

JK LakshmiPat University Jaipur
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, April/May-2016
B. Tech. in Mechanical Engineering, Semester IV

Roll No.....

ME407: Kinematics of Machines

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type questions 1 mark each

10

- i. Relative motion between links is more than one direction which is unpredictable is known as
a) completely constrained motion b) incompletely constrained motion
c) successfully constrained motion d) none of the above
- ii. Match the following Group 1 items (Kinematic pairs) with Group 2 items (Examples) and select the correct option
1. Revolute pair ----- A. Ball bearing
2. Helical pair ----- B. Ball and socket
3. Rolling pair ----- C. Lathe spindle in the head stock
4. Globular pair ----- D. Motion between bolt and fixed nut

a) 1 - D, 2 - A, 3 - C, 4 - B b) 1 - B, 2 - D, 3 - A, 4 - C
c) 1 - C, 2 - D, 3 - A, 4 - B d) 1 - A, 2 - C, 3 - D, 4 - B
- iii. In a single slider four bar linkage, when the slider is fixed, it forms a mechanism of
(a) Hand pump (b) Oscillating cylinder (c) reciprocating engine (d) Quick return
- iv. The Kutzbach criterion for determining the number of degrees of freedom (n) is (where l = number of links, j = number of joints and h = number of higher pairs)
a) $n = 3(l-1) - 2j - h$ b) $n = 2(l-1) - 2j - h$ c) $n = 3(l-1) - 3j - h$ d) $n = 2(l-1) - 3j - h$
- v. In a fourbar linkage, S denotes the shortest link length, L is the longest link length, P & Q are the lengths of other two links. At least one of the three moving links will rotate by 360° if
(a) $S+L \leq P+Q$ (b) $S+L > P+Q$ (c) $S+P \leq L+Q$ (d) $S+P > L+Q$
- vi. Instantaneous center of rotation of a link in a four bar mechanism lies on
a) Right side of pivot of this link b) Left side of pivot of this link
c) A point obtained by intersection on extending adjoining links d) cannot occur
- vii. The number of Instantaneous centres in a mechanism is (where n is the number of links)
a) $n(n-1)/2$ b) $2n(n-1)/3$ c) $n(2n-1)/2$ d) $3n(n-1)/2$
- viii. The absolute acceleration of any point P in a link about center of rotation O is
a) Along PO b) Perpendicular to PO c) At 45° to PO d) none of the above
- ix. Corioli's component acts
a) Perpendicular to sliding surfaces b) along sliding surfaces
c) somewhere in between above two d) Unpredictable
- x. In following which is not a type of kinematic synthesis
a) function generation b) structure generation c) motion generation d) path generation



Q.1B Short answer type questions 2.5 marks each

- a. Define i) A Kinematic chain, ii) A mechanism and iii) A Machine based on Reuleux's classifications
- b. **Figure 1** shows a quick return mechanism. The crank OA rotates clockwise uniformly. $OA = 2$ cm, $O'O = 4$ cm. calculate the ratio of time for forward motion to that for return motion.

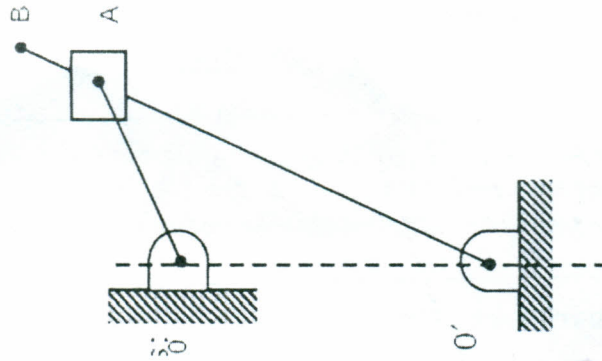


Figure 1

- c. Determine the number of degree of freedom for the mechanisms shown in Fig.2 (a & b) using Kutzbach's equation

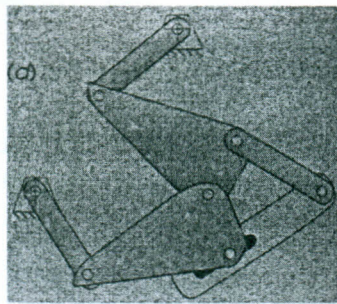


Fig. 2 (a)

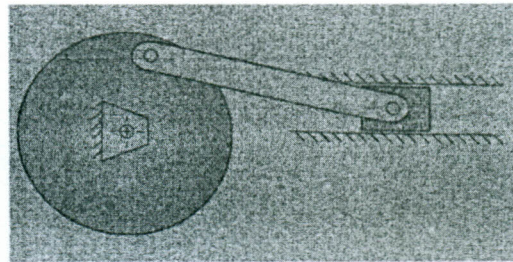


Fig. 2 (b)

- d. State and prove Arnold Kennedy theorem.

- Q.2A What do you mean by Coriolis's acceleration? Show that Coriolis's acceleration is $2\omega \cdot r$. 5
- Q.2B Draw schematic notations for kinematic diagram for various links and joints 5
- Q.3A How do you classify kinematic pairs (joints)? Explain with proper sketches and notations. 5
- Q.3B What is meant by inversions of mechanism? Sketch and explain four distinct inversions of the fourbar slider-crank mechanism 5
- Q.4A For a mechanism in **Figure 3**, crank OA rotates at 100 rpm clockwise using instantaneous centers (I.C) method determine the linear velocities of points B, C, D and angular velocities of links AB, BC and CD. 10
- $OA = 20$ cm $AB = 150$ cm $BC = 60$ cm
 $CD = 50$ cm $BE = 40$ cm $OE = 135$ cm

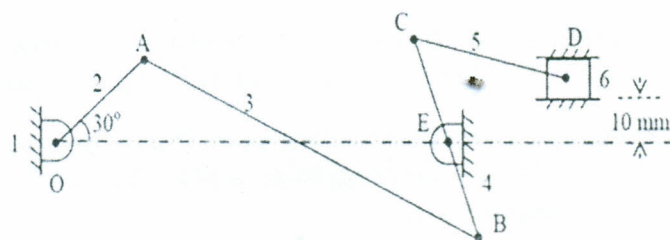


Fig. 3

The general linkage and configuration and terminology for an inverted fourbar slider crank linkage are shown in figure 4. The link lengths (mm) and the values of θ_2 (deg), ω_2 (rad/s) and γ (deg) are defined in following table 1. Draw the linkage to scale and find the velocities of point A and B using graphical method.

Table 1: Data for above problem 4B

Link 1	Link 2	Link 4	γ	θ_2	ω_2
127	203.2	203.2	90	150	100

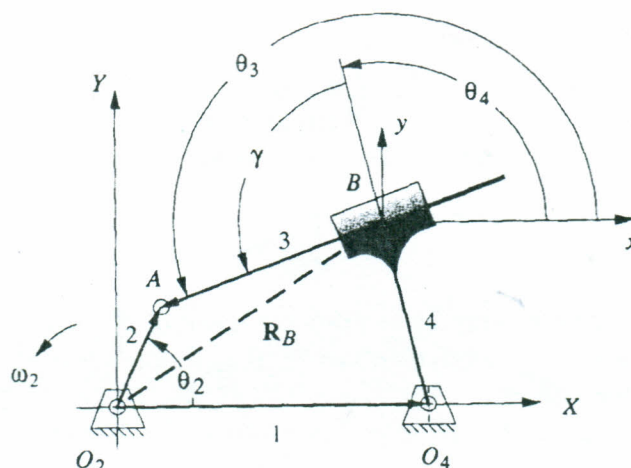


Figure 4: Configuration and terminology for problem 4B

- Q.5A The linkage in **Figure 5** has $O_2O_4 = 508$, $O_2A = 254$, $AB = 127$, $AP = 26$, $BO_4 = 254$, angle $AO_2O_4 = 33^\circ$, angle $\delta_3 = 0^\circ$. $\omega_2 = 25$ rad/s. and $\alpha_2 = -40$. Draw the linkage to scale and graphically find the accelerations of the pin joints A & B. then calculate α_3 & α_4 and the acceleration of point P.

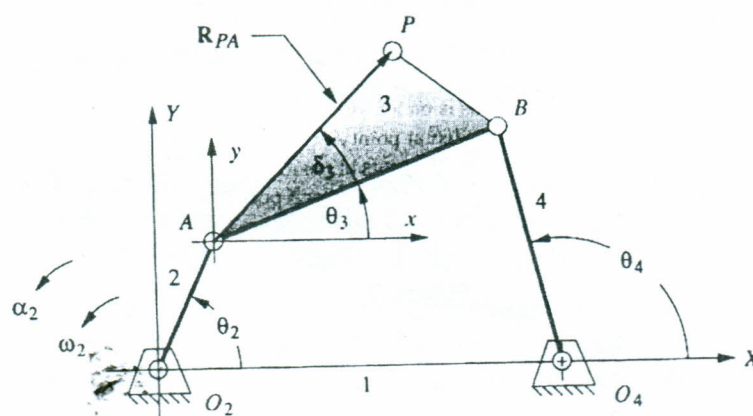


Figure 5

OR

- Q.5A The linkage in Figure 6 has $O_2A = 20.3$, $AB = 49$, $AC = 33.8$ and offset = 9.7 mm. the crank angle in the position shown is 34.3° and angle $BAC = 38.6^\circ$. Find ω_3 , V_A , V_B and V_C for the position shown for $\omega_2 = 15$ rad/s in the direction shown using an analytical method.

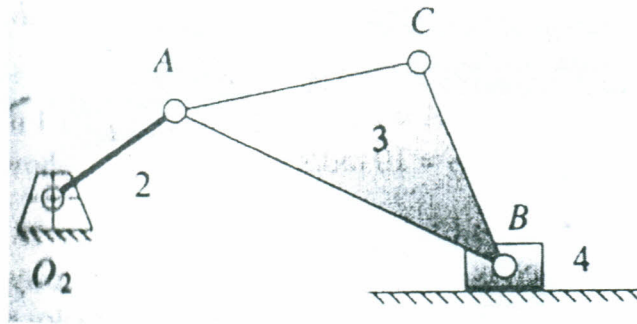


Figure 6

- Q.6A The linkage in Figure 6 has $O_2A = 20.3$, $AB = 49$, $AC = 33.8$ and offset = 9.7 mm. the crank angle in the position shown is 34.3° and angle $BAC = 38.6^\circ$. Find ω_3 , V_A , V_B and V_C for the position shown for $\omega_2 = 15$ rad/s in the direction shown using velocity difference graphical method. 15

OR

- Q.6B Design a linkage to carry the body in in Figure 7 through the two positions P_1 and P_2 at the angles shown in the figure. Use analytical synthesis without regard for the fixed pivots shown. Hint. Try the free choice values $z = 1.075$, $\phi = 204.4^\circ$, $\beta = -27^\circ$; $s = 1.24$, $\psi = 74^\circ$, $\gamma_2 = -40^\circ$ 15

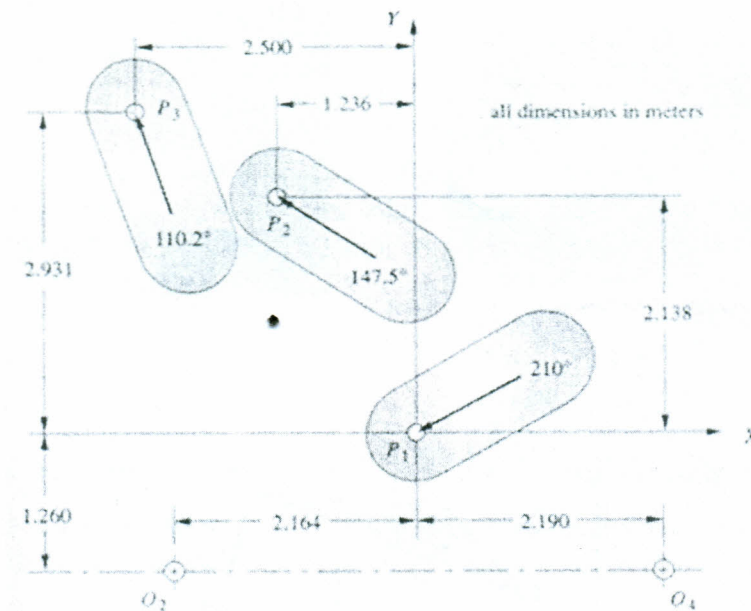


Figure 7