Total No. of Questions: 09

B.Tech. (2010 Batch) (Sem. – 1, 2)

ELEMENTS OF MECHANICAL ENGINEERING

M Code: 54012

Subject Code: ME-101

Paper ID: [A0123]

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

INSTRUCTIONS 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 at least TWO questions from SECTION - B & C.**

SECTION A

1. a) What is meant by thermodynamic equilibrium? How does it differ from thermal equilibrium?

   b) What is significance of $\int pdv$ in a non-flow system?

   c) Differentiate between *pv* and *pdv* and give examples of the inclusion of these terms in energy equation.

   d) Why Carnot cycle cannot be used practically?

   e) What does the principle of increase of entropy specify?

   f) List the assumptions made in the analysis of air standard cycles.

   g) What is the function of compression and oil control rings provided on the piston of an IC engine?

   h) State the condition of reversibility and self-locking of a machine.

   i) A composite bar constituting of iron and copper in parallel is heated. What would be the nature of the thermal stresses induced in the two bars?

   j) Define resilience, proof resilience and modulus of resilience.

SECTION B

(8 marks each)

2. a) A mass of 1.5 kg of air is compressed in a quasi-static process from 1.1 bar to 10 bar according to the law $pV^{1.25}$ = Constant. The initial density of air is 1.2 kg/m^3. Find the work involved in the compression process. (4)

   b) What is the concept of continuum? How density and pressure are defined using this concept? (4)

3. 0.2m^3 of a gas at 400 *kPa* and 127°C is contained in a cylinder. A reversible adiabatic expansion takes place to a pressure of 100 *kPa*. The gas is then heated by an isobaric process till the enthalpy increase is 72*kJ*. Find:

   a) The net work done

   b) The index of expansion if the above processes are replaced by a single reversible polytropic process giving the same work between the same initial and final states. Take c_p= 1 *kJ/kg-K* and c_v = 0.714 *kJ/kg-K*. (8)

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

   b) A centrifugal pump delivers 50*kg* of water per second. The inlet and outlet pressures are 1 bar and 4.2 bar respectively. The suction is 2.2m below the centre of the pump and delivery is 8.5m above the centre of the pump. The suction and delivery pipe diameters are 20 cm and 10 cm respectively. Find the capacity of electric motor to run the pump. (6)

5. a) Derive an expression for the efficiency of a heat engine What is the normal range of efficiency of heat engine (3)

   b) Which is more effective way to increase the efficiency of a Carnot heat engine to increase the source temperature T_1 , while the sink temperature T_2 is held constant or to decrease the sink temperature by the same amount while the source temperature is held constant How this result would be affected in case of a Carnot heat pump? (5)

SECTION C

(8 marks each)

6. In an air standard Otto cycle the compression ratio is 10, the compression begins at 38°c, 1 bar, and the maximum temperature of the cycles is 1060°C. Determine,

   a) heat supplied per kg of air,

   b) work done per kg of air,

   c) maximum pressure of the cycle,

   d) thermal efficiency. (8)

7. a) Prove that heat absorbed during a process is approximately equal to the change in entropy multiplied by the mean absolute temperature during process. (4)

   b) Show that whenever a system executes a complete cyclic process $\oint \frac{\delta Q}{T}$, is less than zero or in the limit is equal to zero. (4)

8. A rectangular steel plate 100 cm long, 40 cm wide and 2cm thick is subjected to bi-axial stress σ_x and σ_y acting along length and width respectively. If the increase in length is 0.6 mm and the increase in width is 0.09 mm, calculate,

   a) σ_x and σ_y,

   b) change in thickness of the plate

   c) change in volume of the plate (8)

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

   b) Sketch and briefly explain any two inversions of a double slider crank chain. (4)