

Chapter 6 (CAM) HW Hints

Problem 6.2. *NOTE:* DO NOT offset the follower stem for this problem! Assume that the follower axis (stem) intersects the axis of the cam (my examples will all have zero follower axis offset).

You may use the MATLAB function `camprofile.m` (it will be on the class website) to find the cam profile:

```
function [xc,yc] = camprofile(Ro,y,yp,theta,dir)
%
% This function finds the cam profile for a disk cam with an reciprocating
% flat-face follower. It accepts the base circle radius Ro, vectors of y
% and yp (all in displacement units), and cam angle theta (RAD). These
% vectors should all correspond to a full cycle of cam rotation from 0 to
% 2*pi. Obviously the smaller the stepsize the more accurate and smoother
% the final plot of cam profile.
%
% Vectors xc and yc containing the coordinates of the cam profile are
% returned. The cam profile points are generated so the follower axis is
% vertical (i.e. pi/2 has been added to the follower angle).
%
% NOTE: The "dir" flag is either 'CW' or 'CCW' to denote the direction of
% cam rotation. The algorithm is written for 'CW' rotation, but if the
% direction is 'CCW' all that must be done is to change the sign of the x
% coordinates of the cam profile.
```

Both the rise (full-rise) and return (full-return) motions are SHM (Simple Harmonic Motion); the plots for these motions are in text Figures 6.14 and 6.17, respectively. The corresponding equations y , y' , y'' , *etc.* are 6.12(a–d) and 6.15(a–d), respectively. I advise you to keep all angles in RAD (although DEG are useful for visualizing the displacement diagrams).

(a) Find the displacement functions $y(\theta)$ for the full motion and plot the displacement diagram using MATLAB. Use units of DEG for the plot.

(b) Assuming the follower has a circular cross-section, how large must this follower radius be to accommodate the contact point?

(c) Find and plot the profile that will accomplish this motion. Use 1° steps for cam angle θ .

Problem 6.7: This problem is similar to text Example 6.2. The motion is composed of:

1. Initial dwell
2. Full-rise lift
3. Half-return to a uniform velocity
4. Uniform velocity return segment
5. Half-return back to rest (ending at $\theta = 360^\circ$)

Since it's said to be a "high-speed" cam you must keep the 2nd kinematic coefficient y'' continuous between motion segments. Also, if you have a choice of motion types, select those that yield lower peak values of acceleration (text Figures 6.14–6.23 are scaled the same so you can compare their peak values). Of particular interest are the motions used for segments 2 + 3; the two possibilities—as I see it—are to use either (a) a cycloidal full-rise followed by a cycloidal half-return, or (b) an 8th-order polynomial full-rise followed by a harmonic half-return. You will need to find the lift L and the cam duration β for each segment. Then match the first and second derivatives all through the motion.

You will end up with five equations (one of them nonlinear) in five unknowns. They're a little tricky to solve but with

some thinking you can do it. Two of my results are:

$$\beta_2 = 1.084 \text{ rad } (62.1084^\circ)$$

$$L_3 = 0.0814 \text{ in}$$

- (a) Plot the position y (in), velocity $\dot{y}$ (in/s), and acceleration $\ddot{y}$ (ft/s²) vs cam angle θ (DEG) for the complete motion.
- (b) Assuming the follower has a circular cross-section, how large must the follower radius be to accommodate the contact point?
- (c) Find and plot the cam profile. To avoid any cusps on the cam profile, the radius of curvature $\rho > 0$. Apply text equation (6.27) and find the minimum base circle $(R_o)_{min}$. Round $(R_o)_{min}$ up to the nearest inch, and use that value for R_o .
- Use 1° increments for θ . Note that this cam rotates CW when you use `camprofile.m`.
- (d) Using the numerical data from parts (b) and (c), construct an ADAMS model of the cam and follower. This is Section 9 in the “ADAMS Guide.” Create ADAMS plot of the follower displacement, velocity, and acceleration. They should agree with the desired behavior.

This problem is a *LOT* of work, but I feel it is highly instructive.

Problem 6.9: You are given a cam angular speed of 400 rpm; the dwell time should be simple to find. The maximum and minimum velocity and acceleration will be given by the displacement functions you selected in Problem 6.7.

Note: It is these maximum and minimum velocities and accelerations that influenced your choice of motions (a) or (b) for motion segments 2 + 3 as I discussed in Problem 6.7 above.