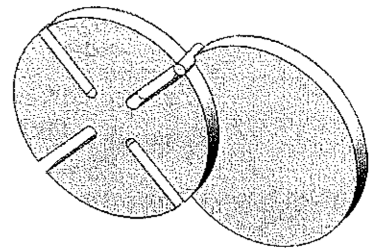
Section 5.2

Geneva Mechanism



5.2-1 Introduction

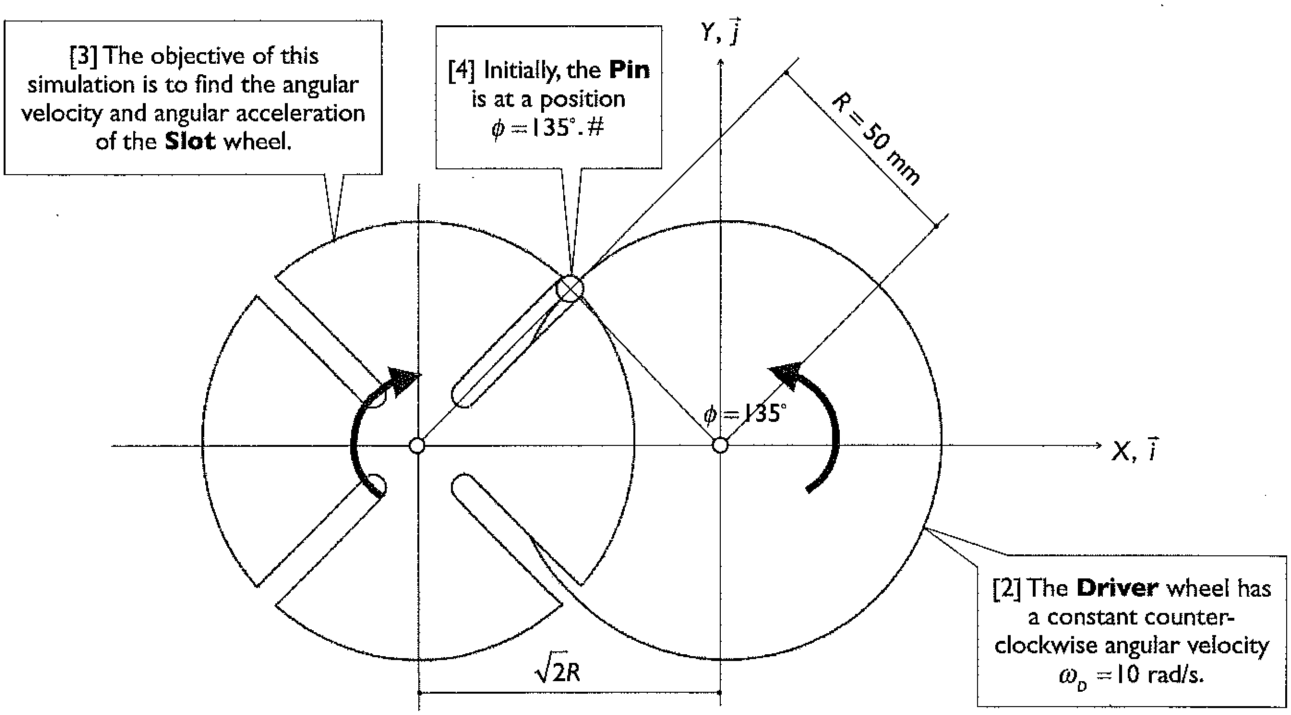
[1] A geneva mechanism translates a continuous rotation of a **Driver** wheel [2] into an intermittent rotation of a **Slot** wheel [3, 4]. This problem is adapted from Sample Problem 15.9, *Vector Mechanics for Engineers: Dynamics, 9th ed. in SI Units*, by F. P. Beer, E. R. Johnston, Jr., and P. J. Cornwell. Some of the quantities calculated by the textbook are: when $\phi = 150^\circ$,

The angular velocity of the **Slot** wheel $\quad \vec{\omega}_S = -4.08\ \vec{k}$ (rad/s) (1)

The angular acceleration of the **Slot** wheel $\quad \vec{\alpha}_S = -233\ \vec{k}$ (rad/s^2) (2)

Note that the negative signs indicate that both the angular velocity and angular acceleration are in a clockwise sense.

In this section, we'll perform a simulation for the Geneva mechanism and validate the results with the values in Eqs. (1, 2).



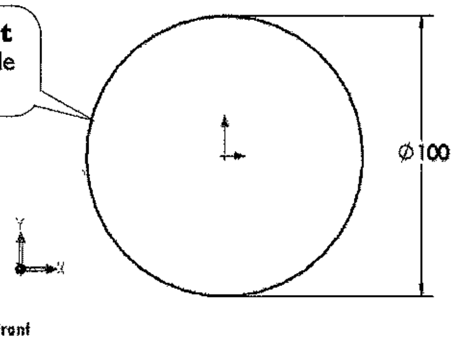
5.2-2 Start Up and Create a Part: **Driver**

[1] Launch **SOLIDWORKS** and click **New** to create a new **Part**.

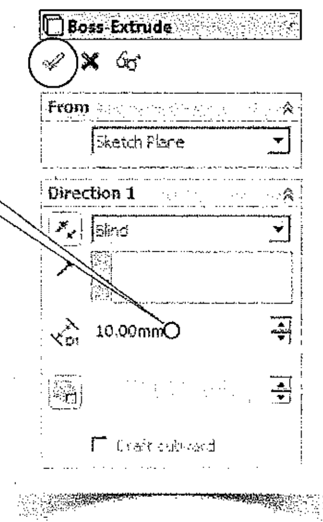
[2] Save the **Part** with the name **Driver**.

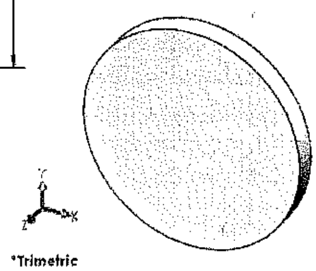
[3] Set up **MMGS** unit system with two decimal places.

[4] On the **Front** plane, draw a circle like this.

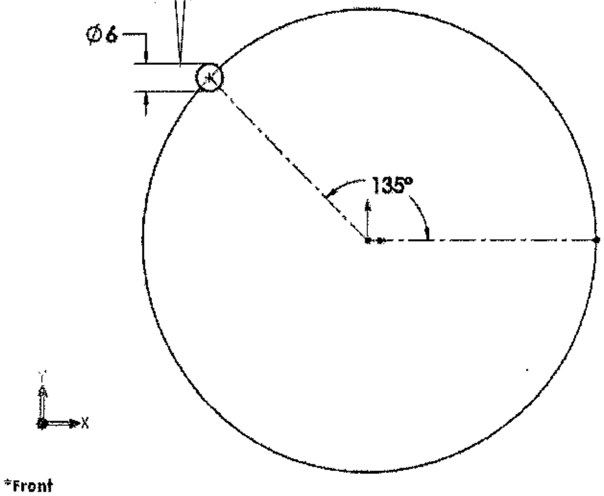


[5] Extrude the sketch 10 mm.

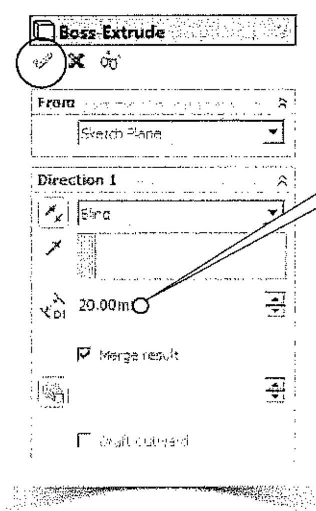


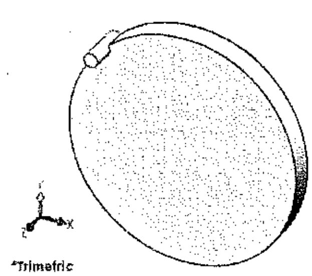


[6] On the **Front** plane, create a new sketch, and draw a small circle and two **Centerlines** like this.

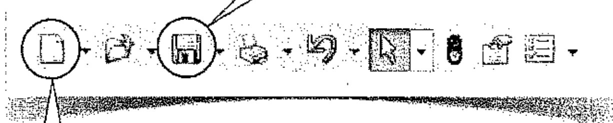


[7] Extrude the sketch 20 mm.#





5.2-3 Create a Part: **Slot**



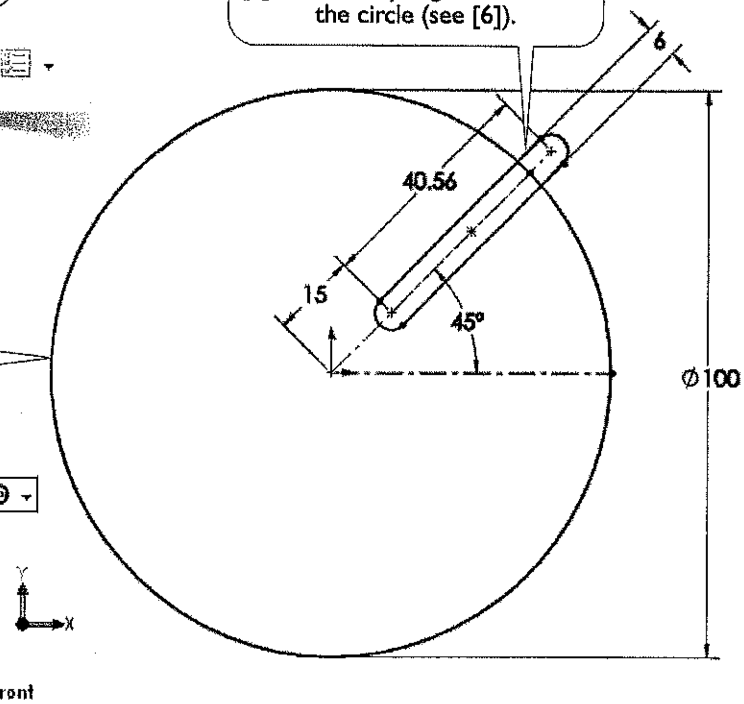
[1] Click **New** to create a new **Part**.

[2] Save the **Part** with the name **Slot**.

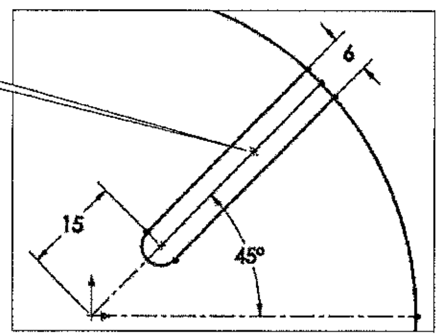
[3] Set up **MMGS** unit system with two decimal places.

[4] Create a sketch on the **Front** plane. Draw a **Circle**, two **Centerlines**, and a **Straight Slot**. The length of the **Straight Slot** (here 40.56) is not important.

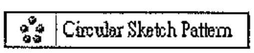
[5] **Trim** away segments outside the circle (see [6]).

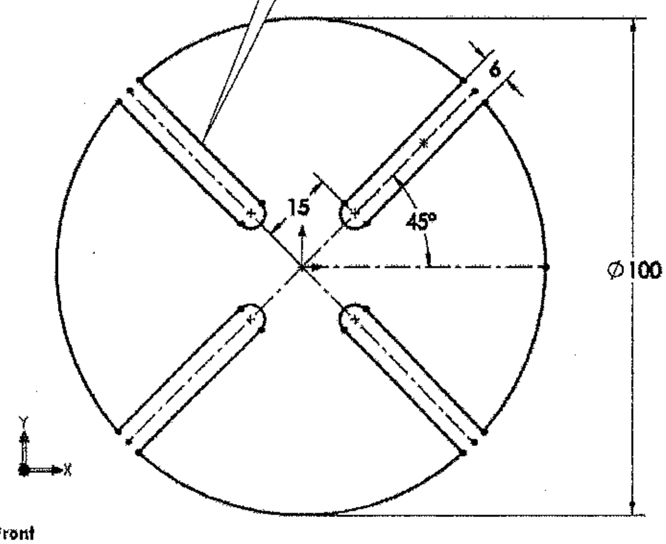


[6] After trimming, fix all entities. Remember, you can drag a blue-colored entity to figure out what relations you should add. In this case, you may add two **Parallel** and two **Tangent** relations to fix all entities except this point, which is not relevant.

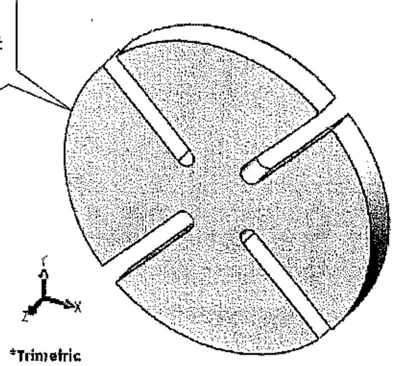


[7] Use **Circular Sketch Pattern** to duplicate the slot (including the **Centerline**). **Trim** away unwanted segments like this.





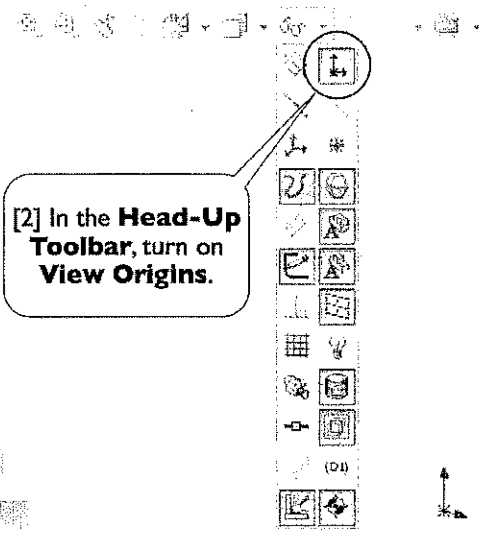
[8] Extrude the sketch 10 mm. #



5.2-4 Create an Assembly: **Geneva**

[1] Click **New** and create an **Assembly**.

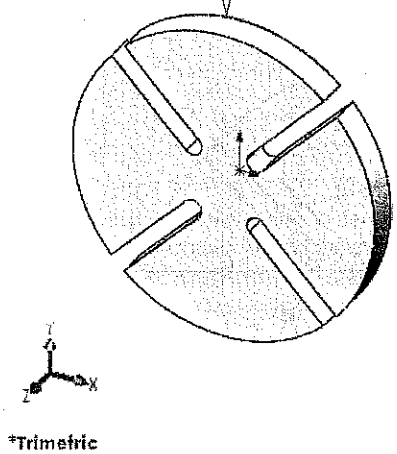
[4] Save the **Assembly** with the name **Geneva**.

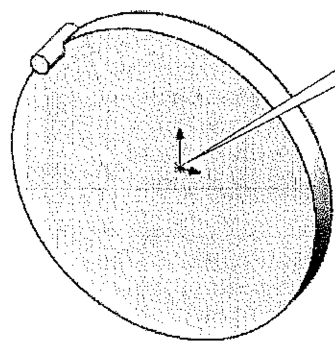


[2] In the **Head-Up Toolbar**, turn on **View Origins**.

[5] Set up **MMGS** unit system with two decimal places.

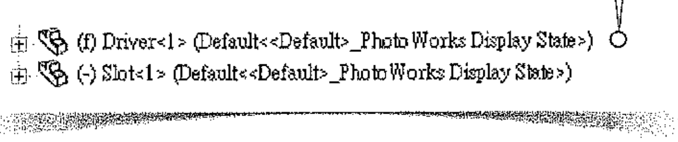
[6] In the **Assembly Toolbar**, click **Insert Components** and park **Slot** anywhere.

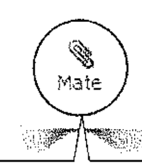




[3] In the **Begin Assembly Property Box**, select **Driver** and click the assembly's **Origin**.

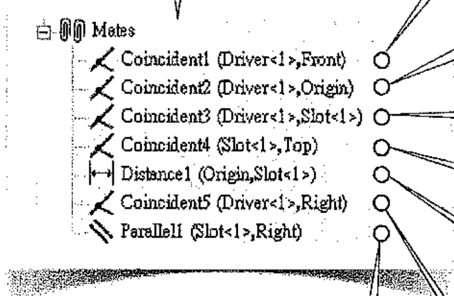
[7] Right-click **Driver<1>** and select **Float**.





[8] In **Assembly Toolbar**, click **Mate**.

[9] We'll create these 7 **Mates** in [10-21].



[10] The **Assembly's** and the **Driver's Front** planes are **Coincident**.

[11] The **Assembly's** and the **Driver's Origins** are **Coincident**. Before clicking **OK**, uncheck **Align axes** (see [12]).

[13] The **Driver's** frontal face and the **Slot's** backside face are **Coincident** (see [14, 15])

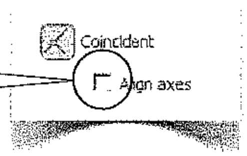
[16] The **Slot's Origin** and the **Assembly's Top** plane are **Coincident**.

[17] The **Assembly's** and the **Slot's Origins** has a **Distance** of 71.414 mm. This distance is calculated by: $\sqrt{2R^2 + (10\text{ mm})^2} = 71.414$ mm, where $R = 50$ mm.

[20] The **Assembly's** and the **Slot's Right** planes are **Parallel**. This is the initial configuration of the **Slot**. We'll suppress this **Mate** later.

[19] The **Assembly's** and the **Driver's Right** planes are **Coincident**. This is the initial configuration of the **Driver**. We'll suppress this **Mate** later.

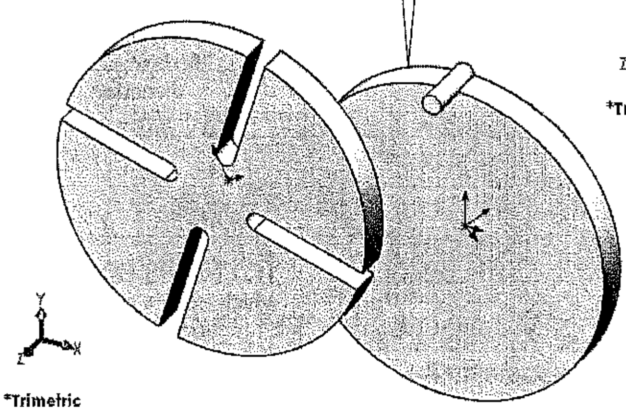
[12] Uncheck **Align axes**.



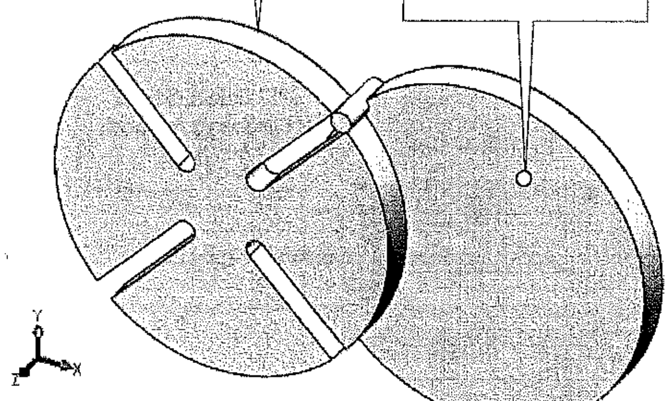
[15] The **Slot's** backside face.

[14] The **Driver's** frontal face.

[18] Now, use your mouse to rotate the **Driver** and the **Slot**.



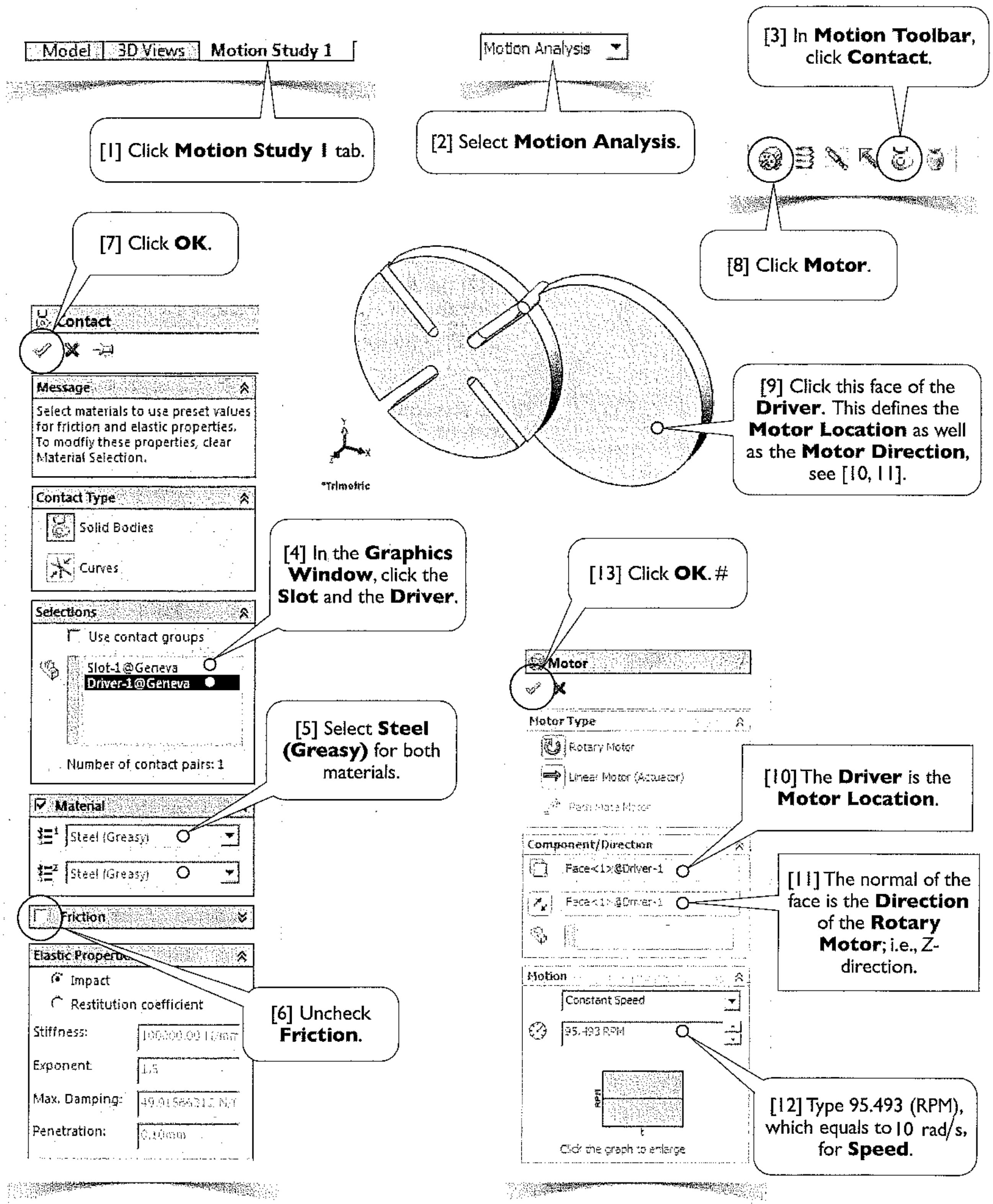
*Trimetric



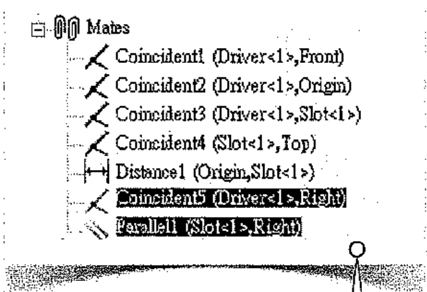
*Trimetric

[21] This is the initial configuration. Dismiss **Mate** box and turn off **View Origins**. #

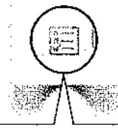
5.2-5 Create a **Motion Study**, Set Up **Contact** and **Motor**



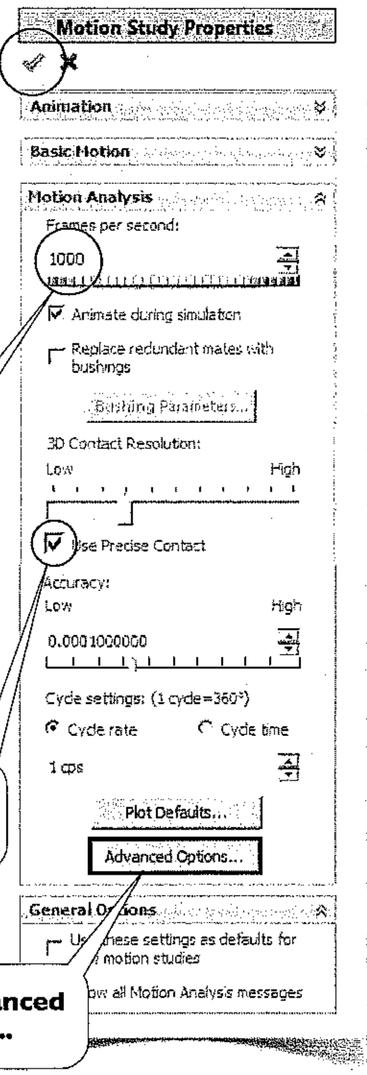
5.2-6 Calculate and Animate **Results**



[1] In the **Assembly Tree**, under **Mates**, suppress **Coincident5** and **Parallel1** (see 5.2-4[19, 20], page 117).



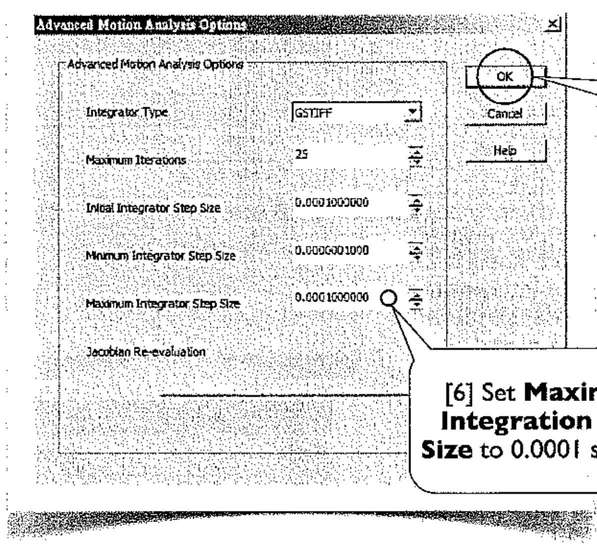
[2] In the **Motion Toolbar**, Click **Motion Study Properties**.



[3] Type 1000 for **Frames per second**.

[4] Click **Use Precise Contact**.

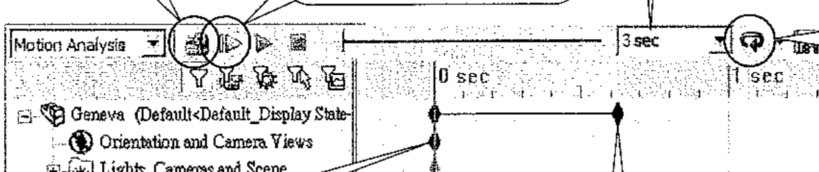
[5] Click **Advanced Options...**



[6] Set **Maximum Integration Step Size** to 0.0001 seconds.

[7] Click **OK**.

[8] Click **OK**.



[9] Right-click this **Key Point** and select **Edit Key Point Time** and type 0.628 (s). The simulation will be one cycle (10 rad/s = 0.628 s/cycle). Click **Time Scale Zoom Buttons** to enlarge the time scale (1.1-11[2], page 14).

[10] Right-click this **Key Point** and select **View Orientation>Front**.

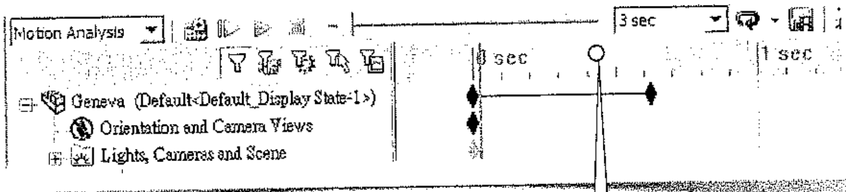
[11] Click **Calculate**.

[12] Set **Playback Speed** to **3 sec**. A cycle will play 3 sec.

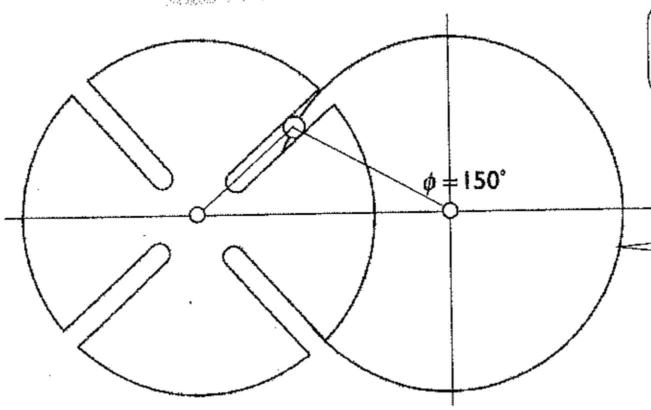
[13] Make sure **Playback Mode** is **Loop**.

[14] Click **Play from Start**. Click **Stop** after viewing the animation. #

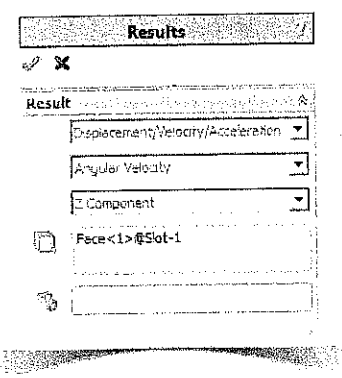
5.2-7 Results: Angular Velocity and Acceleration of the **Slot**

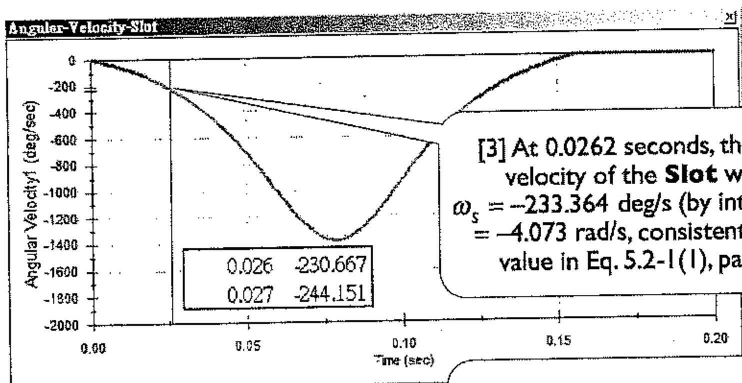


[1] Right-click the yellow area and select **Move Time Bar** and type 0.0262 (s).

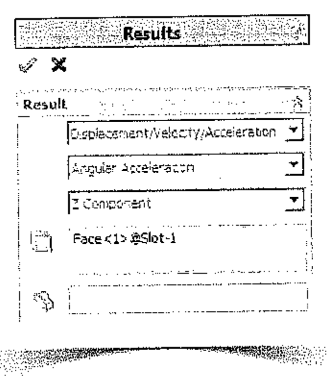


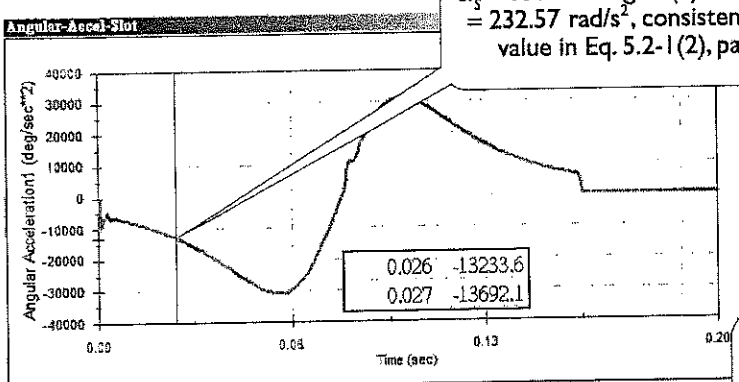
[2] The configuration at $t = 0.0262$ sec ($\phi = 150°$).





[3] At 0.0262 seconds, the angular velocity of the **Slot** wheel is $\omega_s = -233.364$ deg/s (by interpolation) $= -4.073$ rad/s, consistent with the value in Eq. 5.2-1(1), page 113.





[4] At 0.0262 seconds, the angular acceleration of the **Slot** wheel is $\alpha_s = 13325.3$ deg/s^2 (by interpolation) $= 232.57$ rad/s^2, consistent with the value in Eq. 5.2-1(2), page 113.

Wrap Up

[5] Save all files and exit **SOLIDWORKS**.#