

Answer any FIVE questions.

All question carry equal marks.

1. (a) Derive Kutzbach criterion for a planar mechanism, Define transmission angle and explain its significance. (6M)
 (b) Derive the analytical expressions for the motion analysis of the slider in a slider – crank mechanism (6M)

2. (a) Derive Euler – Savary equation (6M)
 (b) State and explain Bobillier's theorem. (6M)

3. Find the inflection circle for the motion of the coupler of the slider – crank linkage of fig. and determine the instantaneous radius of curvature of the part of the coupler point C. (12M)

4. (a) Explain the three phases of kinematic synthesis. (6M)
 (b) Explain the graphical synthesis procedure for motion generation with three prescribed positions. (6M)

5. (a) Derive Dyad or standard form equation (6M)
 (b) Explain the procedure of dimensional synthesis of a function generation mechanism for 3 precision points with Chebyshev's spacing using Freudenstein's equation. (6M)

6. Completion of an assembly line required the synthesis of a motion generator linkage to transfer boxed from one conveyor belt to another as depicted in fig. a pickup and release position plus an intermediate location are specified. For simplicity a four bar linkage is the type of linkage chosen for the task. From fig. prescribed quantities for the motion generation are :

$$\begin{aligned} \phi_2 &= -6 + 114, & \phi_3 &= -17 + 134, & \phi_4 &= 90=0, \\ \psi_2 &= 22^\circ, & \psi_3 &= 68=0, & \psi_4 &= 40^\circ, \\ \phi_2 &= 198^\circ, & \psi_2 &= 73^\circ \end{aligned}$$

the free choices are arbitrarily set as

Determine the link lengths

(12M)

7.

(a) Explain inertia forces and D'Alembert's principle.

(4M)

(b) The dimensions of a four-link mechanism are $AB = 500$ mm, $BC = 660$ mm, $CD = 560$ mm and $AD = 1000$ mm. The link AB has an angular velocity of 10.5 rad/s counter-clockwise and an angular retardation of 26 rad/s counter-clockwise at the instant when it makes an angle of 60° with AD , the fixed link. The mass of the links BC and CD is 4.2 kg/m length. The link AB has a mass of 3.54 kg, the centre of which lies at 200 mm from A and a moment of inertia of 88500 kg mm². Neglecting gravity and friction effects, determine the instantaneous value of the drive torque required to be applied on AB to overcome the inertia forces.

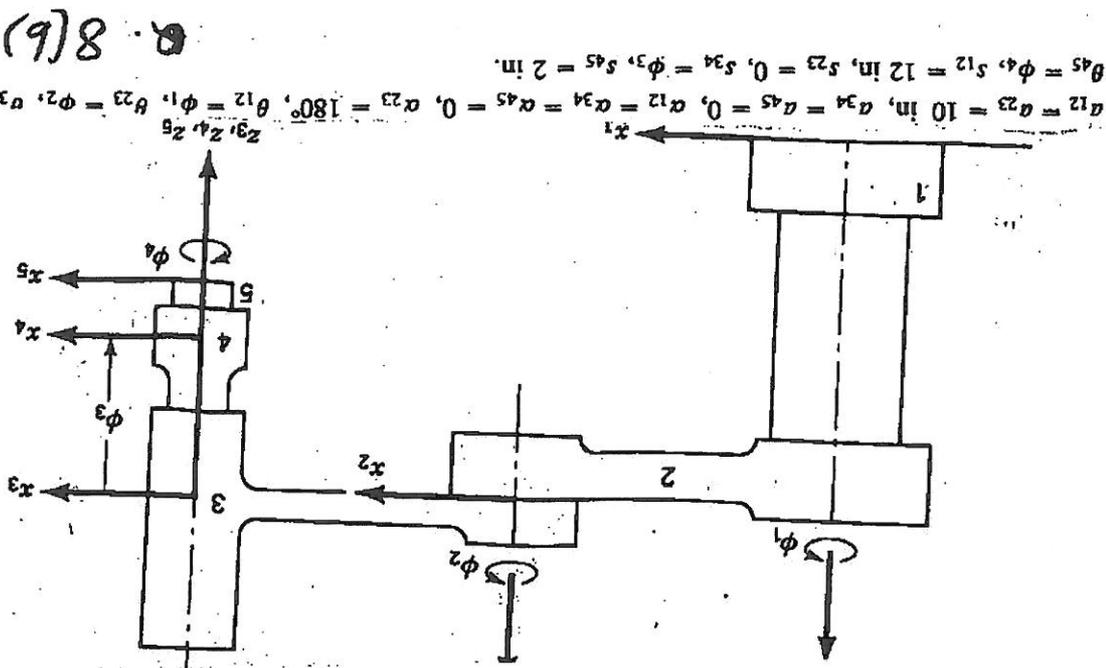
(8M)

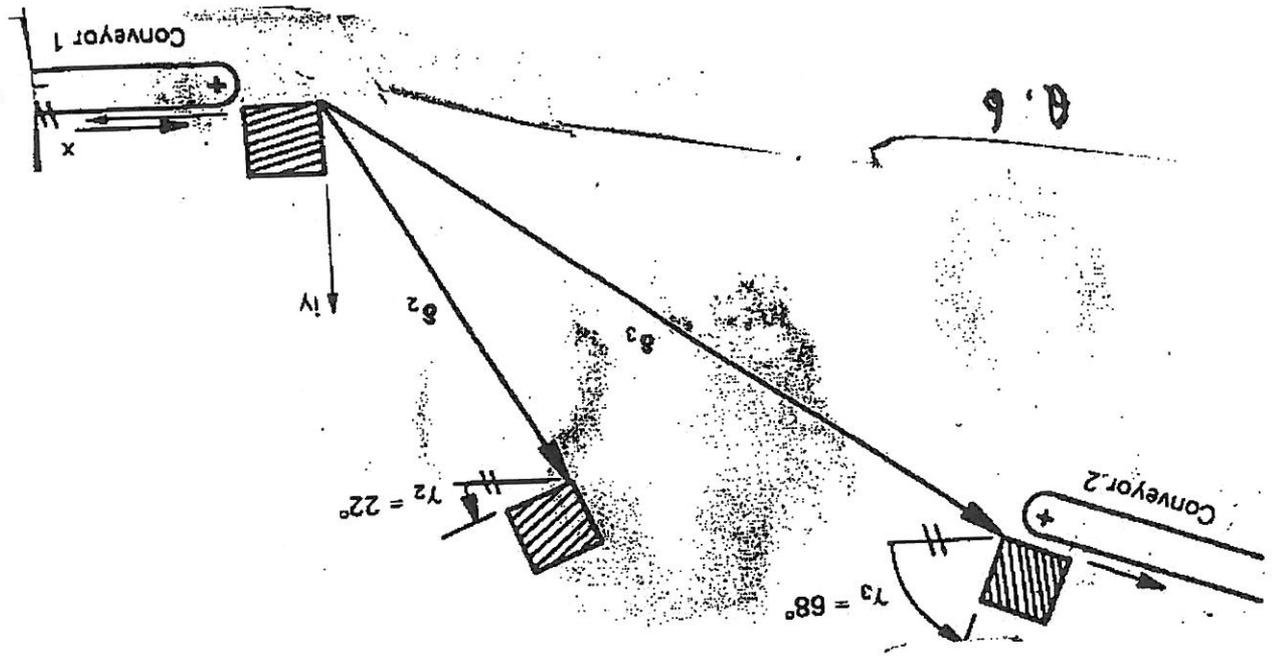
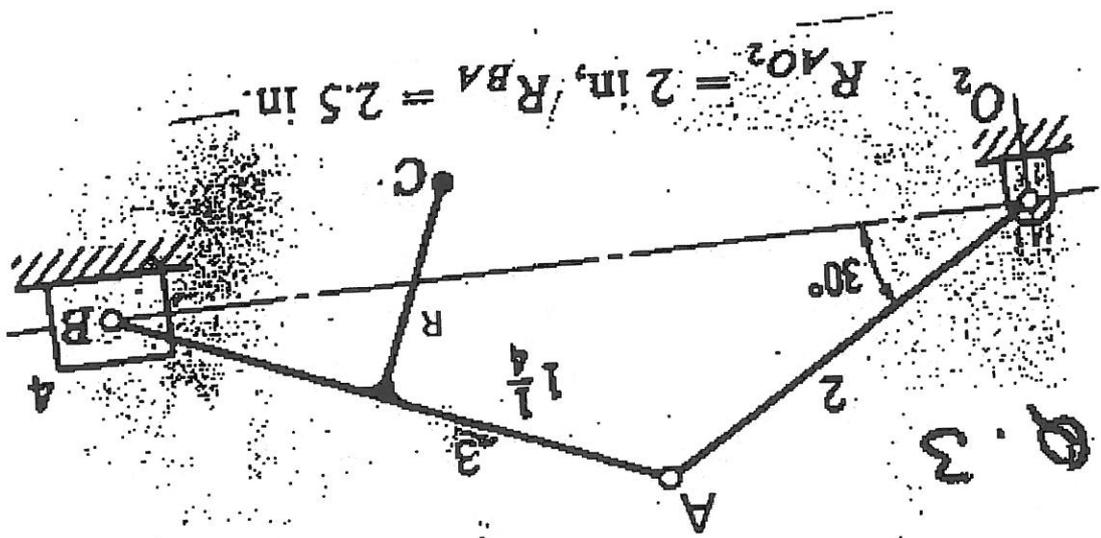
(a) Define Denavit-Hartenberg (D-H) Parameters. And derive the transformation matrix based on them.

(6M)

(b) For the SCARA robot shown in the figure, find the transformation matrix T_5 relating the position of the tool coordinate system to the ground coordinate system when the joint actuators are set to the values $\phi_1 = 30^\circ$, $\phi_2 = -60^\circ$, $\phi_3 = 2$ in, $\phi_4 = 0$. Also find the absolute position of the tool point which has coordinates of $x_5 = y_5 = 0$, $z_5 = 1.5$ in.

(6M)





Q. 7 (b)

