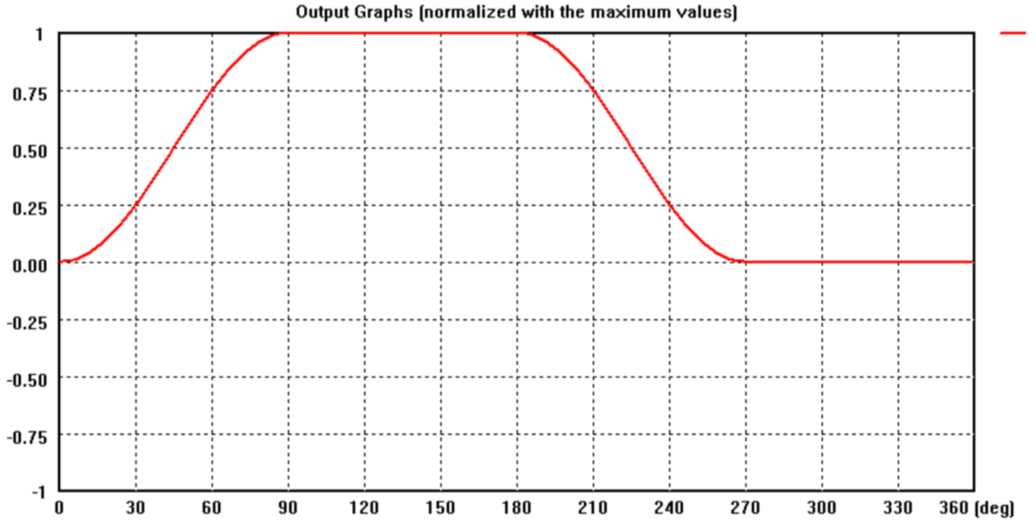
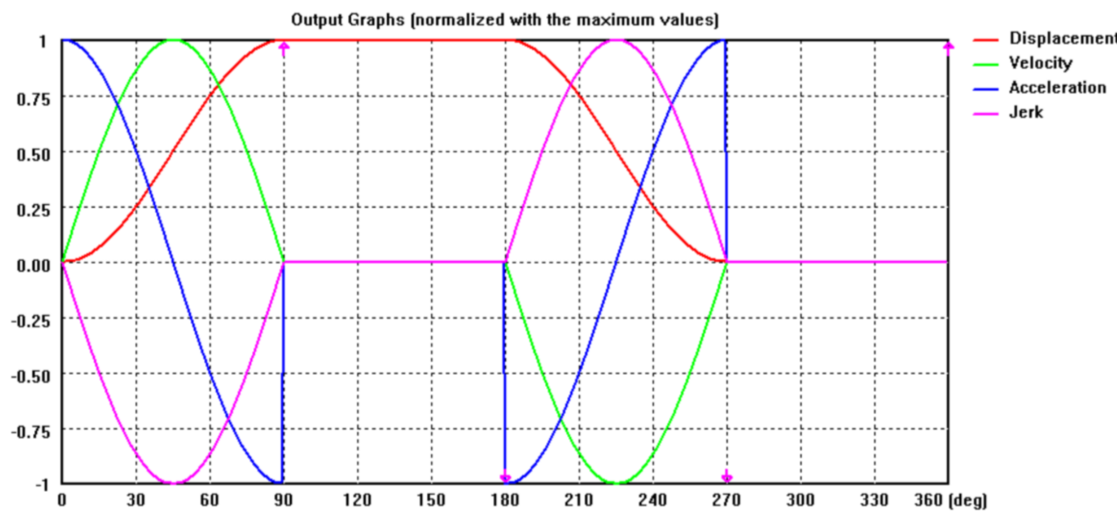
MECH 3652 March 25, 2020

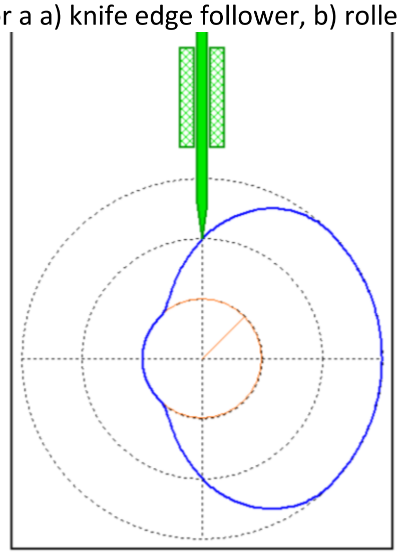
For today's lecture, I am going to illustrate some cam profiles using some commercial cam design software. For the first scenario, let's consider the following desired follower motion consisting of a rise, dwell, return, and dwell:

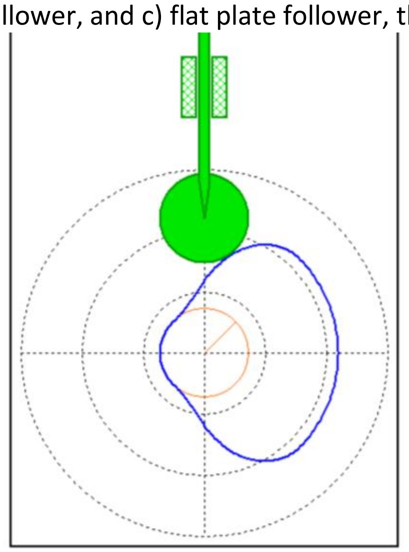


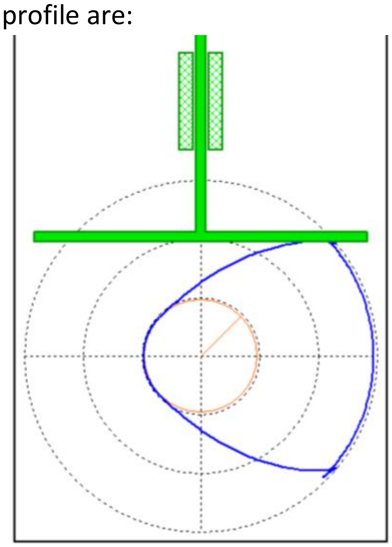
The software will also plot the velocity, acceleration and jerk profiles for us. Notice, they are essentially the same as what I had in last class' lecture notes. The purple color is the jerk and notice the small arrows indicating that the jerk goes to infinity. Incidentally, infinite jerk is often the cause of pitting on the cam surface, whereas infinite acceleration (and hence infinite force) is often the cause of localized plastic deformation of the cam surface, both should be avoided.



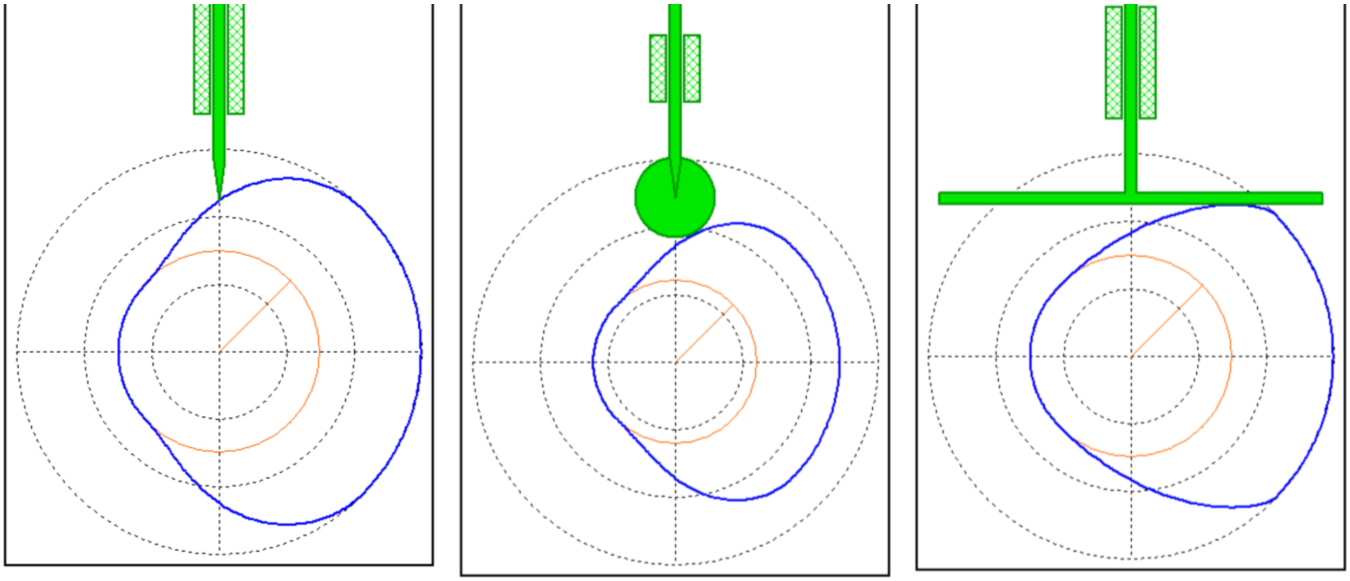
For a a) knife edge follower, b) roller follower, and c) flat plate follower, the profile are:


a)

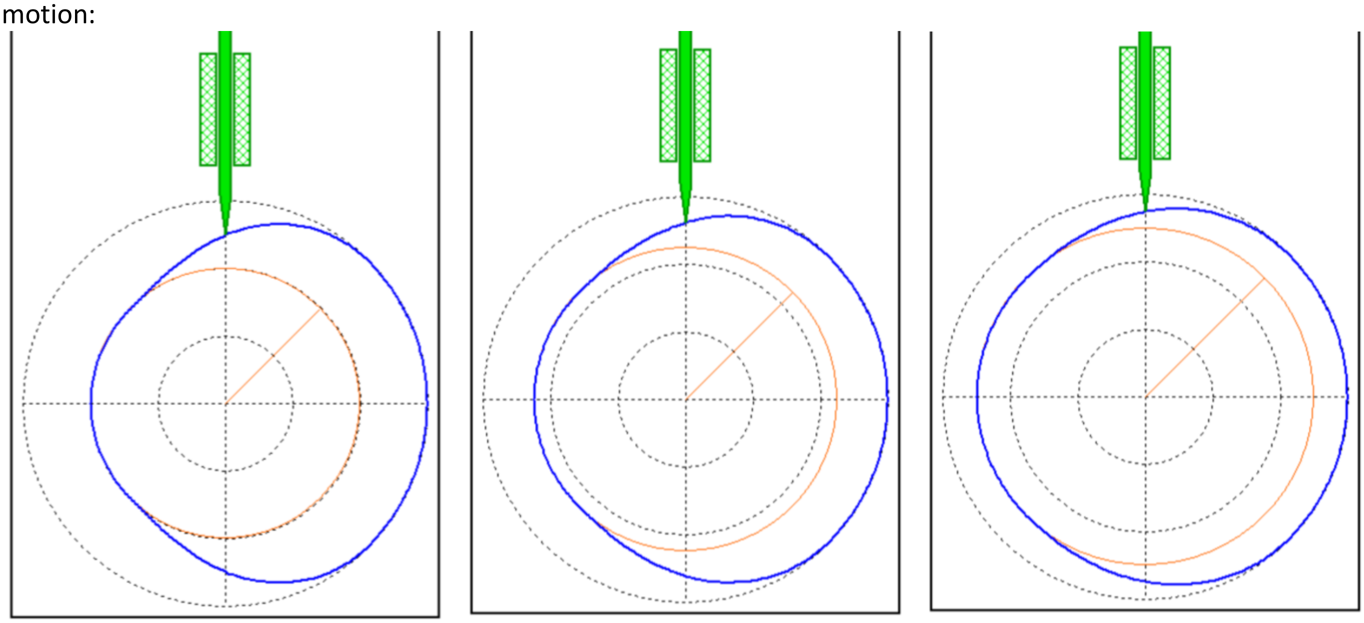

b)


c)

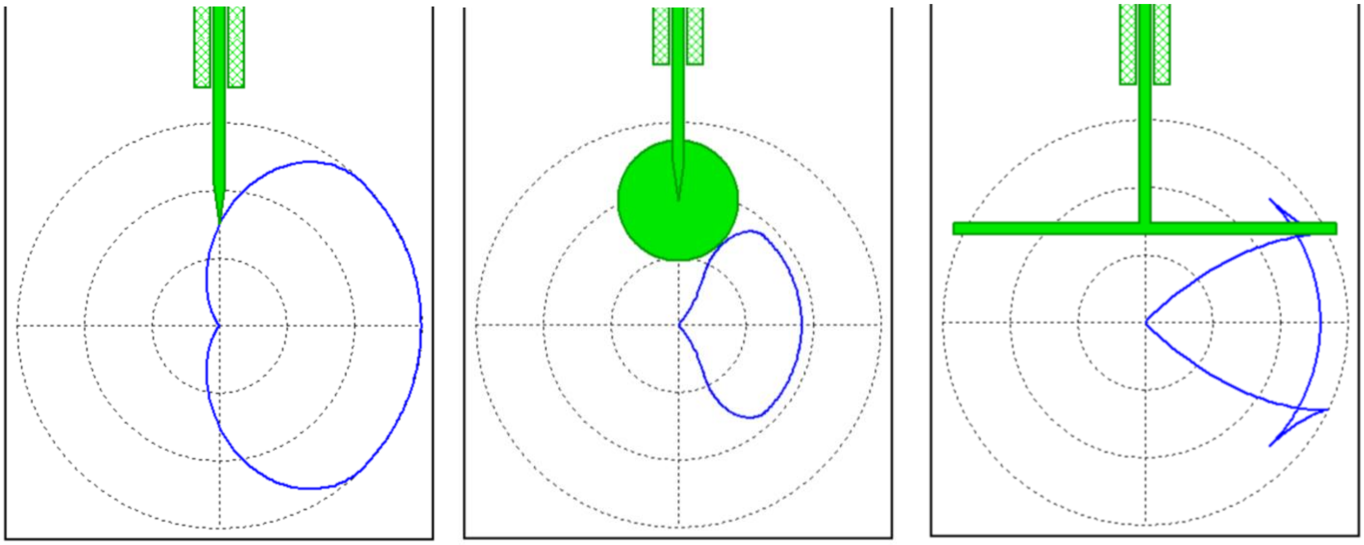
The plots are automatically scaled by the software so it can be a little difficult to see the differences, at least for the first two plots. Clearly there is a big difference for the third scenario. Actually in this case, the mathematical expressions give a cam profile that turns itself out in order to achieve the desired follower motion. One approach to eliminate this effect is to increase the base circle radius. Remember the base circle represents to starting or zero location of the followers motion. Here are the three cases is we double the base circle radius



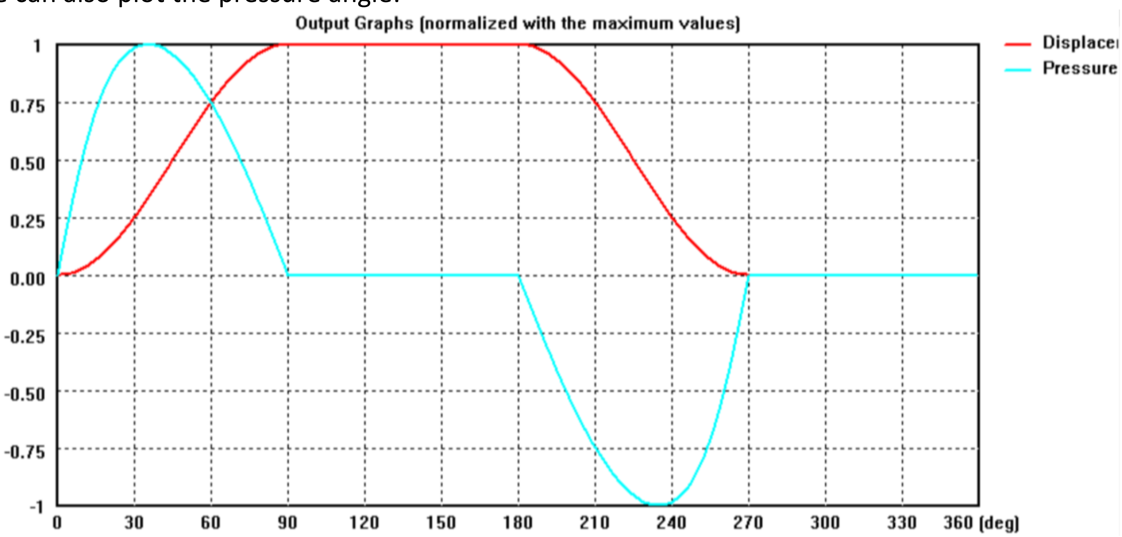
The issue with the third cam has been almost eliminated. Increasing the base circle makes the cam appear more round. Here is the cam for a knife edge follower with increasing base circle radius. All cases result in the same desired follower motion:



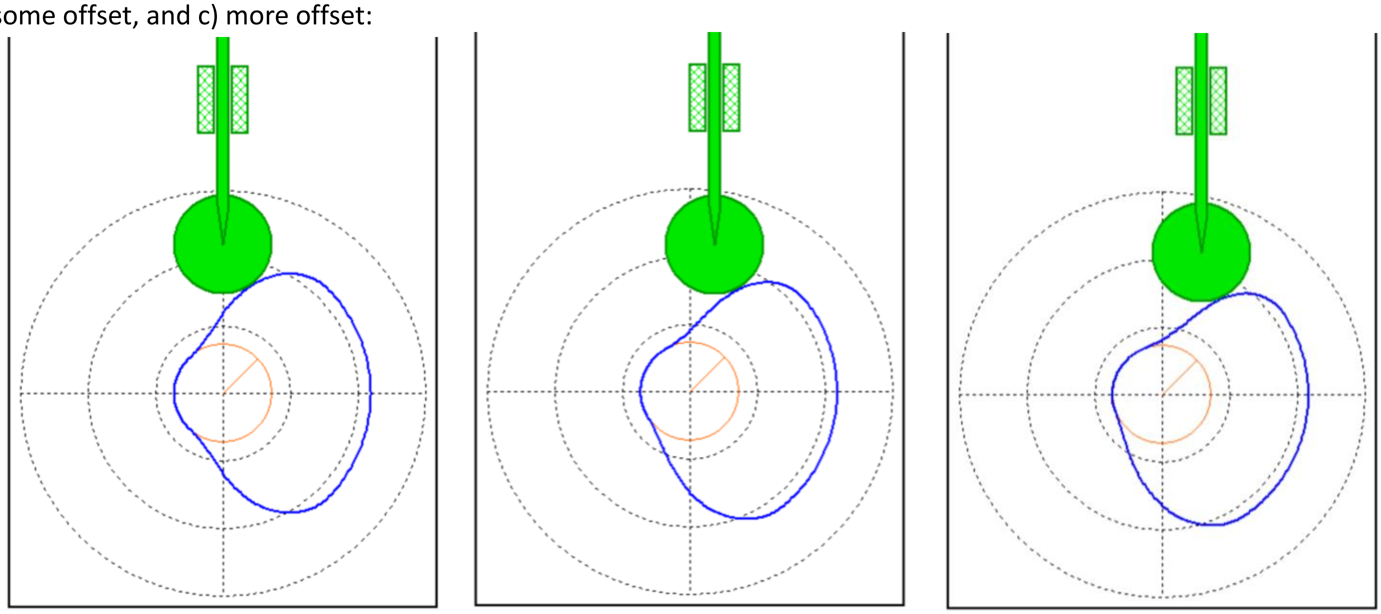
If we make the base circle radius zero, then we can see a potential issue with the cam profile



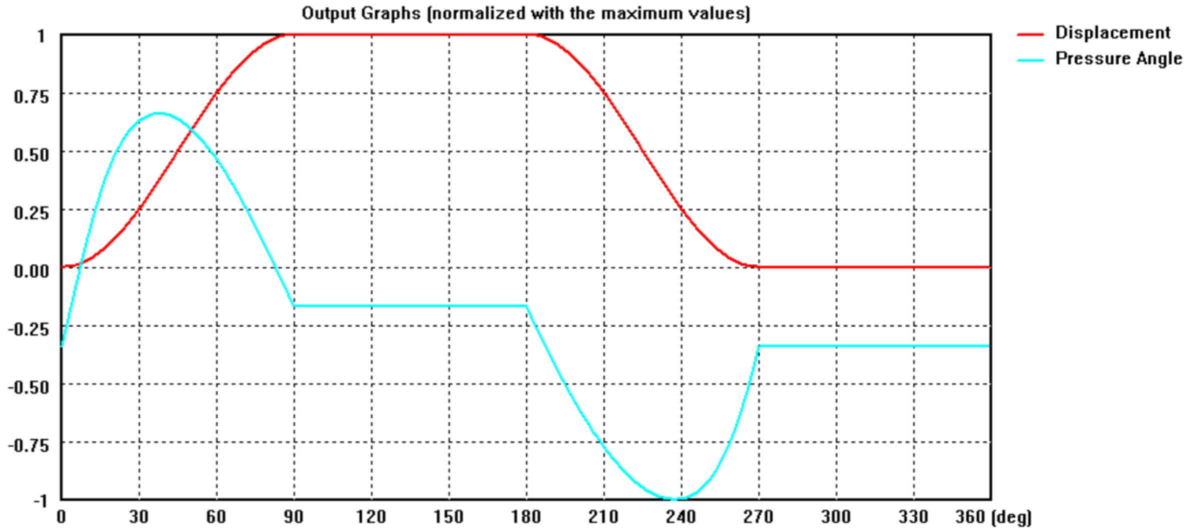
Remember that a knife edge can be thought of as a roller follower with a radius of zero and a flat plate follower as a roller follower with a radius of infinity.
We can also plot the pressure angle:

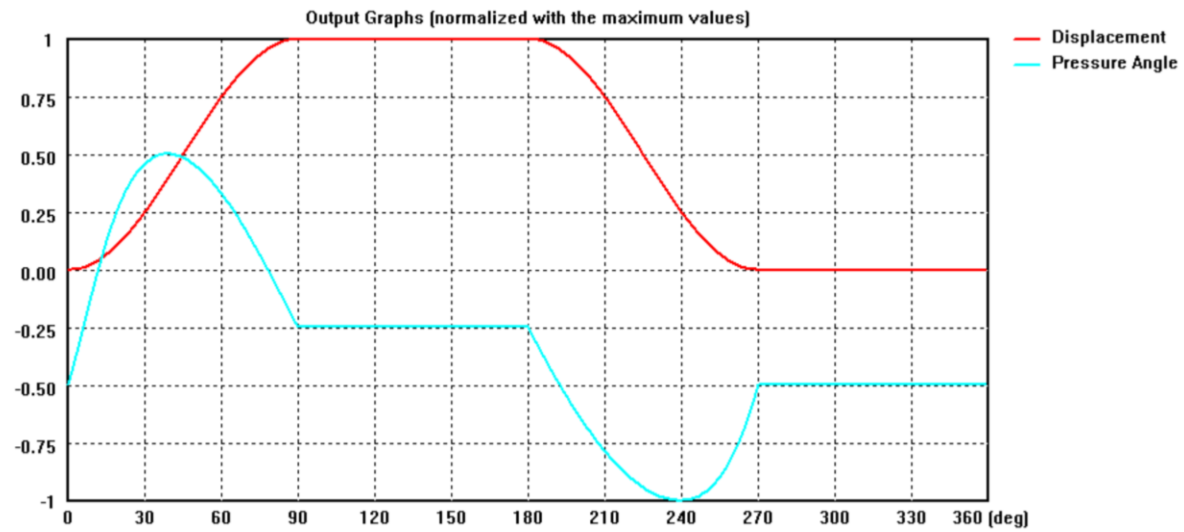


The pressure angle is the same during both the rise and the return. As I mentioned last time, the pressure angle can be manipulated through the use of an offset in the cam from the center position. This can be used to reduce the pressure angle during the rise motion and hence reduce the likelihood of binding of the cam. Here are three case: a) no offset b) some offset, and c) more offset:

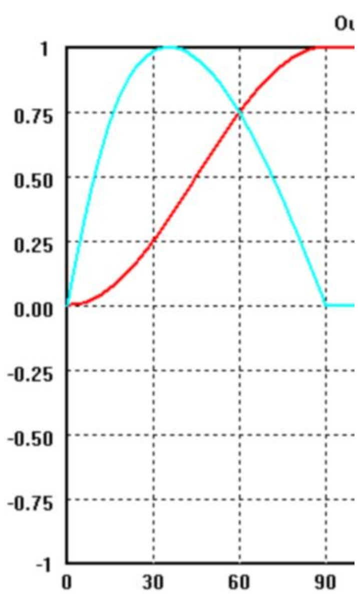


You can see that the cam profile changes ever so slightly and becomes asymmetrical with increasing offset distance. The pressure angle plots for case b) and c) are:

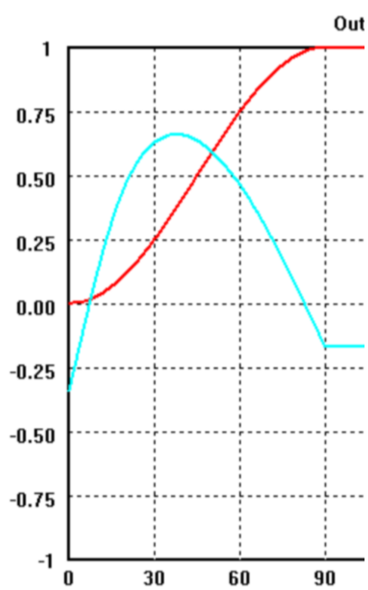




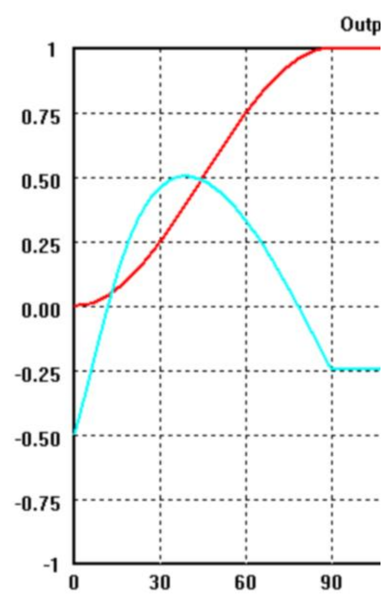
Let us compare these side by side



a)

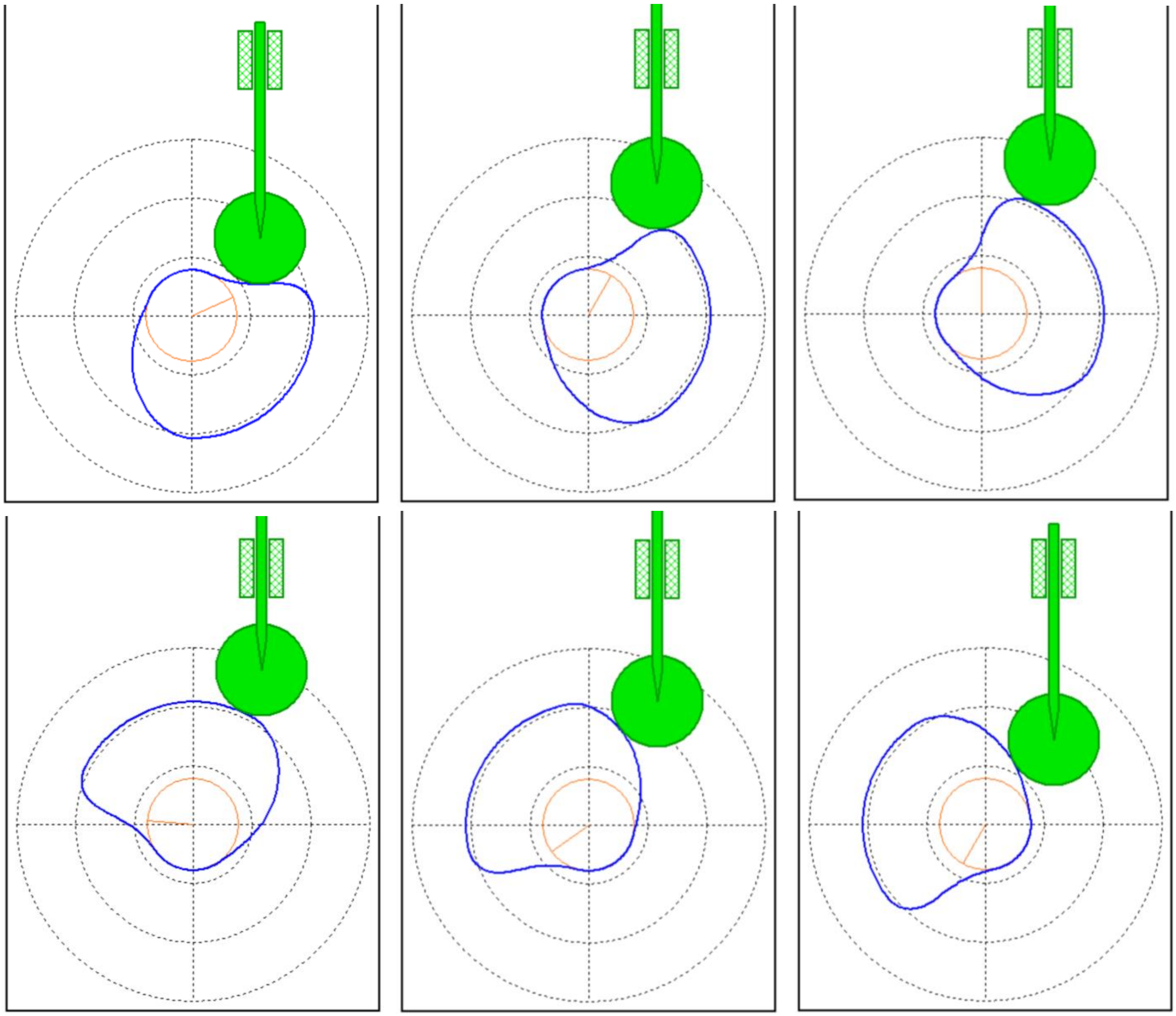


b)



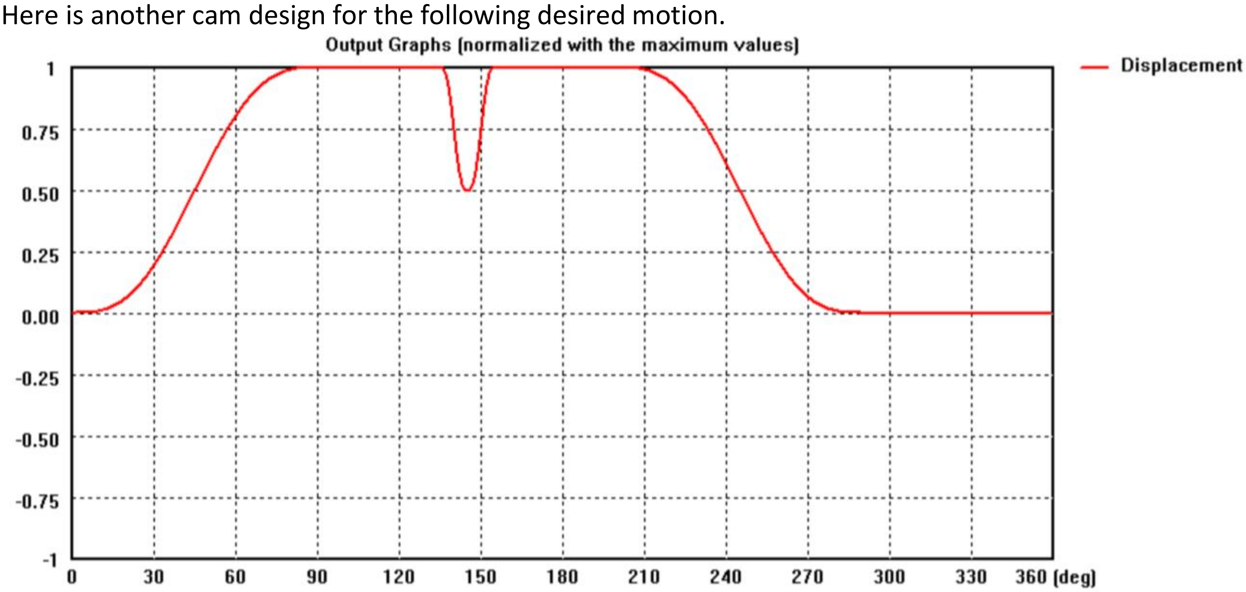
c)

The decrease in the pressure angle during the rise is very clear. Here is a sequence of images when the offset distance is maxed out (equal to the roller follower radius plus the base circle radius):



The pressure angle becomes quite large during the return motion as is evident in the last image; however, the return motion is often driven by an external force, say a return spring, and hence there is minimal risk of binding as a result of the large pressure angle.

Here is another cam design for the following desired motion.



Here I messed around with some of the parameters, can you identify the key parameter changes in each case?