits of 25 bar and 0.10 bar and handles 2 kg of steam. The temperature of steam at turbine inlet is 360°C. The steam enters a condenser and after condensation, the pump feeds back the steam into boiler. Show (a) p-v diagram with saturation lines; (b) T-S diagram with saturation lines; and calculate (c) the thermal efficiency of the cycle, (d) the net power output of the power plant, (e) the work ratio. akubihar.com 9

5. (a) Show the equivalence between statements of Kelvin-Planck and Clausius for 2nd law of thermodynamics. 5

(b) Derive the Inequality of Calusius as an criterion of reversibility of irreversibility of a thermodynamic cycle.

9

6. (a) Draw p-v diagram for polytropic process pv^n=constant, for n=0, n=1, n=2 & n=∞ under expansion and compression processes. akubihar.com 5

(b) A vessel of volume 0.04 m³ contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy. Use the Steam Table. 9

7. (a) Describe Available and Unavailable energy. 5

(b) What are Helmholtz's and Gibb's functions. Write four Maxwell's Equations. 5+4

8. (a) Derive equation of efficiency for ideal Otto Cycle i.e.

$\eta_{otto} = 1 - \dfrac{1}{r_k^{\gamma-1}}$ In an ideal Otto cycle, the air at the beginning of isentropic compression is at 1 bar and 15°C. The ratio of compression is 8. If the heat added during the constant volume process is 1000 kJ/kg then determine (i) the air standard efficiency; (ii) work done; (iii) heat rejected; (iv) maximum temperature of air during the cycle.

akubihar.com 5+4

(b) A reversible heat engine operates between two reservoirs at temperatures of 600°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and –20°C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ.

(a) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C.

(b) Reconsider (a) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values. 5

9. (a) Using the steady flow energy equation, find the work done in Turbine and compressor.   akubihar.com   5

(b) Derive a steady state energy flow equation for any thermodynamic system operating under control volume and control surface.   9

***