INDIAN INSTITUTE OF TECHNOLOGY

Date: Feb 2012 **Spring Semester** **Time:** 2 hrs **Full Marks:** 60

Dept.: ME **Subject Name:** Kinematics of machines **Subject No.:** ME21008

No of students: 171 approx **2nd Year ME+MF**

Question paper has 3 pages (2 back to back+1). Scaled drawings will be acceptable for graphical methods.
Graphical constructions may be done on the relevant sheet of the question paper and attached with the answer script. Points must be marked with pen/pencil of different color. Total of 4 questions have to be answered. All questions carry equal marks. Any assumptions made in solving the questions should be justified with reasons.

1. Find degrees of freedom for the following mechanisms. State the number of links and number of joints for each mechanism. Mention any assumption of pure rolling or rolling and sliding that you consider at any contact.

Fig 1(a)

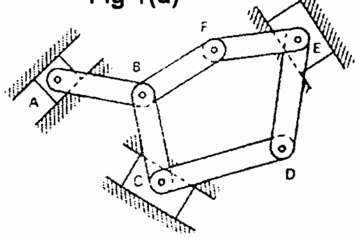
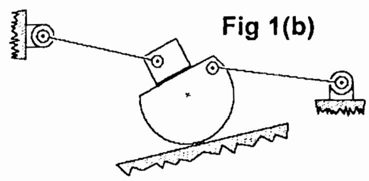


Fig 1(b)



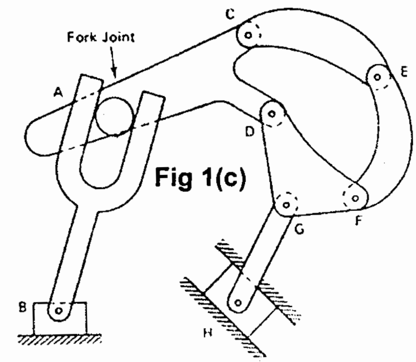
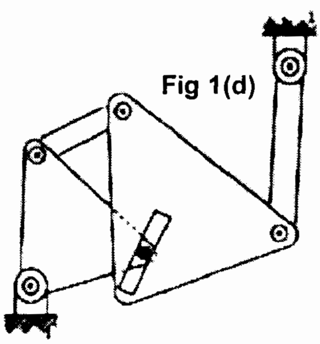


Fig 1(c)

Fig 1(d)



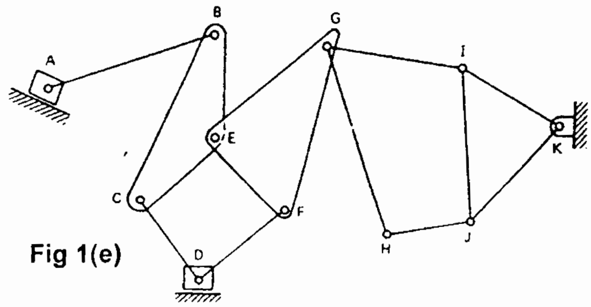


Fig 1(e)

2.

a. For the mechanism shown in fig 2 (a)

i. State the condition for full rotation of link 2.

ii. State the conditions for partial rotation of link 2.

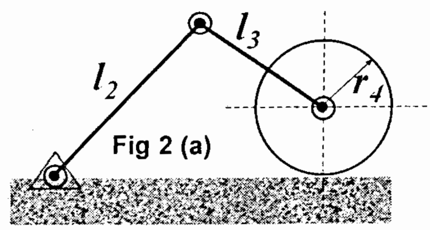


Fig 2 (a)

b. For the mechanism shown in fig 2(b), l_2 =4a, l_3 =3a. Draw sketches of the mechanism for the case when the

- roller has maximum displacement
- link 2 reaches its extreme (maximum/minimum angular displacement) positions.

Repeat the same exercises for l_2 =3a, l_3 =4a.

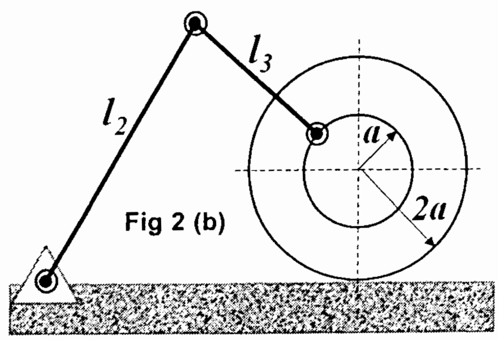


Fig 2 (b)

3. Answer either (a) or (b)

a. Design a four-bar linkage to move a coupler containing the line AB through the three positions shown in figure 3. The moving pivot (circle point) of one crank is at A and the fixed pivot (center point) of the other crank is at C*. Draw the linkage in position 1, and use Grashof's equation to identify the type of four-bar linkage designed. Position A_1B_1 is horizontal, and positions A_2B_2 and A_3B_3 are vertical. AB = 6 cm.

b. Design a slider crank mechanism to coordinate the following set of motions

- θ_{12} = 50^0 clockwise, s_{12} = 40 units horizontally towards right.
- θ_{13} = 100^0 clockwise, s_{13} = 60 units horizontally towards right.
- Choose offset as 15 units and the slider to be at 90 unit distance from the fixed pivot of the crank along the line of sliding. That is, if the fixed pivot of link 2 is at (0, 0), the slider should be at (90, 15) in the initial position or position 1, where the x axis is horizontal and the y axis is vertical.

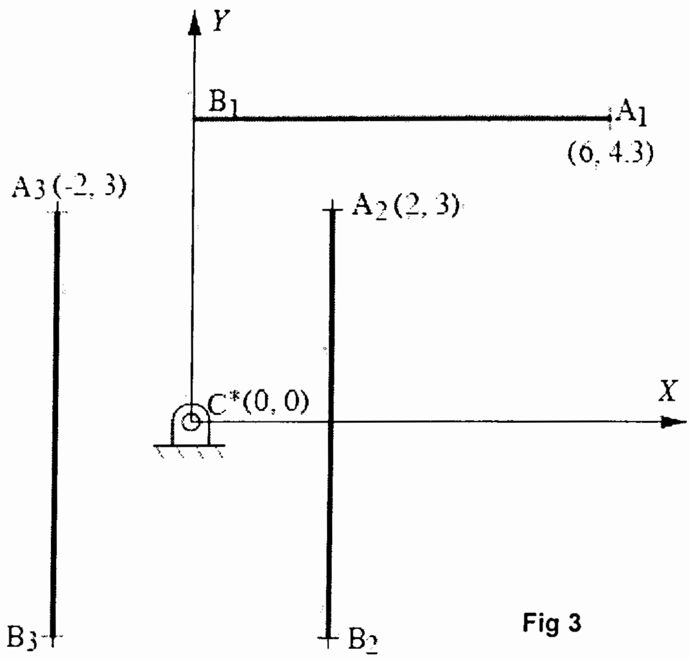


Fig 3

4. Attempt either (a) or (b)

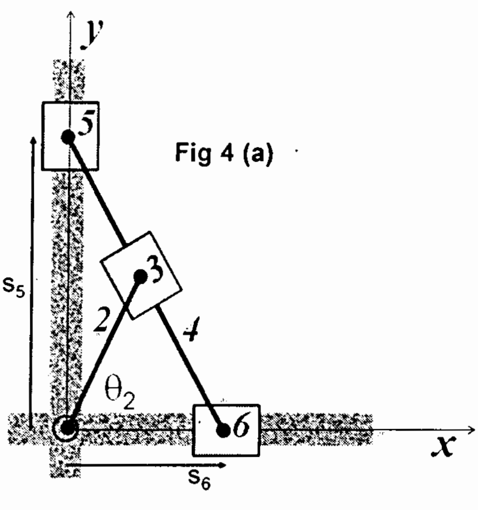


Fig 4 (a)

a. For the mechanism show in figure 4 (a) l_2 =a, l_4 =2a. Note that there is a revolute joint between link 2 and 3 and a sliding joint between link 3 and 4 and in the position shown θ_2=60^0. Derive the displacement equations for the sliders 5 (s_5) and 6 (s_6) in terms of the rotation of link 2 (i.e. any q_2), using the coordinate system and notations shown. If link 2 rotates counterclockwise at 1 rad/sec, draw the velocity and acceleration vector diagrams for the mechanism in the current configuration where θ_2=60^0. Verify the answers for velocity and acceleration of link 6 by differentiating the expression derived earlier.

b. For the mechanism shown in figure 4 (b) l_2 =a, l_4 =2a. Link 4 is an isosceles traingle. Derive the displacement equations for the sliders 5 (s_5) and 6 (s_6) in terms of the rotation of link 2 (θ_2), using the coordinate system and notations shown. If link 2 rotates counterclockwise at 1 rad/sec, draw the velocity and acceleration vector diagrams for the mechanism. Verify the answers for velocity and acceleration of link 6 by differentiating the expression derived earlier. You may do the constructions on this sheet itself and attach it with the answer script after writing your name and roll no in the space provided. You may choose a to be any appropriate length if you solve this problem in the main answer script.

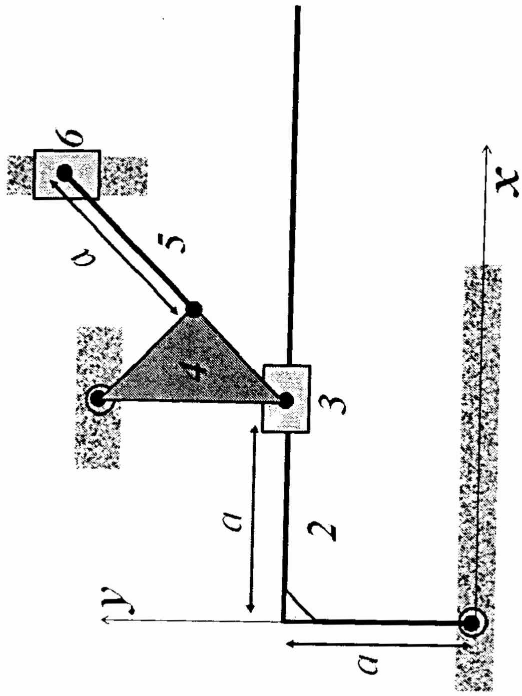


Fig 4 (b)