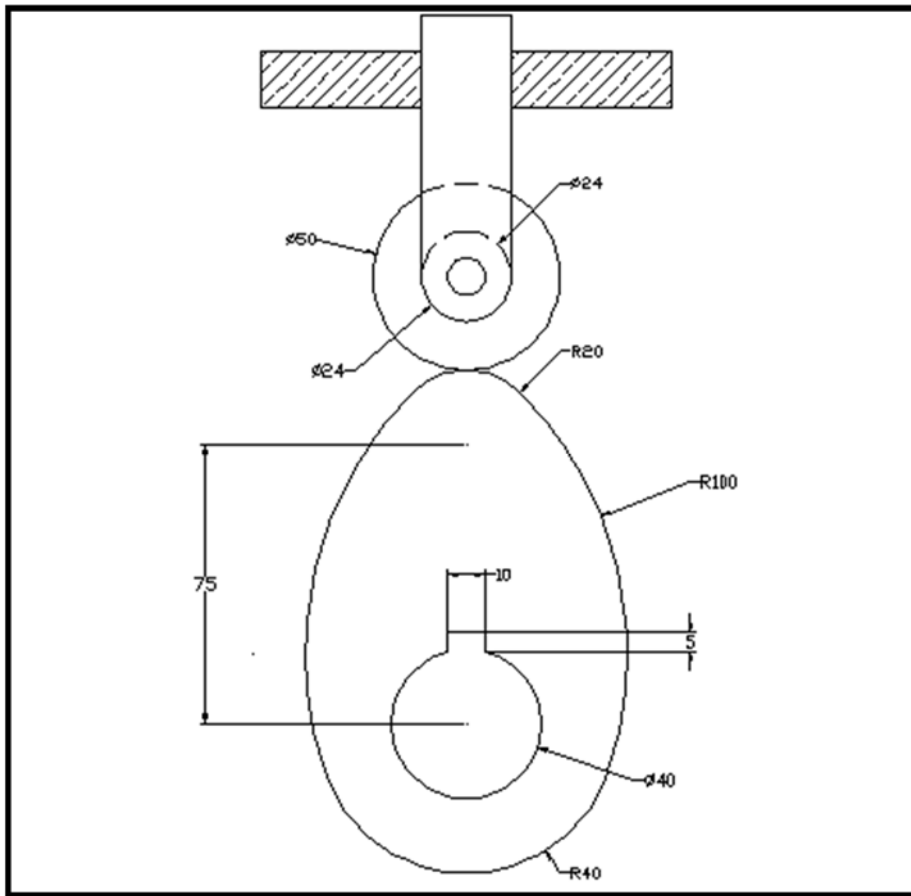


Engr 210 – Engineering Graphics
Lab #3 – More Geometric Construction
The Cam-Follower Example

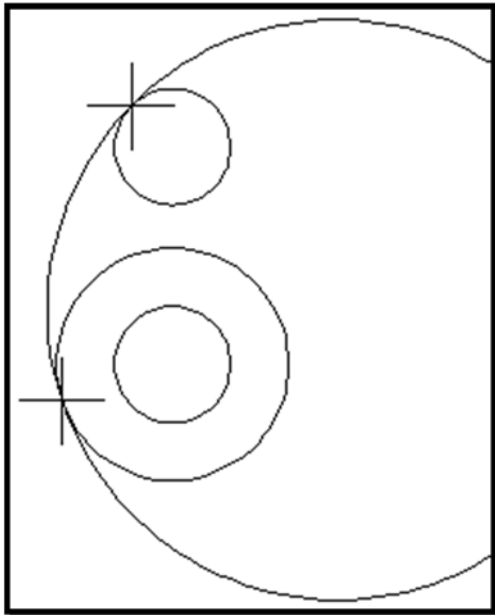
In this exercise more geometric construction techniques will be applied including internal and external tangencies of circles, creating blocks, hatching, loading other linetypes, and modifying and rotating blocks.

Part 1. Creating the cam and the follower



1. Start by opening a new file.
2. In the *Select Template* manager, **left-mouse-click** on the *triangular* button to the right of the *Open* button, and select *Open with no Template – Metric*.
3. Set the default units to Millimeters.
4. Create two concentric circles with center at coordinates **0,0** and radii **20** and **40** mm. The point with coordinates (0,0) corresponds to the center of rotation of the cam.

5. Create another circle with center at coordinates **0,75** and radius **20** mm.



6. In the pull-down menus, select:
[Draw] => [Circle] => [Tan,Tan,Radius]

7. At the prompt “*Specify point on object for first tangent of circle:*” **left-click** the upper circle at the approximate position of the point of tangency.

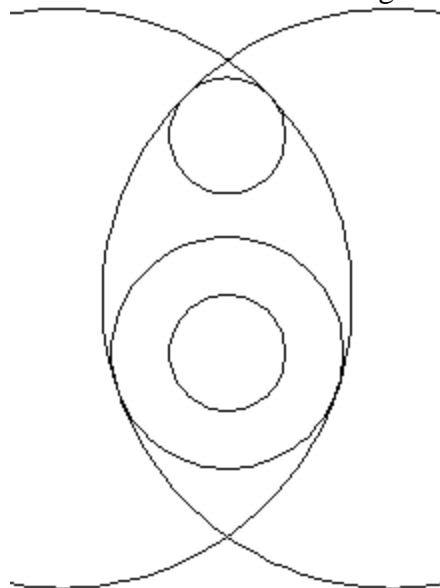
8. At the prompt “*Specify point on object for second tangent of circle:*” **left-click** the big circle at the approximate location of the point of tangency.

9. At the prompt “*Specify radius of circle:*” type **100 [ENTER]**.

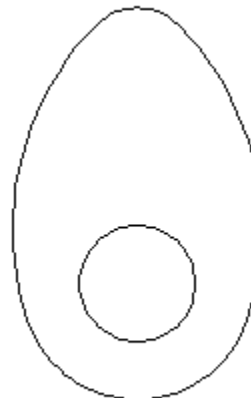
If the R100 circle created is on the wrong side of the drawing (i.e., externally tangent rather than internally tangent), repeat and make sure that the cursor is positioned near the center of the R100 circle to be drawn when its radius is typed.

10. Create the other R100 tangent to the other side of the circles.

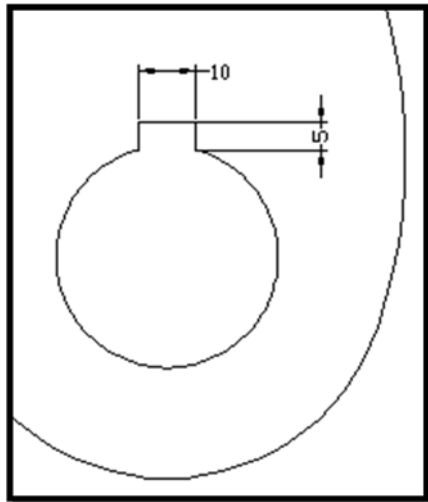
11. **Trim** entities in the drawing to create the cam as shown.



Before Trim



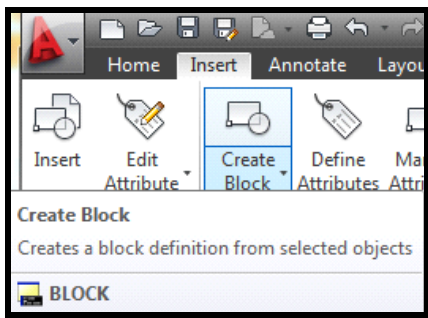
After Trim



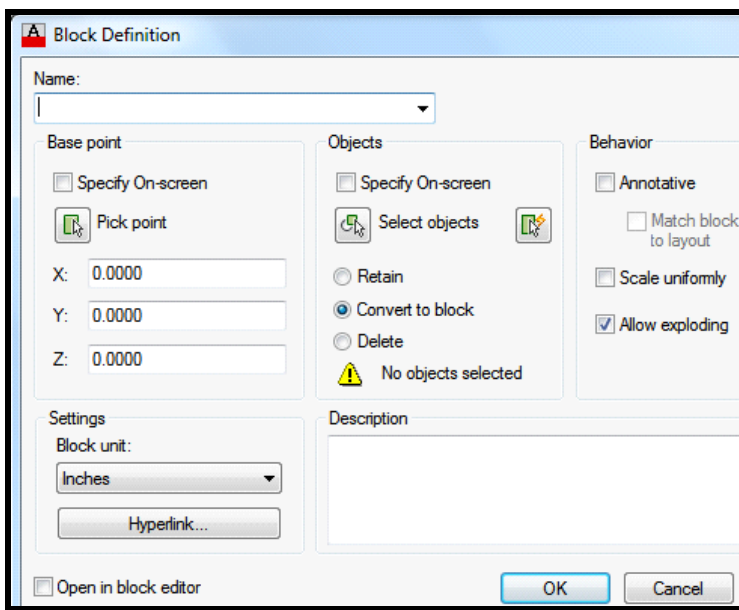
- Construct the key way as shown. (Note: Be careful in locating the horizontal line.)

You can first create a vertical line through the center of the circles and offset this line 5 units to the right and to the left.

- The next few steps will create a *Block* for the cam. A **block** is a set of entities that are grouped together as a single object and assigned a name. Since all the entities created thus far are parts of the cam, we will group them together into a block named “cam”.



- Select the *Insert* tab, then select pick the **Create Block** command icon. The *Block Definition* dialog box appears.

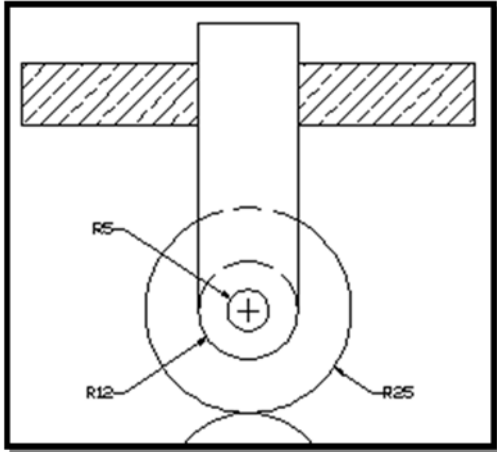


- In the *Block Definition* dialog box, enter “**Cam**” as the name and description.

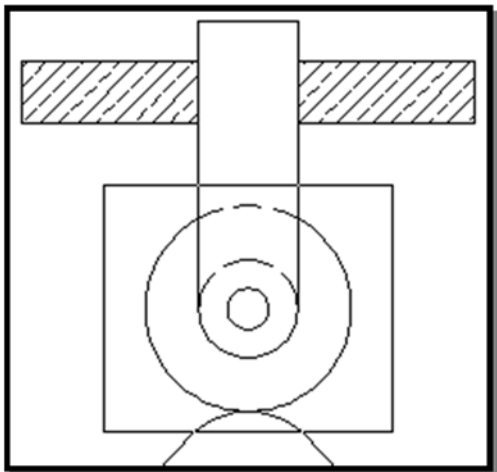
- Click on **Select objects**, and make a window around the cam to select objects.

- Click on **Pick Point** and select the center of the $\phi 40$ circle (center of the cam) as the base point of the block.

- Click the **OK** button.



19. Create the “FOLLOWER” by drawing three concentric circles with center at (0,120) and radii 25, 12, and 5.
20. Create vertical arm attached to the follower. The length of this arm is arbitrary.
21. Create the hatched follower guide as shown. Its actual position is not important. Use the **Hatch** command icon in the *Draw* toolbar. Use Pattern ANSI33. Click the “Pick Points” option to identify the area to be hatched.



22. For the dashed lines, select [FORMAT] => [LINETYPE] from the pull-down menus, and load the HIDDEN linetype.
23. Create a block for the follower. In the *Draw* toolbar pick the **Make Block** command icon. The Block Definition dialog box appears.
24. Click on **Select Objects**, and make a window around the follower as shown to select objects.
25. Click on Pick Point and select the center of the circles as the base point of the block.

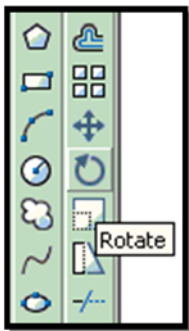
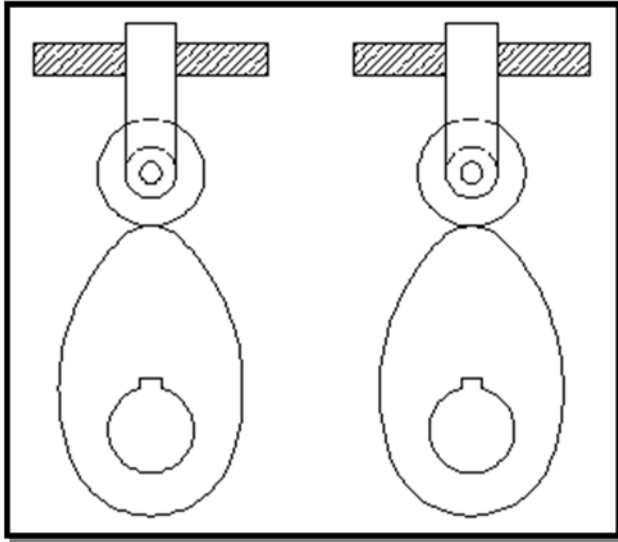
26. Click the OK button.

27. Save the drawing as **cam-follower.dwg**.

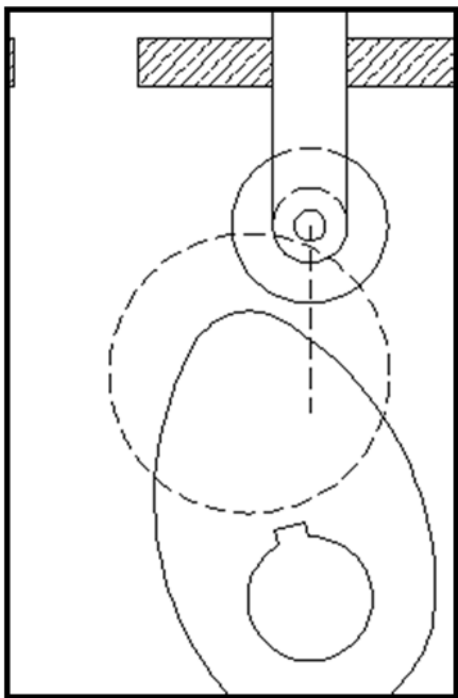
Part 2. Rotating the cam

In this part of the exercise, the cam will be rotated 15° counterclockwise, and the follower will drop an appropriate distance to stay tangent to the cam

1. Make a copy of the cam-follower assembly using the **Copy Object** command icon in the *Modify* toolbar. Create a window around the drawing to select objects. Position the copy to the right of the original drawing as shown.



2. In the *Modify* toolbar, select the **Rotate** command icon.
3. At the prompt “*Select objects:*” **left-mouse-click** the cam in the copy of assembly (the right figure).
4. **Right-mouse-click** to finish selection of objects.
5. Select center of the cam hole as the base point of rotation, and key-in **15** as the angle of rotation.



6. To find the final position of the cam, create a circle of radius 45 whose center is the same as that of the cam’s R20 arc.
7. Create a vertical line passing through the center of the follower.
8. Select the **Move** command icon in the *Modify* toolbar.
9. At the prompt “*Select objects:*” pick the follower, then **right-click** to finish selection.
10. For *base point*, pick the center of the follower, and pick the intersection of the circle and the circle and the vertical line created in Step 5 as the “*second point of displacement*”.
(Note: It might be necessary to zoom in on the cam and use Snap Intersection to

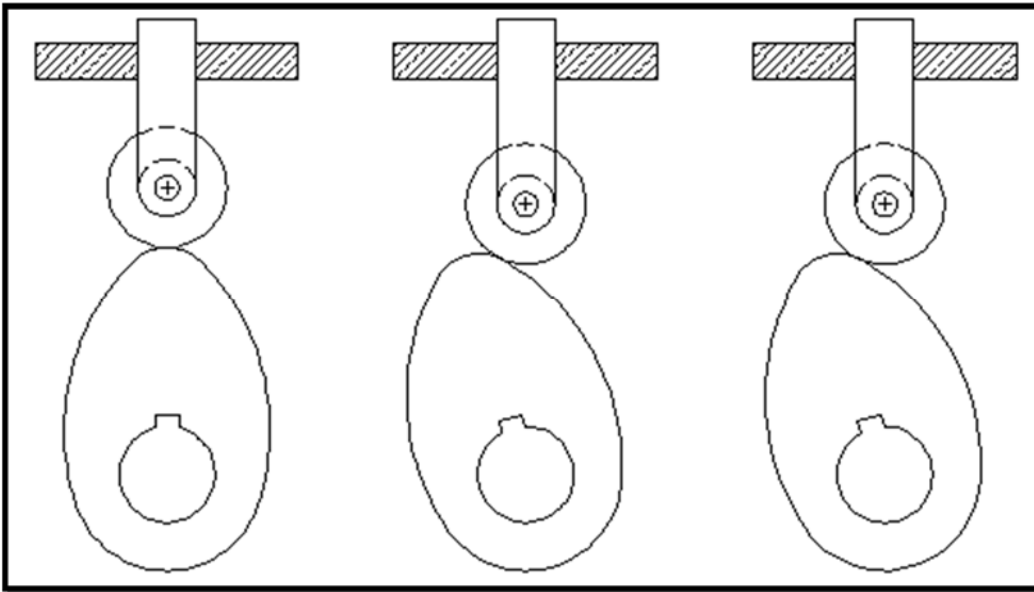
accurately locate the new position of the follower.)

11. Extend the two vertical lines of the follower's arm to extend to the follower's new position.
12. Save the drawing.

Part 3. Dropping the follower

In this part of the exercise, the follower will be dropped 20 mm, and the cam will rotate an appropriate angle to stay tangent to the follower.

1. Make a copy of the cam-follower assembly using the *Copy Object* command icon in the *Modify toolbar*. Create a window around the second drawing to select objects. Position the copy to the right of the second drawing.

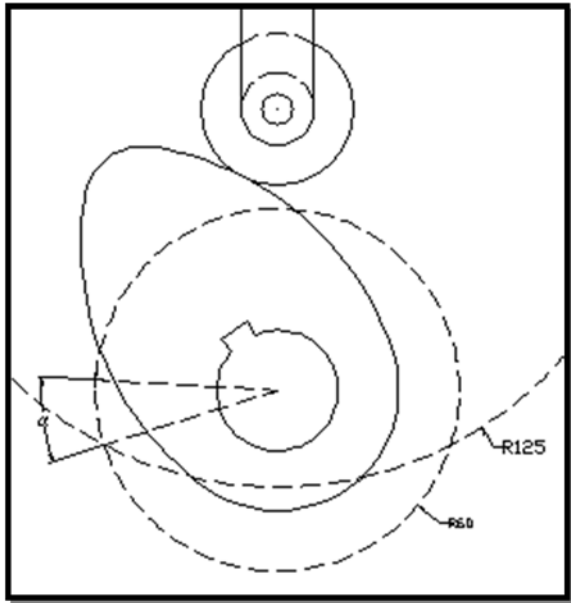


2. Select the *Move* command icon in the *Modify toolbar*.
3. *Left-mouse-click* the follower to select as the object to be moved, and *right-mouse-click* to finish selection of objects.
4. *Left-mouse-click* the center of the follower as the *base point*.
5. At the prompt “*Specify second point of displacement...*” key in **@0,-20 [ENTER]**

The above entry will specify a point of relative coordinates (0,-20) with respect to the previous location of the center of the cam.

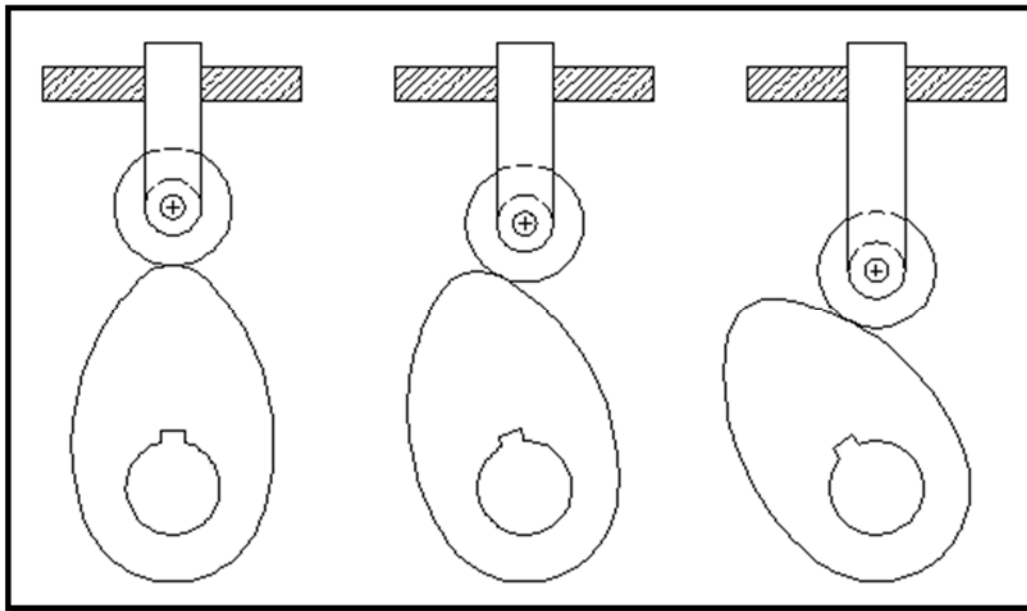
6. Extend the vertical arm of the follower to the new position of the follower.

At the final position, the R100 arc of the cam is externally tangent to the R25 of the follower.



7. To find the new position of the center of the right-side R100 arc of the cam, construct the two circles shown as dashed lines: one of radius 125 ($25 + 100$) and same center as that of the $\phi 50$ circle of the follower, the other of radius 60 ($100 - 40$) and the same center as that of the cam's point of rotation.
8. To find the angle of rotation α of the cam, construct two lines from the center of rotation: one to the old position of the center of R100, and the other to its new position (the intersection between the two circles drawn in step 7).

9. Measure the angle α to five decimal places.
10. Rotate the cam by the angle α . The new position of the cam should be such that R100 is tangent to the follower.
11. Save the drawing as **Lab3.dwg**.



Part 1

Part 2

Part 3