Working Model 2D: Tutorial 5

Example 12-15

Link AB of the mechanism shown in Figure 1 rotates at 5 rad/s counterclockwise. Point C, a point on link BD, is assumed to be directly over pin E for the purpose of this example. Determine the velocity of points B, C, and D, and the angular velocity of link BD.
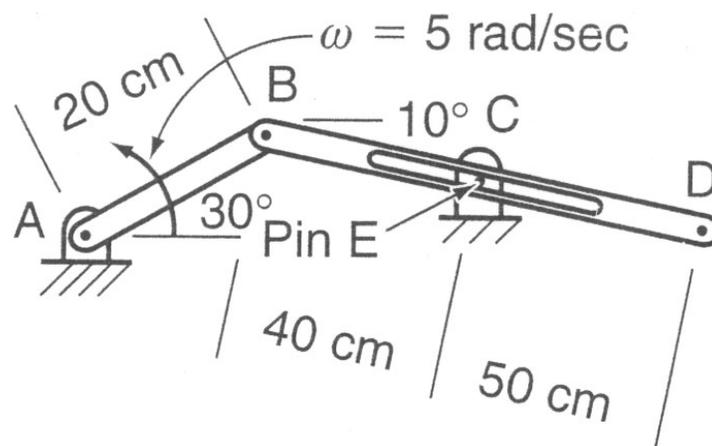

Figure 1

Initial Setup:

1. Set the Unites to SI(radians) on Numbers and Unites… sub menu and click on the More Choices. Set the distance to Centimeters on the Distance pull-down menu.
2. Select the View Size menu from View and set the Window Width to 200 cm.
3. Set the Gravity to None.
4. Change the accuracy to 0.0001
5. Set the Pause Control to pause when t > 0

Creating Geometry

1. Draw link AB and incline it by an angle of 30 degrees similar to Figure 1.

   Notice that you have to convert the 30-degree angle to the equivalent radians. You can do this manually, or type the following formula at the orientation (see Figure 2) of the coordinate bar as
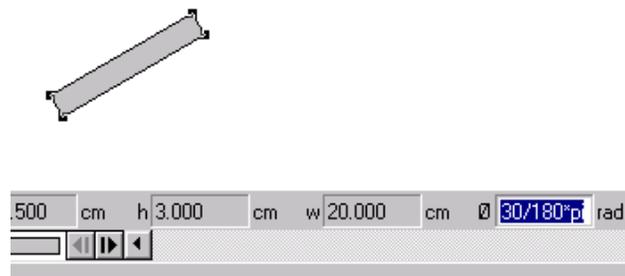
   30/180*pi

Figure 2

2. Place a motor constraint at point A on the link AB and change the motor velocity to 5 rad/s.
3. Draw link BD anywhere on the working space and incline it by an angle similar to Figure 1. In this instance also, you can type –10/180*pi to convert the angle to radians. You should have a workspace similar to Figure 3.
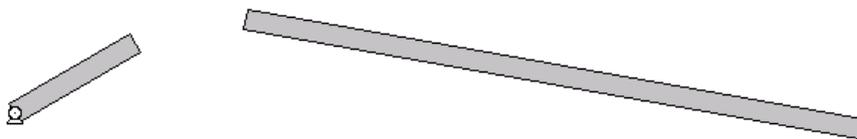

Figure 3

4. Anchor link AB

5. Place two point elements, each at B end of links AB and BD, and join the two links (see Figure 4).
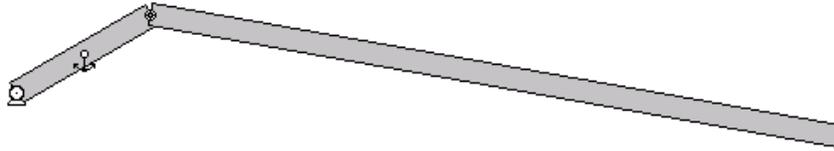

Figure 4

6. Place a point close to the middle of link BD, select this point and change the coordinates of the point to (-5, 0).

   The point coordinates are in local coordinate system, where the origin is in the middle of link BD and the coordinate axis are parallel to the major and minor axis of the link. Distance from the middle of link AB (length is 90 cm) to pin E in Figure 1 is 5 cm along the link in negative X direction..

7. Draw another rectangle in the vicinity of link BD similar to Figure 5, and place a point on this link similar to the point on the figure below.
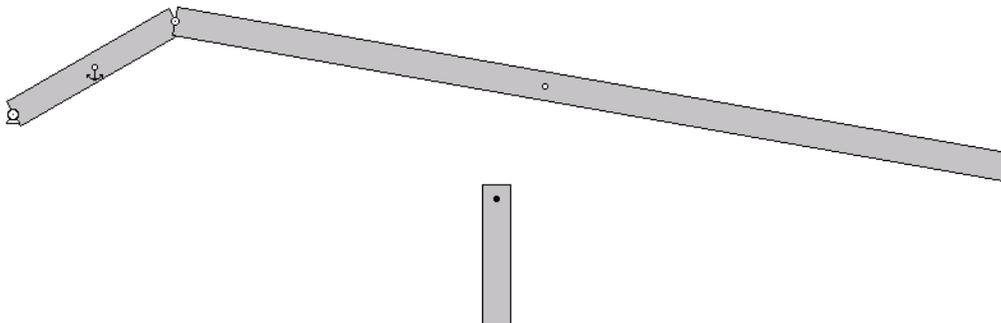

Figure 5

8. Place an anchor on link BD

9. Select the two points drawn during the steps 6 and 7, and join them to get the view in Figure 6.
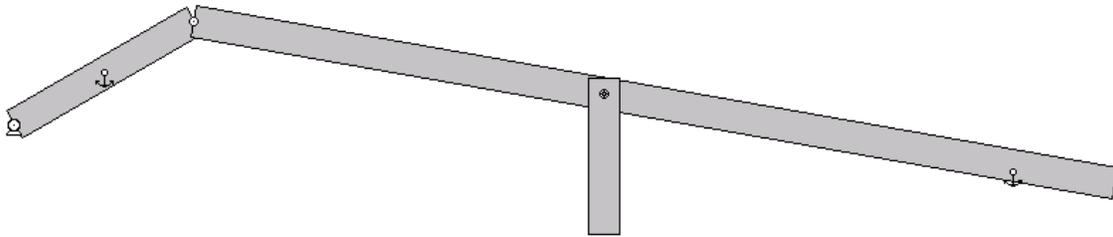

Figure 6

10. Now, select the combined point in the previous step (pin E) and click on Split button **Split○··○** on the drawing tools menu.

11. Select the Slot Joint [icon] from drawing tools and place it on point E

12. Delete the anchor on BD and place a new anchor on the vertical link drawn at point E. Now, the workspace should look like Figure 7.
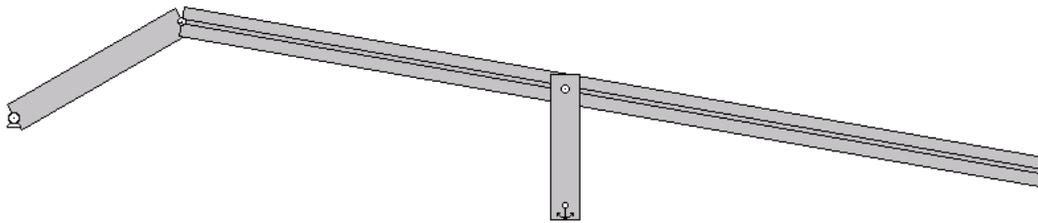

Figure 7

<u>Post Processing</u>

13. In order to measure the velocity at point B, place a point at B and select Velocity from Measure menu.

It will be easy to keep track of the relevant graph for each point if you change the title of the graph to resemble that point. To do that, select the graph and go to Window menu and select Appearance. You should get a window similar to Figure 8.
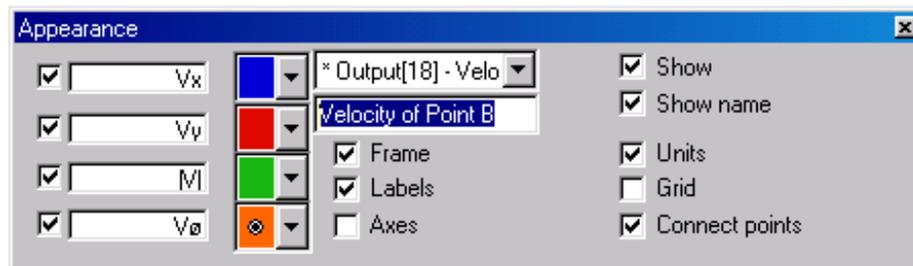

Figure 8

You will see a title similar to Velocity of Point XX (any numerical number) as in the highlighted text portion in Figure 8. Change it according to the title you wish to display.

14. Repeat step 13 to measure the velocity at point D.

15. Since point C is on link BD, it is necessary to bring forward the link BD and send the pin E to the background. Select link BD and go to Object menu and click on "Move To Front", which will bring the link BD to front. Now, place a point element above pin E to measure the velocity at C similar to step 13.

16. Select link BD and choose Rotational Graph under Velocity in Measure menu to display the angular velocity of link BD.

17. Click on the Run button to get the results similar to the Figure 9.

Velocity of Point B		Velocity of Point C		Velocity of Point D		Velocity of Link BD	
Vx	-50.000 cm/s	Vx	-63.303 cm/s	Vx	-79.931 cm/s	Vø	-1.915 rad/s
Vy	86.602 cm/s	Vy	11.162 cm/s	Vy	-83.138 cm/s		
M	100.000 cm/s	M	64.279 cm/s	M	115.329 cm/s		
Vø	-1.915 rad/s	Vø	-1.915 rad/s	Vø	-1.915 rad/s		

Figure 9