**Faculty of Engineering & Technology**
**Seventh Semester B.E. (Mech. Engg.) (C.B.S.)**
**Examination**
**ELECTIVE-I SYNTHESIS OF MECHANISMS**

Time—Three Hours]                    [Maximum Marks—80

### INSTRUCTIONS TO CANDIDATES

(1)  All questions carry marks as indicated.

(2)  Solve Question No. **1 OR** Question No. **2**.

(3)  Solve Question No. **3 OR** Question No. **4**.

(4)  Solve Question No. **5 OR** Question No. **6**.

(5)  Solve Question No. **7 OR** Question No. **8**.

(6)  Solve Question No. **9 OR** Question No. **10**.

(7)  Solve Question No. **11 OR** Question No. **12**.

(8)  Due credit will be given to neatness and adequate dimensions.

(9)  Assume suitable data wherever necessary.

(10) Illustrate your answers wherever necessary with the help of neat sketches.
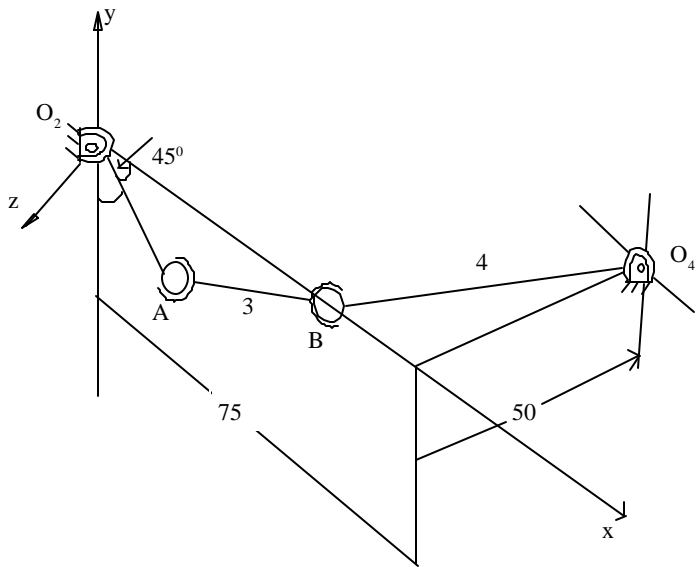
10.



$R_{AO_2} = 25$ mm, $R_{BA} = 87.5$ mm

$R_{BO_4} = 100$ mm

**(Fig 10)**

A form link RGGR crank-rocker mechanism is shown in fig 10. Find the positions of all moving links when the input crank is set to $\theta_2 = -45^0$ as shown.  13

11. (a) How Robot arm is a kinematic device ? Explain.
    4

   (b) Explain the term forward kinematics.  4

   (c) Explain the term inverse kinematic analysis with respect to Robots.  6

**OR**

3. (a) What is Chebyshev Spacing ?  3

   (b) Plot the cubic of stationary curvature (circle point curve) associated with link 3 of the mechanism.



$O_A O_B = 6, O_2 A = 4, O_4 B = 3.75$
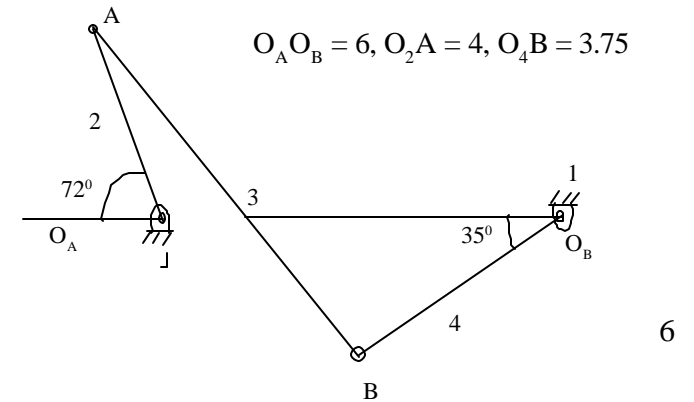
   (c) Explain Euler-Savany equation. How is it used to determine the radius of curvature of the path of a coupler point.  4

**OR**

4. (a) Lay out a mechanism to satisfy the following displacements.

   Input Crank = $\theta_{12} = 20^0$, $\theta_{13} = 35^0$,

   $$\theta_{14} = 60^0$$

   Output Crank – $\phi_{12} = 10^0$, $\phi_{13} = 30^0$, $\phi_{14} = 40^0$.
   7

(b) Design a quick return crank rocker mechanism with a transmission ratio of 1.11 and an output rocker displacement of $70^0$. Initial crank angle is to be $17.5^0$. 6

5. Using Freudenstein's equation, synthesise a four bar mechanism to co-ordinate crank and rocker displacements as below :

| Position | Crank Angle | Rocker Angle | |
|----------|-------------|--------------|----|
| 1 | $30^0$ | $45^0$ | |
| 2 | $45^0$ | $60^0$ | 13 |
| 3 | $60^0$ | $90^0$ | |

**OR**

6. Using the loop equation, design a four bar mechanism to co-ordinate the following displacements.

$$Q_{11} = 20 \quad Q_{31} = 30$$
$$Q_{12} = 40 \quad Q_{32} = 60$$
$$Q_{13} = 60 \quad Q_{33} = 90$$

13

7. (a) What is optimal synthesis ? Explain. 6

(b) Explain Powell's search method in detail with suitable example. 7

**OR**

8. (a) How least square approximation is useful in optimum synthenis of a planer mechanism. 7

(b) Explain how Kinemaitc synthesis task is formulated. Give example. 6

9. (a) What is spatial mechanism ? What is difference between planer and spatial mechanism. 4

(b) Define mobility of a spatial mechanism. Derive equation of mobility. 4

(c) Explain Denerilt, Herterinberg notation used in spatial mechanisms. 5

**OR**

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(11) Use of non programmable calculator is permitted.

(12) Use drawing sheets for all graphical solutions

(13) Retain all construction lines.

1. (a) What is Kinematic synthesis ? What are different types ? 4

   (b) Define Mobility. What is Grubler's criterion ? How is it used to decide number of joints and links for a mechanism ? 4

   (c) Draw neat sketch of six link mechanism having DOF one. 3

   (d) Draw neat sketch of mechanism with two DOF. 3

**OR**

2. (a) State Grashoff's law ? What is its significance in linkage design ? 3

   (b) Define cognates. State Robert-Chebyshev theorem. What is Robert's triangle ? How is it used to design new mechanism ? 6

   (c) What is transmission angle ? Why it is called as merit of index of the mechanism ? What is toggle position ? Comment on mechanical advantage during toggle positions. 5

12. For the gantry robot shown in the figure. Find the transformation matrix $T_{15}$ relating the position of the tool coordinate system to the ground co-ordinate system whenn the joint actuators are set to the values $\phi_1 = 450$ mm, $\phi_2 = 180$ mm, $\phi_3 = 50$ mm, $\phi_4 = 0$. Also find the absolute position of the tool point which has co-ordinates $x_5 = y_5 = 0$, $z_5 = 45$ mm
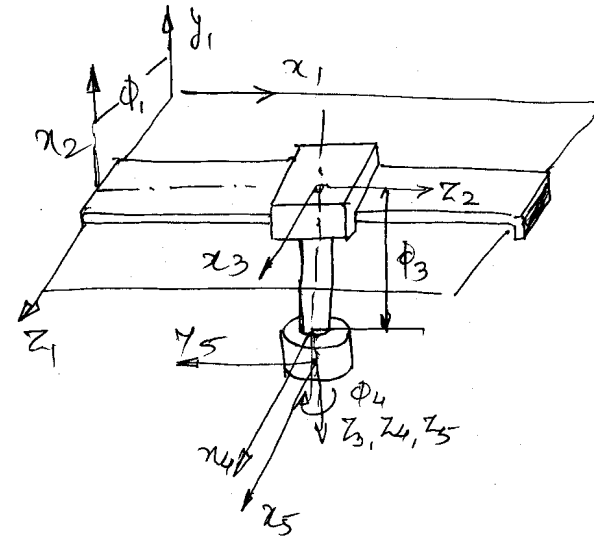


$a_{12} = a_{23} = a_{34} = a_{45} = 0$, $\alpha_{12} = 90^0$, $\alpha_{23} = -90^0$, $\alpha_{34} = \alpha_{45} = 0$, $\theta_{12} = \theta_{23} = 90^0$,
$\theta_{34} = 0$, $\theta_{45} = \phi_4$, $S_{12} = \phi_1$, $S_{23} = \phi_2$,
$S_{34} = \phi_3$, $S_{45} = 50$ mm. 14