Roll No. | | | | | | | | | | | | Total No. of Pages : 3

Total No. of Questions : 09

B.Tech. (Sem.–1st & 2nd)

ELEMENTS OF MECHANICAL ENGINEERING

Subject Code : BTME 101 (2011 & 12 Batch)

Paper ID : [A1107]

Time : 3 Hrs. Max. Marks : 60

INSTRUCTION TO CANDIDATES :

1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION - B & C have FOUR questions each.
3. Attempt any FIVE questions from SECTION B & C carrying EIGHT marks each.
4. Select atleast TWO questions from SECTION - B & C.

SECTION-A

1. Answer briefly :

(a) State the conditions for a process to be reversible.

(b) What do you understand by thermodynamic property and thermometric substance?

(c) Why there are two values of specific heat for a gas?

(d) Explain the term reversibility as applied to a thermodynamic process.

(e) Comment on the statement: *The entropy of the universe tends to be maximum.*

(f) An engine working on Otto cycle has temperatures 300 K and 600 K at the beginning and end of the compression stroke. Determine the compression ratio and air standard efficiency.

(g) List the various advantages of internal combustion engines over external combustion engines.

(h) Explain the terms isotropy and homogeneity.

(i) Define a smart material.

(j) Define first moment of an area about an axis.

SECTION-B

2. a) Differentiate between temperature, heat and internal energy (3)

   b) A cylinder of volume 0.1 m^3 contains nitrogen gas at 1.01 *bar* and 20°C. If 0.5 *kg* of nitrogen is now pumped into cylinder, calculate the new pressure when the cylinder has returned to initial temperature. The molar mass of nitrogen is 28 *kg/mol*. Assume nitrogen to be perfect gas. (5)

3. a) Show that internal energy I is a function of temperature only. (2)

   b) The following is the equation which relates internal energy u, pressure p, and volume *v* for several gases

   $U = a + bpV$

   Where a and b are constants. Prove that for a reversible adiabatic process, $pV^{\gamma} = C$ where $\gamma = b+1/b$. (6)

4. A steady flow thermodynamic system receives fluid at a rate of 6 kg/min with an initial pressure of 2 *bar*, velocity 150m/s, internal energy 800 *kJ/kg* and density 27 kg/m^3. The fluid leaves the system with a final pressure of 8 bar, velocity 200 *m/s*, internal energy 800 *kJ/kg* and density 5 kg/m^3.

   If fluid receives 80 *kJ/kg* of heat during passing through the system and rises through 60 m, determine the work done during the process. (8)

5. a) Two Carnot engines working in series between the source and sink temperatures of 550 K and 350 K. If both engines develop equal power, determine intermediate temperature. (4)

   b) A cyclic heat engine operates between 800°C and 30°C. What is the least rate of heat rejection in *kW* net output of engine? (4)

SECTION-C

6. A gas engine working on Otto cycle has a compression ratio 7. The pressure and temperature at the start of compression is 0.98 *bar* and 328K, the air gas ratio is 1.2:1. If the heating value of the gas is 3850 kJ/m^3 and specific heat at constant volume is 0.719 *kJ/kg* – K, Calculate the thermal efficiency, mean effective pressure and work done per kg of the mixture. (8)

7. a) One kg of water at 273 K is brought into contact with a heat reservoir at 363 K. When the water has reached at 363 K, find:

   i) Change in entropy of water,

   ii) Change in entropy of reservoir,

   iii) Change in entropy of universe. (6)

   b) If the water is heated from 273 K to 363 K by first bringing it in contact with a reservoir at 313 K and then with a reservoir at 363 K, what will be the entropy change of the universe? (2)

8. a) Find the mass moment of inertia of solid cone about its axis of rotation. (6)

   b) Determine the polar moment of inertia of a hollow circular section whose external diameter is 10 *cm* and thickness is 1 *cm*. (2)

9. a) Give a neat sketch of the theoretical and actual pV diagrams for a four stroke Diesel engine. Describe briefly the factors which account for deviations between these plots. (4)

   b) What are ceramic materials? Name some of important ceramic materials. State advantages of ceramic materials. (4)