Total No. of Questions: 09

B.Tech. (2011 onwards) (Sem. – 1, 2)

ELEMENTS OF MECHANICAL ENGINEERING

M Code: 54101

Subject Code: BTME-101

Paper ID: [A1107]

Time: 3 Hrs. **Max. Marks: 60**

INSTRUCTIONS TO CANDIDATES:

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

SECTION A

1. a) Define a quasistatic process and state its salient characteristics.

   b) What is meant by fixed points of a thermometric scale?

   c) How is polytropic exponent determined and within what limits it can range?

   d) State the Carnot Theorem in the context of a heat pump / refrigerator.

   e) State the requirements of a process to be isentropic.

   f) For the same compression ratio and heat input, which cycle is more efficient: Otto, Diesel or Dual. Explain with T - s diagram.

   g) Mention the relative merits and demerits of two stroke engines when compared with four stroke engines.

   h) Compare and contrast elastic and plastic deformation of metals.

   i) Explain the working of piezoelectric ceramics.

   j) Write the position of centre of gravity for cylinder, hemisphere, sphere and right circular cone.

SECTION B

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

   b) A cylinder of volume $0.1m^3$ contains nitrogen gas at 1.01 bar and 20^oC. 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 cylinder contains $0.45m^3$ of a gas at 1 bar and 353K. The gas is compressed to a volume of $0.13m^3$ the final pressure is 5 bar Find:

   a) the mass of gas

   b) polytropic index *n*

   c) change in internal energy

   d) heat transfer during compression.

   Take $\gamma = 1.4$ R = 294.2 J / kg - K

4. a) Make an energy analysis of a centrifugal pump. (2)

   b) A pump is used to raise the pressure of water from 1 bar to 25 bar and delivers 2000 kg/hr of water. Neglect changes in volume, elevation and changes in velocity. The specific volume of water is $0.00145m^3$/kg. Calculate the power required to drive the pump. (6)

5. a) Demonstrate using second law that free expansion is irreversible. (3)

   b) A domestic food refrigerator maintains a temperature of –10°C while ambient temperature is –30°C. The heat leakage into the freezer is estimated to be at a continuous rate of 2*kJ/s*. Determine the least power required to pump out this heat continuously. (5)

SECTION C

6. In an air standard Otto cycle the pressure and temperature at the start of compression is 1 bar and 310 K. The pressure at the end of compression is 28 bar and at the end of heat addition is 75 bar. Calculate

   a) the compression ratio

   b) the maximum temperature in the cycle

   c) work ratio

   d) thermal efficiency (8)

7. a) A mass *m* of the fluid at temperature T_1 is mixed with an equal mass of the same fluid at temperature T_2. Find the expression for resultant change in entropy of the universe and comment whether it is positive or negative. (5)

   b) Find an expression for entropy change for an open system. (3)

8. a) A solid right circular cylinder has its base scooped out so that the hollow is a right circular cone on the same base and having the same height as the cylinder. Find the centre of gravity of reminder. (4)

   b) A hemisphere and cone have their bases joined together, the two bases being of the same size. Find the ratio of height of cone to the radius of the base, so that their common centre of gravity may be at the centre of common base. (4)

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

   b) Explain briefly, particle reinforced, fiber reinforced and structural composites. (4)