B.E. (CST) Part-II 3rd Semester Examination, 2007

Elements of Mechanical Engineering

(ME-304)

Time : 2 hours **Full Marks : 35**

Use separate answerscript for each half.
Answer FOUR questions, taking TWO from each half.
The questions are of equal value.

FIRST HALF

1. a) Explain the working of a reciprocating air-compressor (single-stage) along with a suitable diagram.

   b) Derive the expression for the work done per kg. of air delivered by a reciprocating air-compressor. The clearance volume can not be neglected.

2. a) Draw a Diesel cycle on p-v diagram and state its various thermodynamic processes.

   b) An engine working on Diesel cycle has compression ratio of 16. The pressure and temperature at the beginning of the cycle are 1 bar and 292 K. The heat supplied to the working fluid per cycle is 2000 kJ/kg. Determine (i) the thermal efficiency and (ii) the mean effective pressure of the cycle.
   Take $\gamma = 1.4$ and $C_p = 1.005$ kJ/kg-K for air to be the working fluid.

3. a) Starting from first principles derive the expression of thermal efficiency for Otto cycle.

   b) Show that for the maximum work to be done per kg. of air in Otto cycle between given upper and lower limits of absolute temperature T_3 and T_1 respectively, the ratio of compression should have the value $\left(\frac{T_3}{T_1}\right)^{1.25}$ when $\gamma = 1.4$.

SECOND HALF

4. a) Define a kinematic pair. With the help of a diagram, identify different kinematic pairs in a slider-crank mechanism.

   b) Derive the expression for velocity and acceleration of a slider of the slider crank mechanism.

c) A petrol engine has a stroke of 140 mm and the connecting rod is 5 times the crank length. The crank rotates at 1000 rpm in the clockwise direction. Determine the velocity and acceleration of the piston at a crank angle of 35°. What is the inertia force due to the piston of mass of 25 kg?

5. a) Explain the following terms of a governor mechanism.
i) Sensitiveness , ii) isochronous.

b) Explain briefly the stability of a governor mechanism.

c) Explain the function of a flywheel.

d) Establish the following equation for a flywheel having a mass moment of inertia, I

$$\Delta E = I \omega_0^2 C_s$$

Where, ω_0 = mean angular velocity, C_s = co efficient of fluctuation of speed.

6. a) Define free and forced vibrations.

b) What are the basic elements in a vibratory system? How does a vibratory system maintain the energy balance?

c) Establish the equation of motion of an undamped free vibration of a single spring - mass system using the energy method.

d) Justify that the natural frequency of the above system is a system constant.

———