PROBLEM 15-12

Statement: The cam in Figure P15-2 is a pure eccentric with eccentricity = 20 mm and turns at 200 rpm. The mass of the follower is 1 kg. The spring has a rate of 10 N/m and a preload of 0.2 N. Find the follower force over one revolution. Assume a damping ratio of 0.10. If there is follower jump, respecify the spring rate and preload to eliminate it.

Units: $rpm := 2\cdot\pi\cdot rad\cdot min^{-1}$

Given: Cam eccentricity and speed: $a := 20\cdot mm$ $\omega := 200\cdot rpm$

Follower mass: $m_f := 1\cdot kg$ Damping ratio: $\zeta := 0.10$

Spring: $k := 10\cdot N\cdot m^{-1}$ $F_{pl} := 0.2\cdot N$

Solution: See Figure P15-2 and Mathcad file P1512.

1. Using the equation given in the figure, write functions for the displacement, velocity, and acceleration of the follower. Note that the displacement function is written such that at it is zero at $t = 0$.

Displacement: $s(\theta) := a\cdot(1 - cos(\theta))$

Velocity: $v(\theta) := a\cdot\omega\cdot sin(\theta)$

Acceleration: $a(\theta) := a\cdot\omega^2\cdot cos(\theta)$

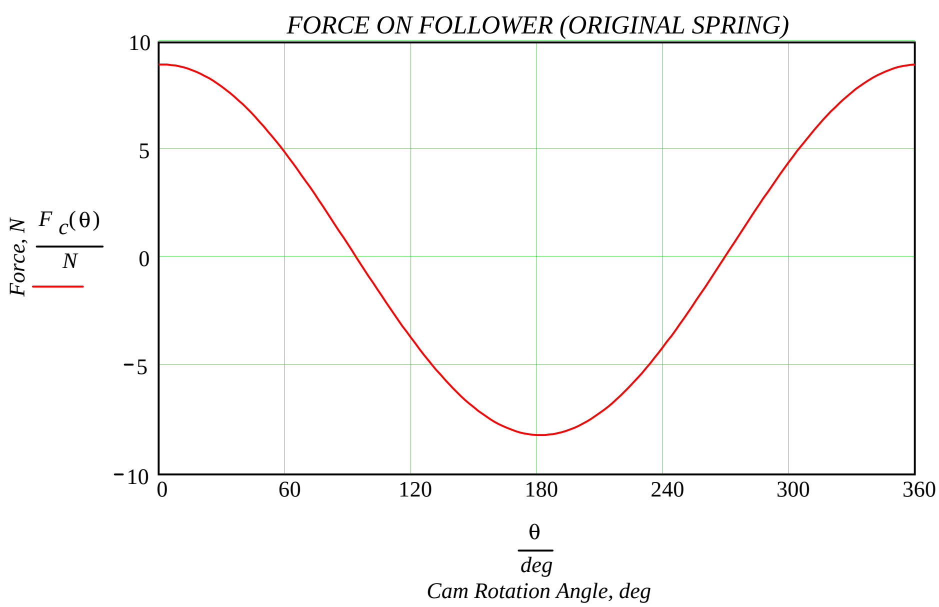
2. Calculate the damping coefficient using equations 15.2i and 15.3a.

$$c := 2\cdot\zeta\cdot\sqrt{m_f\cdot k} \qquad c = 0.632\,\frac{N\cdot sec}{m}$$

3. Substitute the expressions for displacement, velocity, acceleration, and spring preload into equation 15.9 and solve for the force on the follower as a function of cam angle.

$$F_c(\theta) := m_f\cdot a(\theta) + c\cdot v(\theta) + k\cdot s(\theta) + F_{pl}$$

4. Plot the force on the follower for one revolution of the cam. $\theta := 0\cdot deg, 2\cdot deg .. 360\cdot deg$



5. The cam force becomes negative, which indicates that the follower will jump or lose contact with the cam. New values of spring rate and/or preload will be tried iteratively to make the force always positive.

Let the new spring parameters be: $k := 50 \cdot N \cdot m^{-1}$ $F_{pl} := 7.5 \cdot N$

$c := 2 \cdot \zeta \cdot \sqrt{m_f \cdot k}$ $c = 1.414 \, \frac{N \cdot sec}{m}$

$$F_{cn}(\theta) := m_f \cdot a(\theta) + c \cdot v(\theta) + k \cdot s(\theta) + F_{pl}$$