

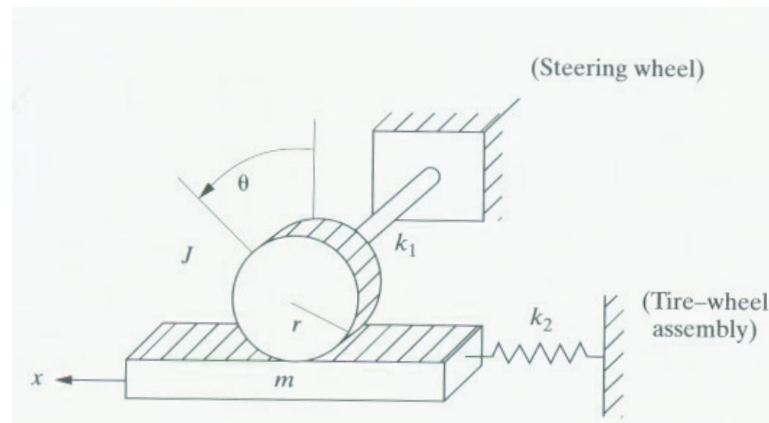
# ME 460/660, Mechanical Vibration

Midterm, Fall 2004

Closed book, closed notes. Test booklets will be provided. Formula sheet must be turned in with the exam. Formula sheet must be exactly the same as that posted on the web site.

Note: Expansion Envelope Slope,  $\frac{f_0}{2\omega_n}$

1. A single degree of freedom system with  $m_{eff} = 10$  kg,  $c_{eff} = 5$  kg/s, and  $k_{eff} = 10$  N/m is subjected to a  $6N$  force at 5 Hz. Determine the magnitude of the response as well as the phase. *Be very careful to delineate whether the angle you give is a phase lead or a phase lag.*
2. A linear system is freely oscillating. The displacement amplitude is measured to be 1 in, the velocity amplitude is measured to be 10 in/sec, and the acceleration amplitude is measured to be 125 in/sec<sup>2</sup>. What can be concluded about the experiment?
3. For the rack and pinion system (shown below)
  - (a) determine the equation of motion in terms of the displacement  $x$ .
  - (b) determine the natural frequency.



4. *Grad student/bonus* Determine the natural frequencies and mode shapes for a clamped-free bar. The equation of motion of a bar is  $\left(\frac{E}{\rho}\right) \frac{\partial^2 w(x,t)}{\partial x^2} = \frac{\partial^2 w(x,t)}{\partial t^2}$ . (20% of other points)