

# **MECH 343 Theory of Machines I**

**Midterm Solution**

**Lecture 8**

Figure shows a valve operated by a cam. Here the valve-seat is fixed to the frame. The frame, roller, follower, rocker-arm, and the valve are links in this mechanism. The function of the spring is to maintain positive contact between the valve-rod and the rocker-arm. The follower and the valve-rod remain in contact with the rocker-arm. The contact between the cam and roller is pure rolling

a) List the Lower and Higher Pairings in the given table

	A	B	C	D	E	F	G	H	I	J
1	Lower Pair	1-2	2-3	3-4	4-1		5-1		6-1	
2	Higher Pair					4-5		5-6		

b) Determine the Mobility of the Mechanism

Mobility: 1

$$n = 6, J_1 = 6, J_2 = 2$$

$$m = 3(6-1) - 2 \times 6 - 1 \times 2$$

$$m = 15 - 12 - 1 = 1$$

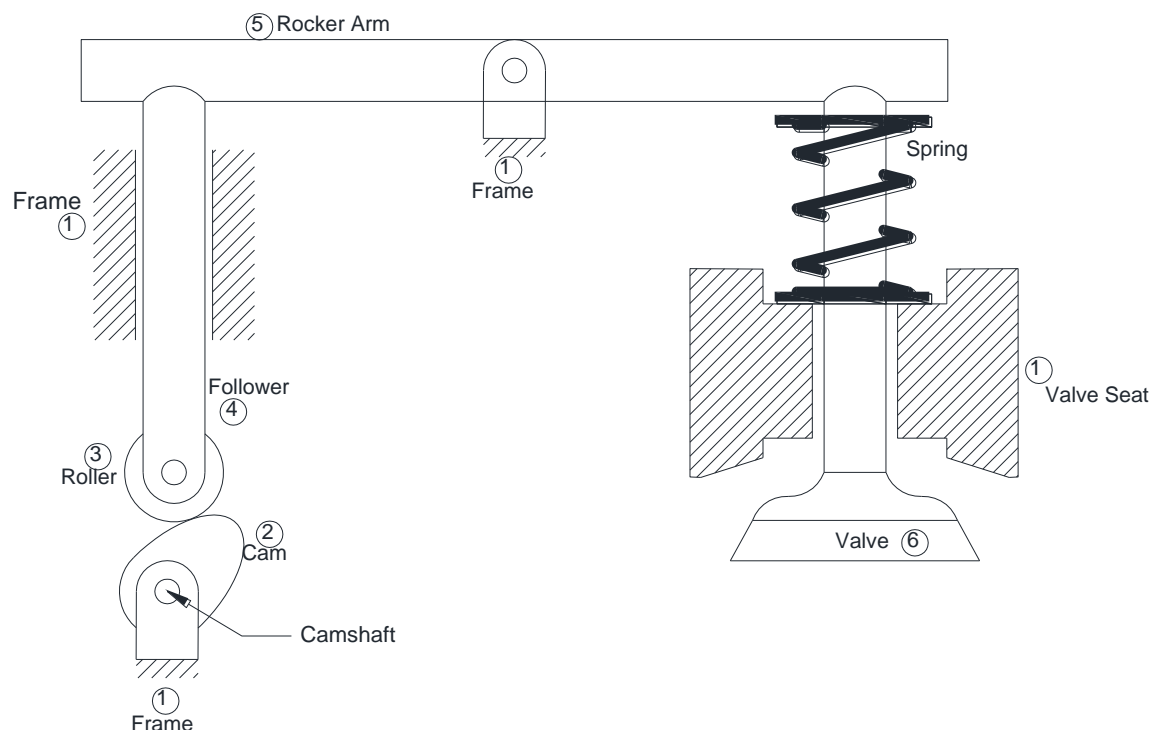
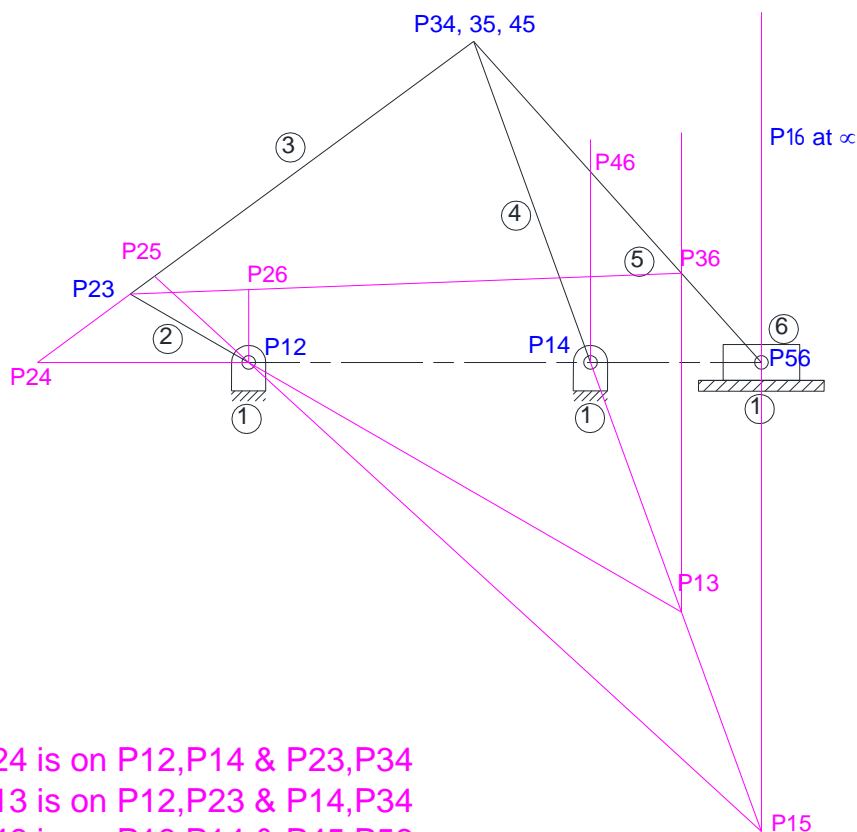
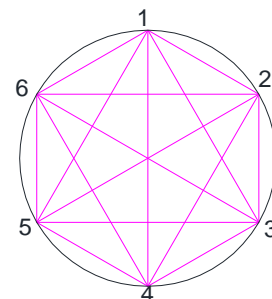


Figure shows a mechanism, the rotation of the crank  $O_2A$  causes a reciprocating motion of the slider 6. the links are numbered.

- Locate the centers of rotation  $P_{12}$ ,  $P_{14}$ ,  $P_{16}$ ,  $P_{23}$ ,  $P_{34}$ ,  $P_{35}$ ,  $P_{45}$  and  $P_{56}$
- Locate the centers of rotation  $P_{13}$ ,  $P_{24}$ ,  $P_{46}$ ,  $P_{36}$ ,  $P_{26}$ ,  $P_{15}$ , and  $P_{25}$

*Hint: use Circle Diagram Method*



$P_{24}$  is on  $P_{12}, P_{14}$  &  $P_{23}, P_{34}$   
 $P_{13}$  is on  $P_{12}, P_{23}$  &  $P_{14}, P_{34}$   
 $P_{46}$  is on  $P_{16}, P_{14}$  &  $P_{45}, P_{56}$   
 $P_{36}$  is on  $P_{13}, P_{16}$  &  $P_{46}, P_{34}$   
 $P_{26}$  is on  $P_{12}, P_{16}$  &  $P_{23}, P_{36}$   
 $P_{15}$  is on  $P_{16}, P_{56}$  &  $P_{13}, P_{35}$   
 $P_{25}$  is on  $P_{12}, P_{15}$  &  $P_{24}, P_{45}$

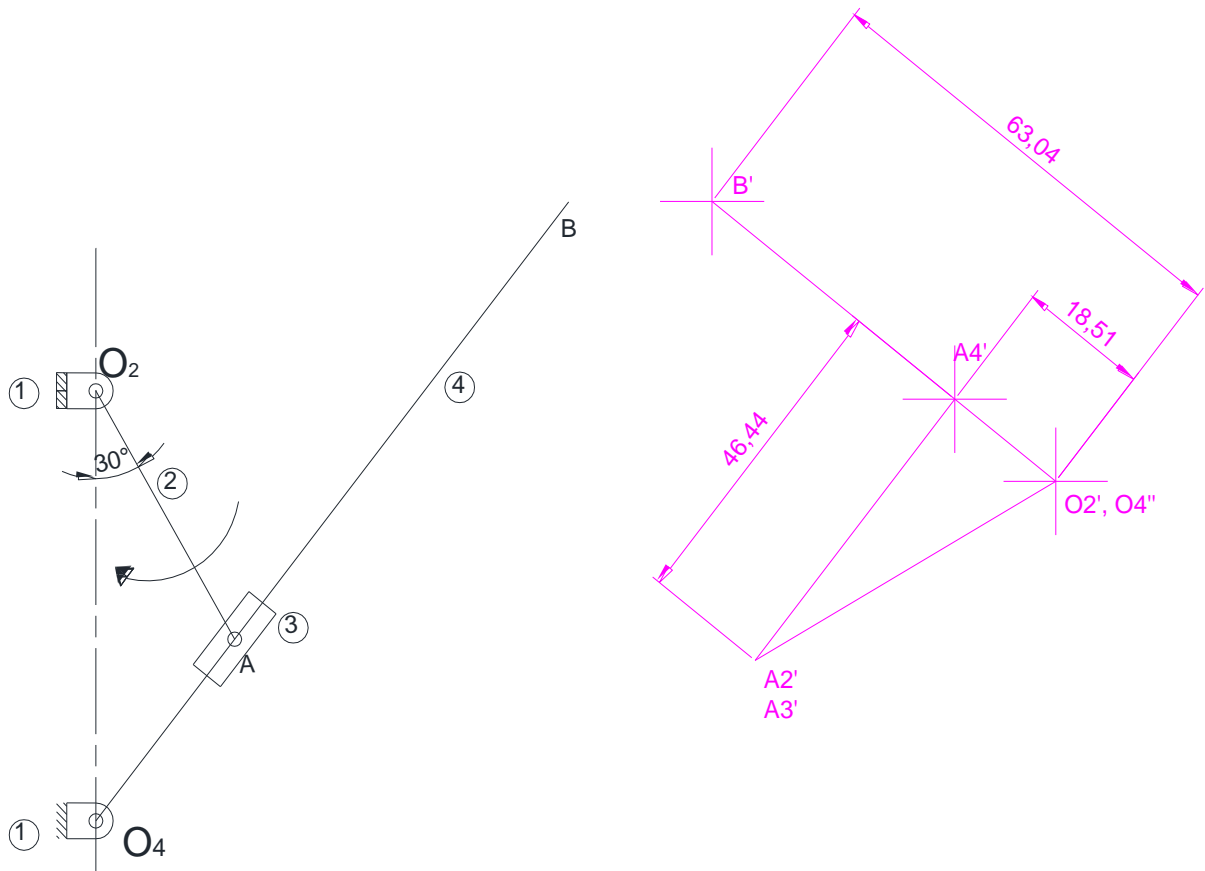
A part of a quick return mechanism is shown in figure. here  $O_2A = 200\text{mm}$ ,  $O_2O_4 = 300\text{mm}$ ,  $O_4B = 550\text{mm}$ . Scale 1:5. The crank rotates in the CW sense at  $100\text{ rad/s}$ . For the configuration shown, the crank  $O_2A$  makes angle  $30^\circ$  with  $O_2O_4$ .

a) Draw the velocity diagram to the scale of  $1\text{ cm} = 4\text{ m/s}$ . Indicate the velocity of B

b) Determine the angular velocity of  $O_4B$   $45.9\text{ rad/s CCW}$

c) Velocity of the sliding collar A with respect to link  $O_4B$

$18.58\text{ m/s II to } O_4A$



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Problem # 3

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An eccentrically pivoted circular cam (2) drives an oscillating follower (3). The cam rotates at 50 rad/s in the CW sense. The cam is of radius 500mm, and its center A is 250 mm from the pivot  $O_2$ . Further  $O_2O_3 = 1000\text{mm}$ . Scale 1:5. For the configuration shown, the angle  $AO_2O_3$  is  $60^\circ$ .

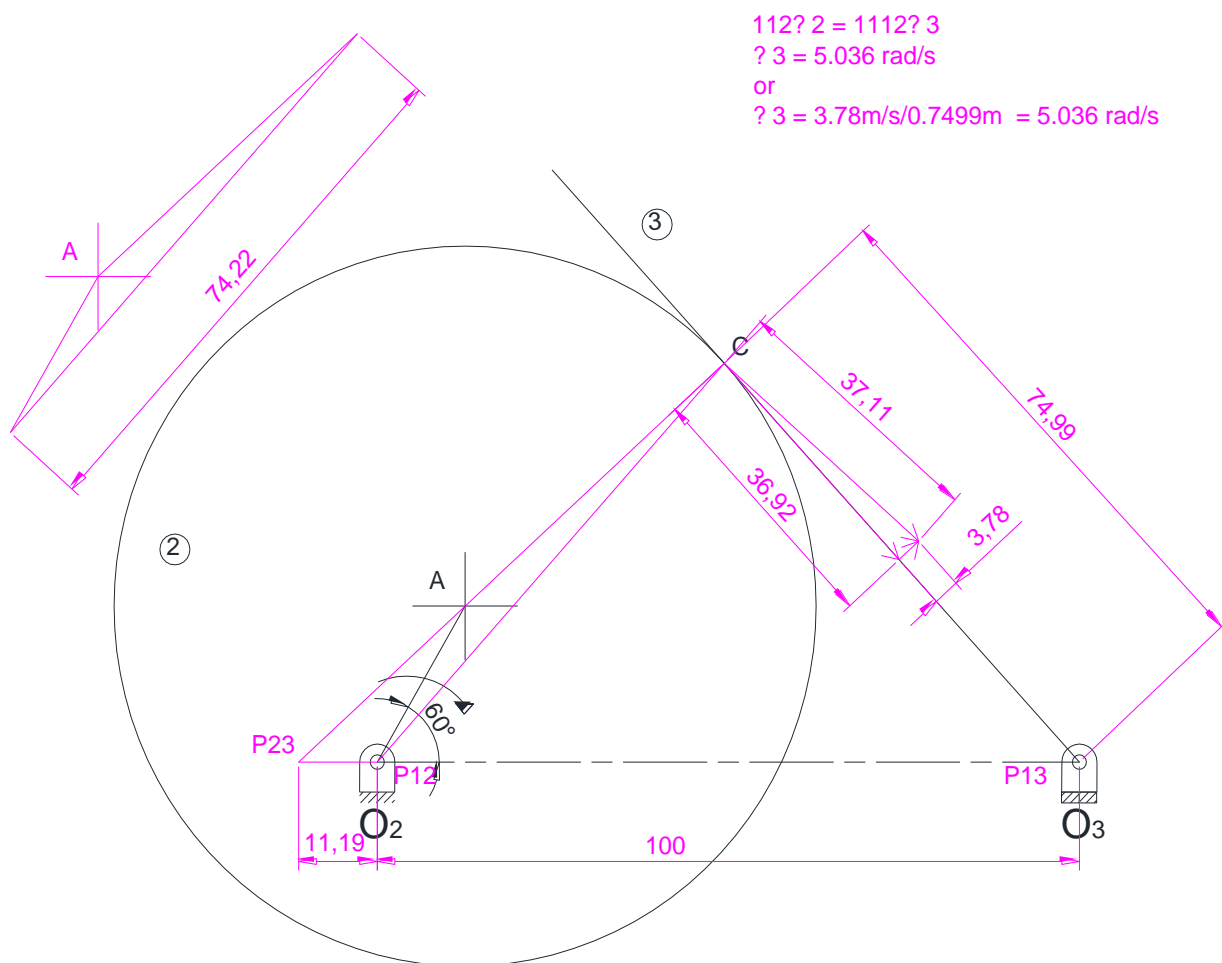
a) Indicate the Centers of Rotation  $P_{12}$ ,  $P_{13}$ , and  $P_{23}$  in the figure

b) Determine the angular velocity of the follower and its sense

Answer for b) = 5.036 rad/s CW / CCW sense

c) Determine the slip velocity of contact  $C_3$  in relation to 2 and its direction

Answer for c) = 36.92 m/s from  $O_3$  to C / from C to  $O_3$



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Problem #4

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