Working Model 2D: Tutorial 2

Example 11-10:

A wheel with Diameter of 1.2m, mounted in a vertical plane, accelerates uniformly from rest at 3 rad/s^2 for five seconds, and then maintains uniform velocity in counterclockwise direction. Determine normal and tangential acceleration of a point at the top of the wheel for t=0 and t=6.

1. Select Number and Units … from View menu and set the Unit System to **SI (radians)** and click OK.
2. Draw a wheel using the circle object and set the radius of the wheel to 0.6m (Diameter is given as 1.2m).
3. Using the Zoom-In and Zoom-Out buttons, get a view similar to the Figure 1.

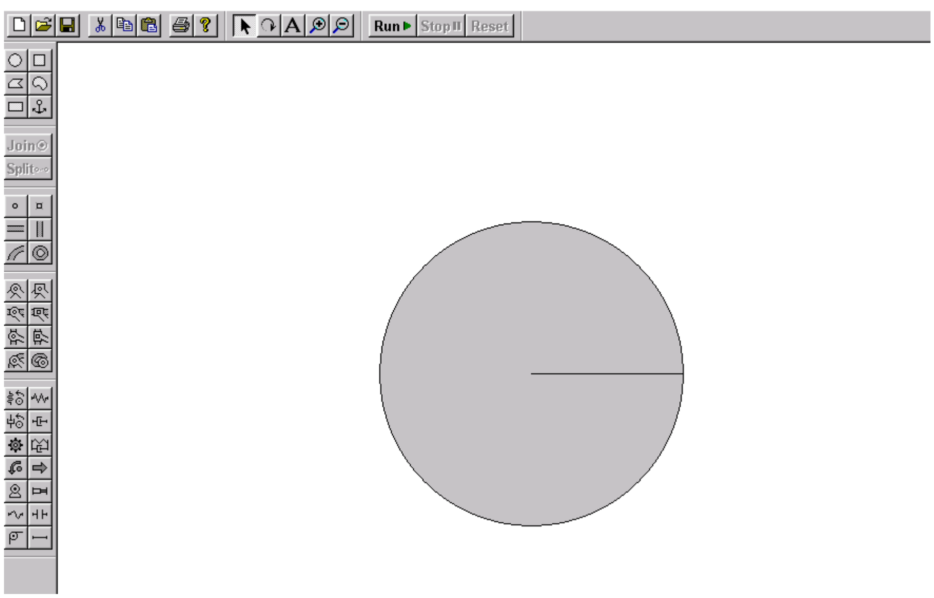
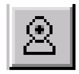


Figure 1

New Constraint: Motor 

A motor has a built-in pin joint, which is composed of two overlapping points. If a motor is attached to a body, it functions as a constraint that exerts the torque necessary to maintain the specified rotation, angular velocity or angular acceleration. You can specify the motor constraint in one of the four terms; torque, rotation, velocity, and acceleration.

Torque: A torque motor applies a torque of equal magnitude in opposite directions on the bodies attached to the motor.

Rotation: A rotation motor exerts whatever torque is necessary to maintain a particular angle between the bodies attached to the motor.

Velocity: A velocity motor exerts whatever torque is necessary to maintain the specified relative angular velocity between the bodies attached to the motor.

Acceleration: An acceleration motor exerts whatever torque is necessary to maintain the specified relative angular acceleration between the bodies attached to the motor.

4. Select the Motor from Constraints menu and the mouse pointed becomes an icon with a Motor symbol. Bring the motor to the center of the circle and click the left mouse button at the exact center to position the motor.
5. Select the motor by a left-click on the already-positioned motor icon and go to Window menu and select Properties menu item. This will bring in a pop-up window with Motor properties (See Figure 2).
6. Select Acceleration from Type drop-down menu
7. Set the value of the acceleration to 3 rad/s^2 in the Value field just below the Type field.
8. Now, go to the bottom of the Properties window and de-select the click box in front of Always in Active When sub-property. This will allow us to input a conditional acceleration, which is similar to the acceleration specified in this example, where the

3 rad/s^2 acceleration exist for only 5 seconds. The positive rotation in WM2D is defined in anti-clockwise direction. Therefore, enter –3 instead of 3 in the acceleration field to have a counterclockwise rotation.

9. Type the conditional statement t <= 5 at the input bar below the Always button and close the Properties window.

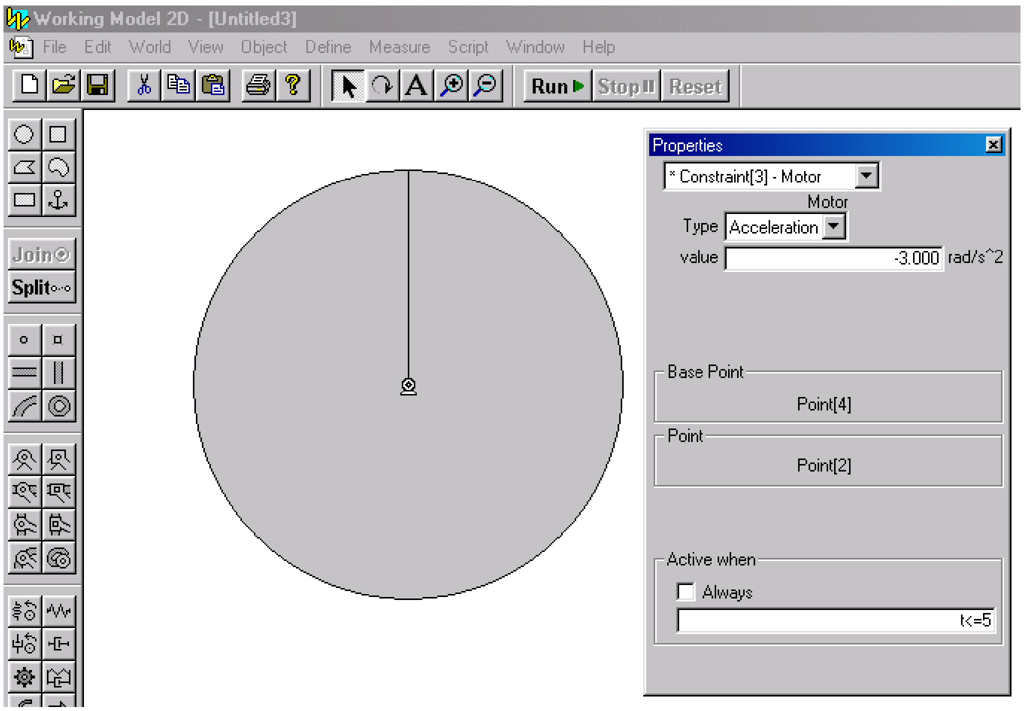


Figure 2

10. Since we are interested in finding the acceleration of a point on the top of the wheel, select the Point Element from the Point Toolbar and place at the exact top of the wheel.

11. We are interested in seen the motion until up to 6 seconds. Therefore, set the Pause criteria as t > 6.0 in the Pause control window as shown in Figure 3.

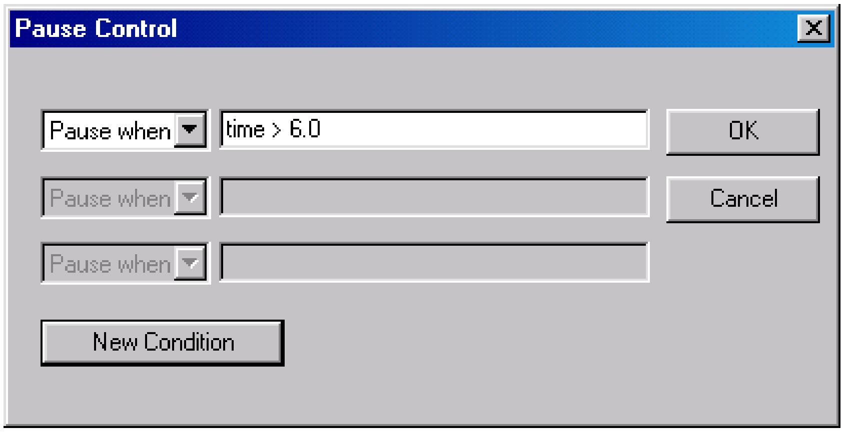


Figure 3

12. Select the point positioned on the top of the wheel and then select the Acceleration from Measure menu. Follow the same procedure and select Time from Measure menu. Re-position the graphs and change the display option of the graphs to numerical values as in Figure 4.

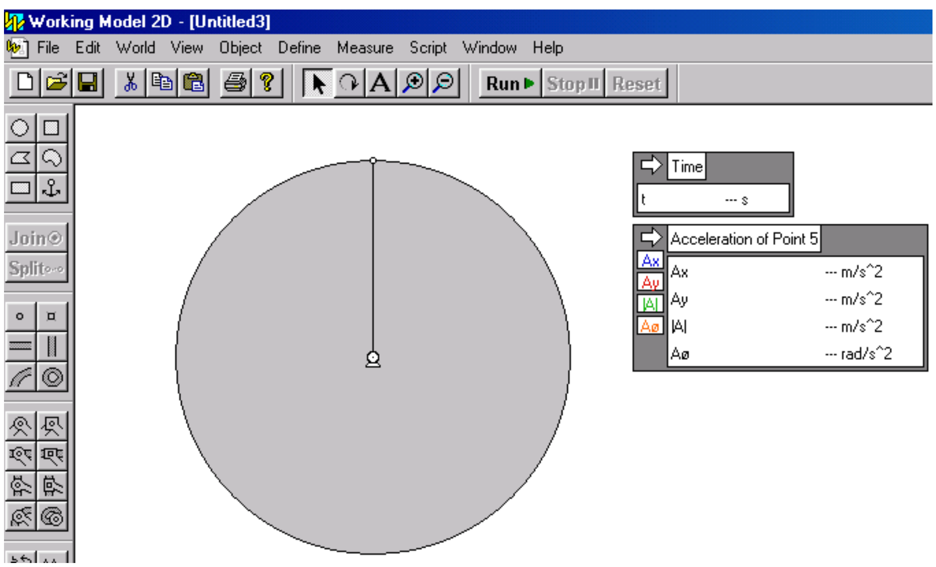


Figure 4

13. Now you can run the simulation to get the results. Reset the simulation to find the acceleration at t=0. Notice that the WM2D produces acceleration values as $\mathbf{A_x}$, $\mathbf{A_y}$, $\mathbf{|A|}$, and $\mathbf{A_\theta}$.

14. At the beginning, acceleration is in X direction, Therefore, $\mathbf{a_t=A_x,\ a_n=A_y=0}$

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15. At t=6, There is no angular acceleration. Therefore, a_t=0, and the magnitude of the acceleration is equal to the acceleration in the radial direction. Therefore, $\mathbf{a_n}$=**|A|**.
16. Check your answers with t=0 and t=6 results shown in Figure 5 and Figure 6, respectively.

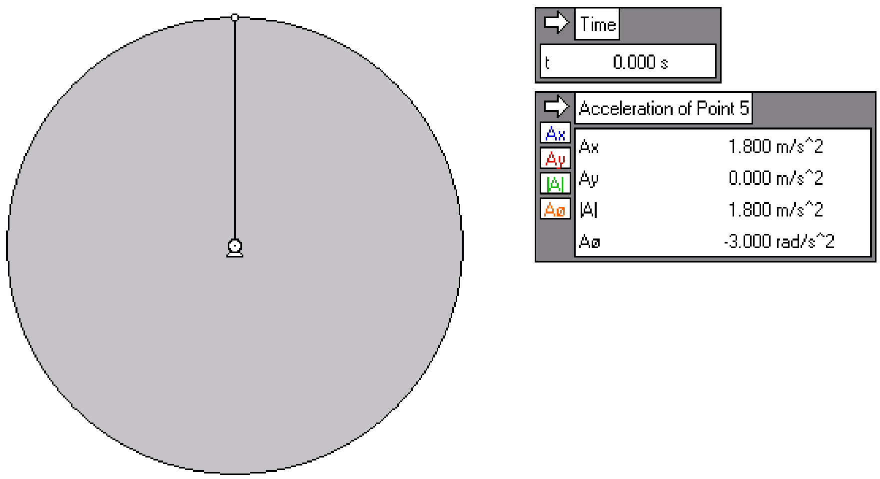

Figure 5

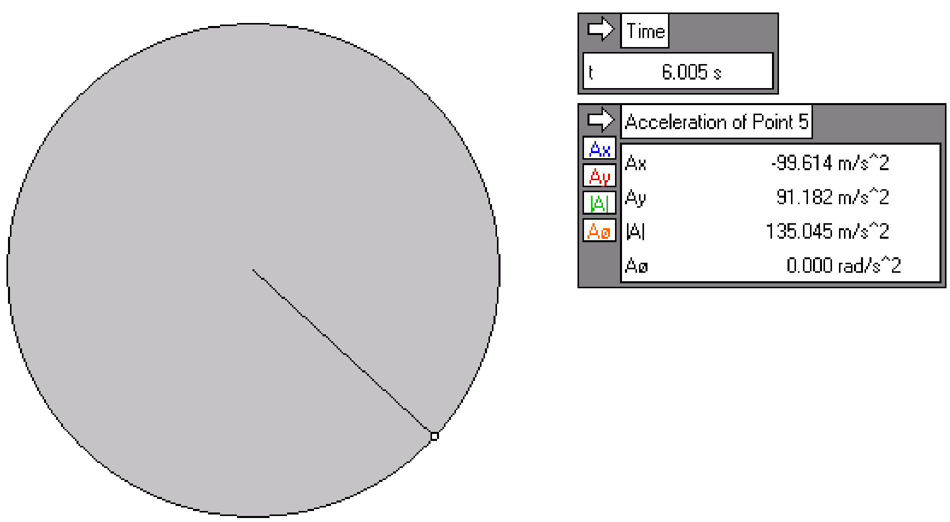

Figure 6