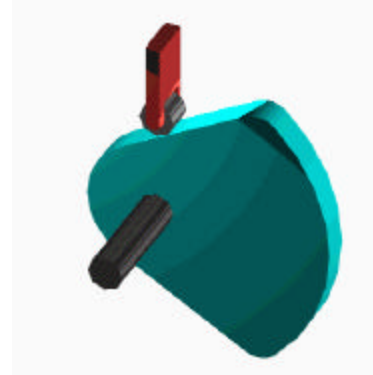


ME232 CAM Handout

Background Information:

A cam is a component on which a particular profile has been machined. The profile of the cam imparts (causes) a follower to move in a particular way. This can be seen if we examine the diagram below. As the shaft is rotated the cam rotates with it causing the follower to move up and down.



Cams fall into two main categories:
plate/face cams, and cylindrical cams.

The plate cam is merely a flat disc that has had a certain shape (or profile) machined on to it. The follower is placed in contact with this profile and as the cam is rotated the profile of it translates into a particular movement of the follower usually up and down.

The face cam is a disc that has a groove machined into its face and a roller follower is used to follow the groove as the cam rotates.

The cylinder or drum cam is a cylinder that has had a profile machined onto it and as the cam rotates the profile imparts a particular motion on its follower.

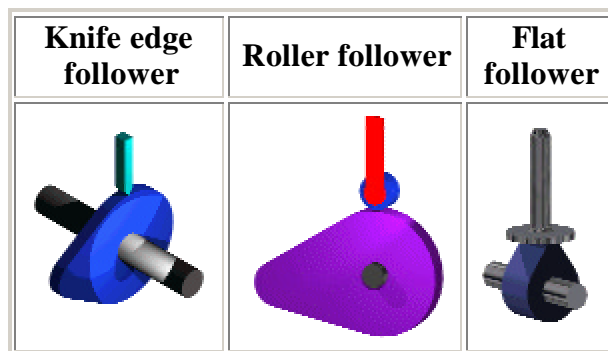
Types of follower:

There are three main types of follower:

the knife edge follower (seen in the cam and follower system table below)

the roller follower (seen in the cam and follower system table below)

the flat follower (seen in the cam and follower system table below)

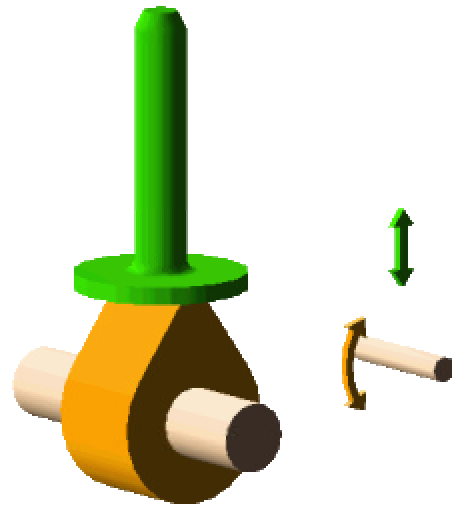


Cam and Follower Systems

As a cam rotates it imparts a particular motion on the follower in contact with it. From the image shown below we can see that as the cam shaft rotates the follower will be forced to move up and down. That is of course provided that there is an external downward force on the follower that makes it keep contact with the cam.

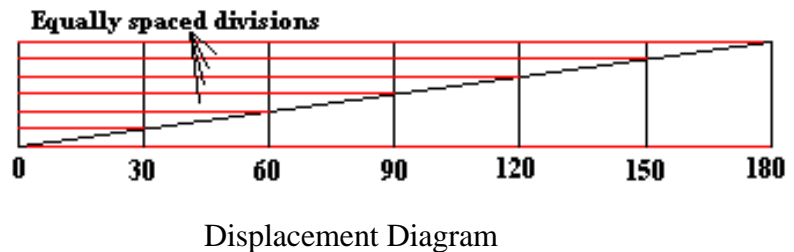
The next consideration is the type of the upward and downward motion of the cam and follower system. There are three different types of motion that could have been imparted on the follower. These are:

- Uniform Velocity
- Simple Harmonic Motion
- Acceleration/Retardation



Uniform Velocity:

Velocity is the rate of change of displacement with respect to time. This change may be a change of speed or a change in direction. From the definition uniform velocity this means that the change in displacement is a steady change. Or to put it differently it means that the change in displacement in the first time step of the uniform velocity motion is the same as the change in displacement in any other time step in that motion. In the displacement diagram for uniform motion, the length of the diagram corresponds to the period of the motion (given in degrees). The height is the maximum follower displacement. This must be done at a scale of 1:1 to use it to generate the cam profile.



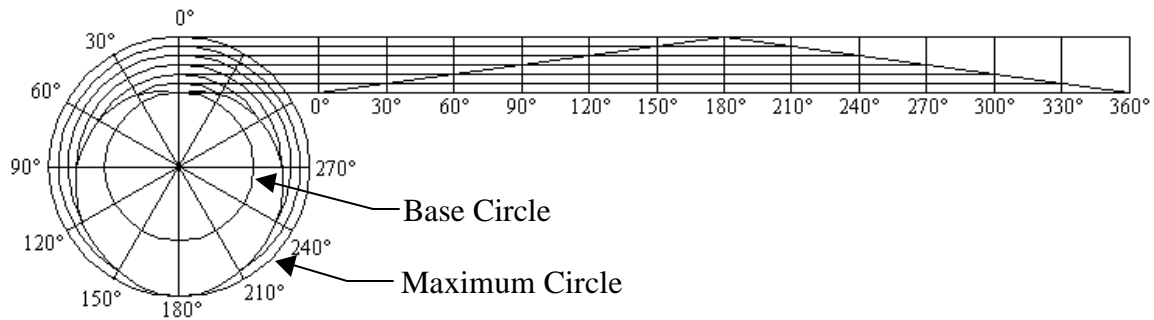
Steps for defining the cam profile for uniform motion: (see following figure)

Given the displacement diagram and the center of revolution, draw the base cam radius circle and the maximum follower displacement circle with the axis of revolution as center.

Divide the circles in an appropriate number of divisions (30 degrees in this example) and project the intersections between these divisions and the displacement diagram to define the corresponding angular displacements.

Join all the points of intersection to define the cam profile.

Cam Profile for Uniform Motion

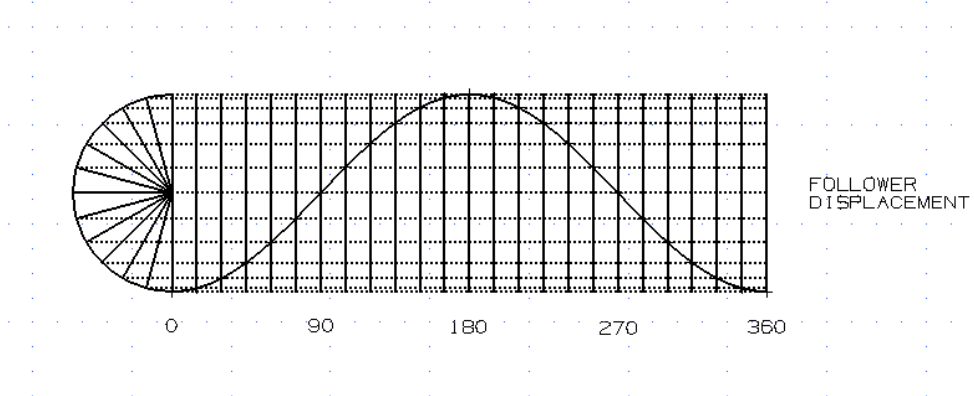


Simple Harmonic Motion:

The motion of a follower is simple harmonic motion if its acceleration towards a particular point is proportional to its displacement from that point. The best way to understand this non-uniform motion is to imagine a pendulum swinging. If you examine a pendulum as it swings you can see that as it swings towards one side it slows down until it finally stops at the maximum displacement. Then it starts to swing back in the other direction. As it does so it starts to gain speed until it reaches its maximum speed at the midpoint of the path. Once the pendulum passes the midpoint it starts to slow down on its approach to the other side. At this maximum displacement, the pendulum stops and begins to swing back. This cycle then keeps repeating itself.

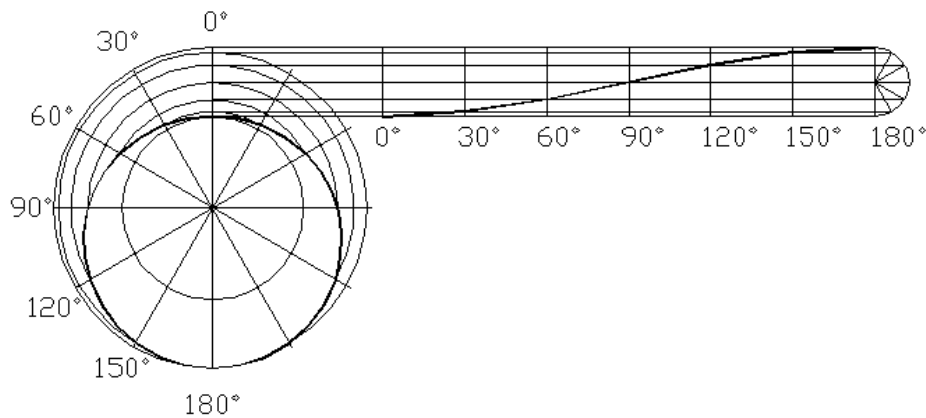
To generate the displacement diagram for simple harmonic motion, create a semicircle with diameter equal to the maximum displacement value. Create radial lines from the center of the arc at the same angular divisions as half of the total period. Horizontally project the intersections of the arc and radial lines. Points for the motion curve lie at the intersections of the horizontal projectors with the vertical divisions of the period. (see figure below)

Displacement Diagram for Simple Harmonic Motion.



To create the cam profile for this displacement, follow the same steps as with the example for uniform motion. See following figure.

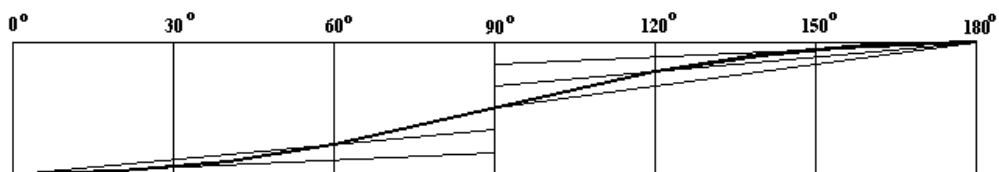
Cam Profile for Simple Harmonic Motion



Uniform Acceleration/Retardation:

Acceleration is the rate of change of velocity with respect to time. This motion is used where the follower is required to rise or fall with uniform acceleration, that is, its velocity is changing at a constant rate.

To generate the displacement graph for uniform acceleration/retardation, lay out the period of the motion along the horizontal (example shown is from 0 to 180). Divide the period into a reasonable number of increments (shown is 30 degrees). The vertical is the maximum displacement. Divide the vertical line at the midpoint of the period (90 degrees in this case) into the same number of divisions as the period. Draw lines from the lower left and upper right to the midline as shown. The intersection points will be the control points of the displacement curve. (see figure below)



Generating a cam profile for uniform acceleration/retardation:

Draw two circles with the following specifications: the base cam radius and the maximum follower displacement.

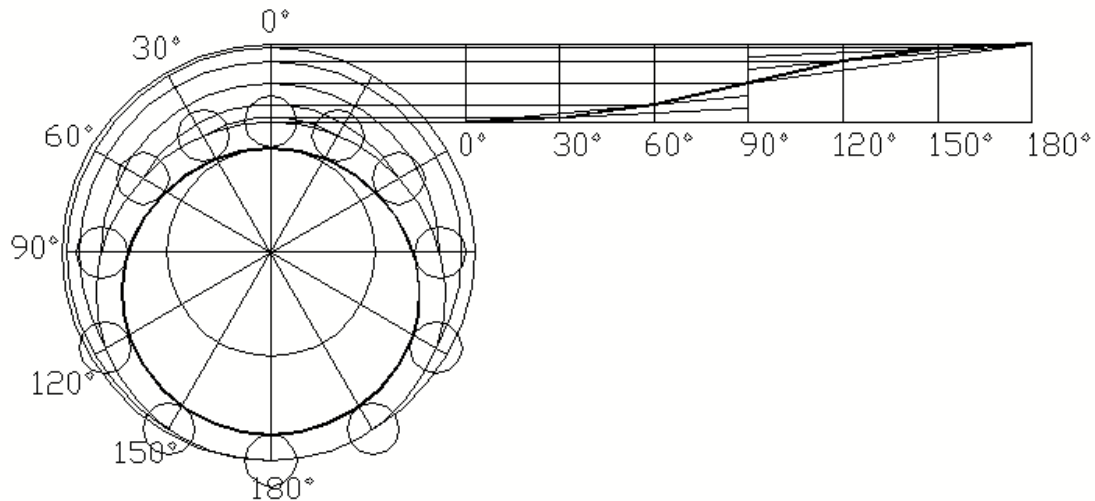
Divide these circles in appropriate divisions (30 degrees was used in this example) and draw the roller follower in its first position. *Note: for a knife-edge follower, you omit the roller follower.*

Construct the displacement diagram as shown. Note that this time the displacement is aligned with the center of the follower. For a knife edge follower the displacement is aligned with cam base diameter.

Index the 30° divisions.

From the displacement diagram project the displacement of the follower at 30° to intersect the 30° division. Then from the displacement diagram project the displacement of the follower at 60° to intersect the 60° division.

Project all the other displacements from the displacement diagram onto the corresponding divisions. Draw the roller follower in at each of these intersections
Step seven: Draw the cam profile tangential to each of the different positions of the roller follower.



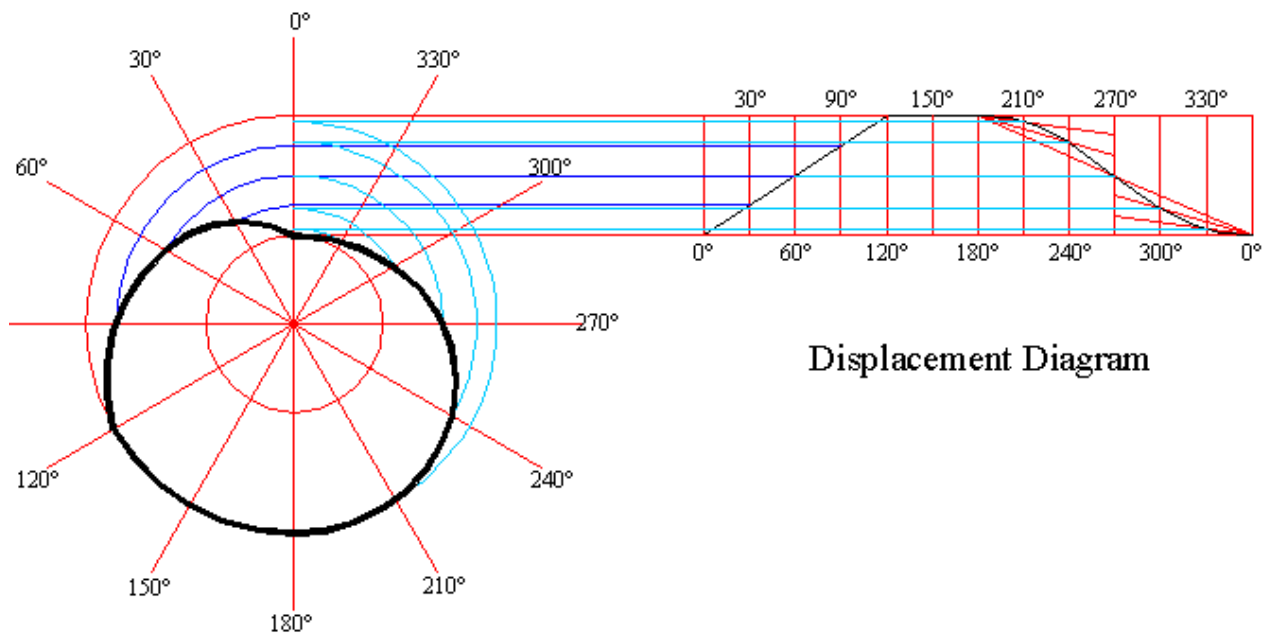
Sample CAM Design Problem

A radial plate cam rotates at 20 revolutions per minute and operates an inline knife-edge follower. The nearest approach of the follower to the cam center is 35 mm. Draw the profile on the cam that will impart the following motion to the follower:

Rise 48 mm with uniform velocity	0 to 1 second
Dwell	1 to 1.5 seconds
Return to initial position with uniform acceleration and retardation	1.5 to 3 seconds

Motion type	Duration of motion	Angular displacement
Rise 48 mm with uniform velocity	0 to 1 second	0° to 120°
Dwell	1 to 1.5 seconds	120° to 180°
Return to initial position with uniform acceleration and retardation	1.5 to 3 seconds	180° to 360°

Solution:



Displacement Diagram

Profile of the Cam