B. Tech.

(SEM. IV) EXAMINATION, 2006-07

KINEMATICS OF MACHINES

Time : 3 Hours] [Total Marks : 100

Note : Attempt all the six questions.

1. Attempt any two of the following : 8×2
   a. Differentiate between
      i) Kinematic chain and mechanism
      ii) Lower pair and higher pair
      iii) Fully constraint motion and successfully constrained motion
      iv) Link and element.
   b. What do you understand by inversion of a mechanism? Explain with sketches the inversion of slider crank mechanism.

V-4041] 1 [Contd...
c. Find expression for constraint motion of a planer mechanism with n links, j lower pairs and h higher pairs. For the mechanism shown in fig.1. Determine the number of degrees of freedom.

![Fig. 1](image)

2 Attempt any two of the following:

a. Determine all the instantaneous centres for the mechanism shown in fig.2. Find also the velocity of slider D-Given that $O_2A = 4.5$ cm, $AB = 12$ cm, $O_4B = 6$ cm, $BC = 2$ cm, $AC = 13$ cm, $CD = 14$ cm and $W_2 = 10$ rad/sec.

![Fig. 2](image)
b. Link 2 of the mechanism, shown in fig. 3, rotates at a constant angular velocity of $W_2 = 1$ rad/sec. Determine the velocity and acceleration of point D.

![Diagram](image)

**Fig. 3**

<table>
<thead>
<tr>
<th>Distance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$O_2A$</td>
<td>5 cm</td>
</tr>
<tr>
<td>$AB$</td>
<td>10 cm</td>
</tr>
<tr>
<td>$AC$</td>
<td>20 cm</td>
</tr>
<tr>
<td>$BD$</td>
<td>10 cm</td>
</tr>
<tr>
<td>$DO_6$</td>
<td>10 cm</td>
</tr>
</tbody>
</table>

c. What do you mean by coriolis component of acceleration? When it will exist in a mechanism? Prove that this component of acceleration is equal to $2V_{p3p2} w_2$, where $V_{p3p2}$ is velocity of the slider (link 3) along the rotating link 2.

3 Attempt any two of the following: \(8 \times 2\)

a. Name different mechanisms which give exact straight line motion. Prove that the tracing point of Hart’s mechanism describes a straight line path.
b. What do you understand by steering gear? Derive expression for the fundamental equation of correct gearing. Describe this with reference to Ackermann steering gear.

c. A Hooke’s joint connects two shafts which are having $165^\circ$ as the included angle. The driving shaft rotates uniformly at 1000 rpm. Find the maximum angular acceleration of the driven shaft and the maximum torque required if the driven shaft carries a flywheel of mass 10 kg and 100 mm radius of gyration.

4 Attempt any two of the following:

a. Determine the chebyshev spacing for a four bar linkage generating the function $y - \sin x$, in the range of $0 \leq x \leq \pi/2$ where three precision points are to be prescribed. For the ranges of input and output link rotations of $\Delta \phi = 60^\circ$ and $\Delta \psi = 90^\circ$ respectively find $\phi_2$, $\phi_3$, $\psi_2$.

b. Synthesize, graphically, a slider – crank mechanism such that $\phi_{12} = 30^\circ$, $\phi_{23} = 50^\circ$ where $\phi_{ij}$ is angular distance between position i and j of crank and $s_{12} = 25 \text{ cm}$, $s_{23} = 20 \text{ cm}$ where $S_{ij}$ is linear distance between position i and j of the slider. The input crank moves in a counter clockwise direction while the output slider moves away from the fixed pivot $O_2$.
c. Synthesize a four bar function generator to solve the equation $y = \sin x$, $0 \leq x \leq \pi/2$. Use three precision points and Chebyshev spacing. Take $\Delta \phi = 60^\circ$, $\Delta \psi = 90^\circ$, $\phi_0 = 30^\circ$ and $\psi_0 = 60^\circ$ where $\Delta \phi$ and $\Delta \psi$ are ranges of input and output link rotations. $\phi_0$ and $\psi_0$ are initial angular positions of input and output link respectively.

5 Attempt any two of the following: 8x2

a. Draw the displacement, velocity and acceleration diagrams for a follower when it moves with uniform acceleration and deceleration. Derive expression for velocity and acceleration during out stroke and return stroke of the follower.

b. Draw the profile of a cam to raise a valve with simple harmonic motion through 45 mm in 1/3 of revolution, keep it fully raised through 1/12 revolution, and to lower it with uniformly accelerated and decelerated in 1/4 revolution. The valve remains closed during the rest of the revolution. The diameter of roller is 20 mm and minimum radius of the cam is to be 25 mm. The diameter of the cam shaft is 25 mm. The axis of the valve rod passes through the axis of the cam shaft. Assume the cam shaft to rotate with a uniform velocity.
c. A symmetrical circular arc cam operating a flat-faced follower has least radius = 27.5 mm, total lift = 12.5 mm, angle of lift = 55°, nose radius = 3 mm speed of cam = 600 rpm. Find:
   i. distance between cam centre and nose centres
   ii. radius of circular blank.

6 Attempt any **two** of the following : 8x2

a. Explain what is interference and how it is prevented. If interference between two involute gears is to be avoided then prove that the maximum length of arc of contact will be equal to \((r + R) \tan \phi\) where \(r\) is pitch circle radius of pinion, \(R\) is pitch circle radius of wheel, and \(\phi\) is pressure angle.

b. Explain the terms : pressure angle, path of contact and contact ratio between two mating gears. What are the advantages of involute tooth profile.

c. In a reverted epicyclic gear train, as shown in fig. 4 the arm F carries two wheels A and D and a compound wheen B-C. The wheel A meshes which wheel B and the wheel D meshes with wheel C. The numbers of teeth on wheel A, D and C are 80, 48 and 72 respectively. Find the speed and direction of
wheel D when wheel A is fixed and arm F makes 200 rpm clockwise.

Fig. 4