(3 Hours)   **Total Marks: 80**

N.B. 1) Question No.1 is compulsory.

2) Attempt any three questions out of the remaining five questions.

3) Figures to the right indicate full marks.

4) Assume suitable data wherever required but justify the same.

Q1.   **Attempt any four**   **(20)**

A.   What are the different types of constrained motions?

B.   What is the initial tension in a belt drive?

C.   What are the different types of instantaneous centers?

D.   Derive the fundamental equation for correct steering in steering gear mechanism.

E.   State and explain law of gearing.

Q2 A.   A flat belt is required to transmit 35 kW from a pulley of 1.5 m effective diameter   **(10)**
running at 300 rpm. The angle of contact is spread over 11/24 of the circumference and
the coefficient of friction between the belt and pulley surface is 0.3. Determine, taking
centrifugal tension into account, width of the belt required. It is given that the belt
thickness is 9.5 mm, density of its material is
1.1×10^3 kg/m^3 and the related permissible working stress is 2.5 N/mm^2.

B.   Two mating gear wheels have 20 and 40 involute teeth of 10 mm module and 20^0 **(10)**
pressure angle. The addendum on each wheel is to be made of such a length that the line
of contact on each side of the pitch point has half the maximum possible length.
Determine the addendum height for each gear wheel and the length of the line of contact.
If the smaller wheel rotates at 250 rpm, find the velocity of point of contact along the
surface of each tooth at the instant when the tip of a tooth on a smaller wheel is in contact.

Q3 A.   With the help of a neat sketch derive the equation for the length of path of contact, arc   **(10)**
of contact and contact ratio for the two gears in mesh.

B.   Derive the equation for the length of an open belt drive.   **(10)**

Q4 A.   A cam with a minimum radius of 25 mm, rotating clockwise at a uniform speed of 100   **(10)**
rpm, to give a roller follower at the end of a valve rod, motion described below,
i)   To raise the valve through 50 mm during 120^0 rotation of the cam.
ii)   To keep the valve fully raised through next 30^0.
iii)   To lower the valve during next 60^0.
iv)   To keep the valve closed during rest of the revolution.
The displacement of the valve, while being raised and lowered, is to take place with
SHM. Draw the displacement, velocity and acceleration diagrams for one complete
revolution of the cam.

B.   A uniform bar of mass 'm' and length 'L' hangs from a frictionless hinge. It is released   **(10)**
from the horizontal position. Find the angular velocity of the center of mass 'G', when
it is in vertical position. Solve by work energy principle.

{ Turn Over }

Q5 A. The mechanism of a wrapping machine, as shown in figure, has the following **(14)** dimensions:

$O_1A = 100$ mm, $AC = 700$ mm, $BC = 200$ mm, $O_3C = 200$ mm, $O_2E = 400$ mm, $O_2D = 200$ mm, $BD = 150$ mm.

The crank O_1A rotates at a uniform speed of 100 rad/s. Find the velocity of the point E of the bell crank lever by

    i)   Instantaneous Center method
    ii)   Relative Velocity method
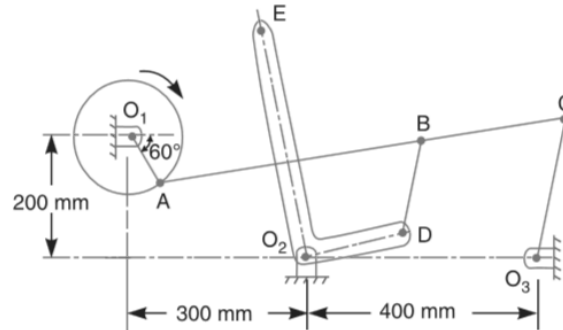
  B. Classify follower in detail. **(6)**

Q6 A. Figure shows the mechanism of a radial valve gear. The crank OA turns uniformly at **(14)** 150 rpm and is pinned at A to rod AB. The point C in the rod is guided in the circular path with D as center and DC as radius. The dimensions of various links are: OA = 150 mm; AB = 550 mm; AC = 450 mm; DC = 500 mm; BE = 350 mm. Determine velocity and acceleration of the ram E for the given position of the mechanism.
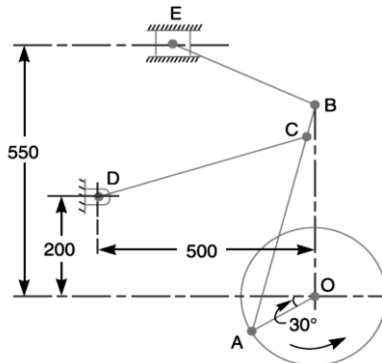
  B. Prove that Hart's mechanism can trace exact straight line. **(6)**