ME125 Practice Exam Questions

1. How would you choose/design a tire to increase the cornering coefficient?
   - radial
   - low profile

2. What are some pros and cons of increasing the hysteresis in tire rubber?
   - improved traction on ice (pro)
   - increased heating at high speeds (con)

3. How is a cam profile modified to accommodate high RPM operation?
   - higher lift
   - longer duration
   - both improve gas flow

4. Roughly how much rotational kinetic energy is required to roll a car in a tripped rollover?
   Just following tripping, the rotational kinetic energy should exceed the potential energy associated with the highest position of the C.G.

5. You are test driver attempting to roll a vehicle having a roll bar. It has a 2 Hz roll resonance. How much time should there be between the left and right turns of the steering wheel in your J turn.

6. In a 4-wheel steer vehicle, the front and rear wheels share the steering effort equally. As a function of steer angle, what is the turning radius? (use small angle approximations)
7. A steering system has stiffness $K_{ss}$ (N-m/deg), tire radius $r$, castor angle $\nu$ radians, and no pneumatic trail. What is the contribution to understeer gradient due to the steering compliance?

$$\text{effective mass on front} = \frac{W_f}{g}$$

$$F_y = \frac{W_f}{g} (a_y \cdot \nu) = W_f a_y$$

$$\text{torque} = F_y \cdot r v$$

$$\Delta \theta = \frac{W_f a_y r v}{K_{ss}}$$

$$\delta = \frac{L \cdot 180}{R \cdot \pi} + \frac{W_o r v}{K_{ss}} a_y$$

8. Find the front roll center for the front suspension below.
9. What is the significance of the anti-squat line having slope $h/L$? Is there a significance to increasing the slope to $2h/L$?
If the vertical pivot for the rear suspension is on the line of slope $h/L$ through the rear contact patch then the vehicle does not squat (no compression of rear suspension). If it is on the line of slope $2h/L$ the car does not pitch.

10. For the following suspension model with no tire mass or tire compliance, find the transfer function from $Z_r$ to $Z$.

\[
\begin{align*}
M \ddot{z} &= -k(z - z_r) - c(\dot{z} - \dot{z}_r) \\
M \dddot{z} + c \dot{z} + k z &= k \dot{z}_r + c \dot{z}_r \\
\frac{1}{m} \Rightarrow s \Rightarrow z
\end{align*}
\]

\[
(\frac{1}{M s^2 + c s + k}) \hat{z} = (k + cs) \dot{z}_r
\]

\[
\frac{\hat{z}}{z_r} = \frac{k + cs}{Ms^2 + cs + k}
\]