MECH 3140
Homework #6

From Palm (Chapter 9)

Problems 1, 8, 9, 16, 43-45,

Transient Response

1. A system oscillates at 5 Hz and takes 10 seconds to settle to within 5 % of its final value.
   a. Sketch the roots on the s-plane
   b. Write out the differential equation
   c. Write out the transient response for the system

2. A second order system does not oscillate. The system has a 5 second and 10 second time constant.
   a. Sketch the roots on the s-plane
   b. Write out the differential equation
   c. Write out the transient response for the system

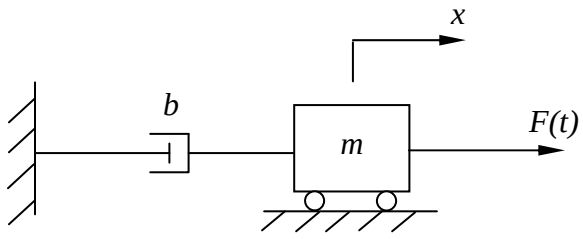
3. Sketch the roots and the transient response for the following characteristic equation: $(s+5)(s^2+25)=0$

4. An object with mass *m* and ***air drag*** damping coefficient *D* is dropped from the sky. Find the time constant(s) for the object for perturbations about terminal velocity.

5. Find the eigenvalues for a regular pendulum and inverted pendulum.

ALSO (by Friday 10/14/11):

Derive the equation for ***velocity*** for the system above (when $F(t)=F_o sin(\omega_{in}t)$). What happens to the magnitude of the velocity (output) as you increase the input frequency (ω_{in})?

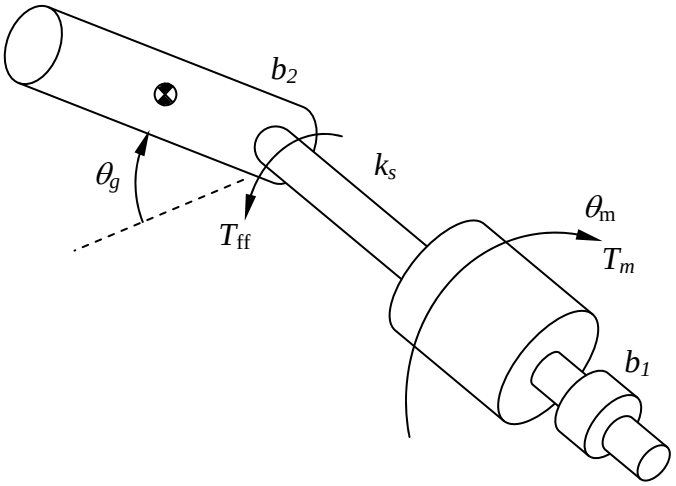


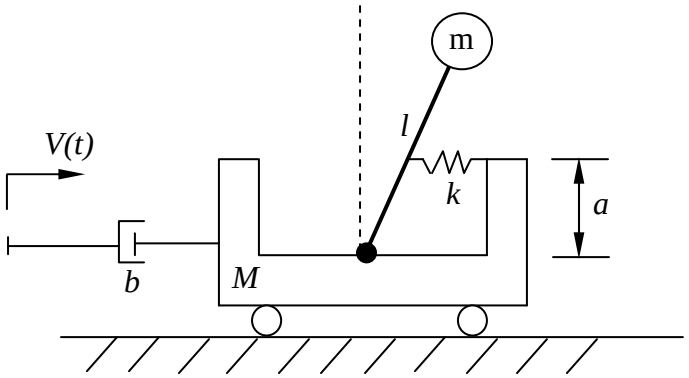
ALSO (by Friday 10/14/11):

Make sure you have worked the exam problems from Exam #1. Exam #1 – Problem #1 (linearize and put into state space). Find the Time Constant for Exam #1-Problem #2. Be able to find the eigenvalues for Problem #3 and #4

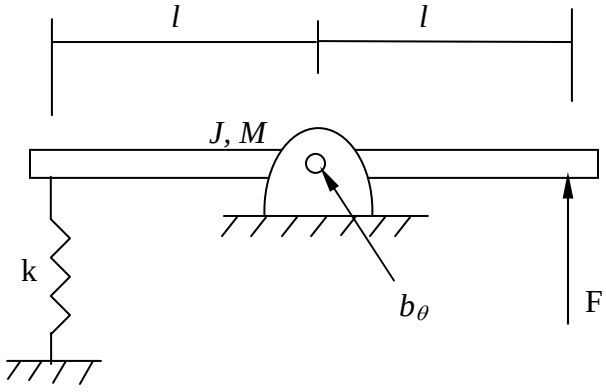
Develop the Equations of Motion for all four systems (place equations in a State Space Format).

1) Sketch out all of the possible eigenvalue location combinations and the corresponding homogeneous responses for the two systems below (and the problem #1 from exam #1). The figure on the left represents a gun on a tank turret, the figure on the right is a model of a building for earthquake analysis.

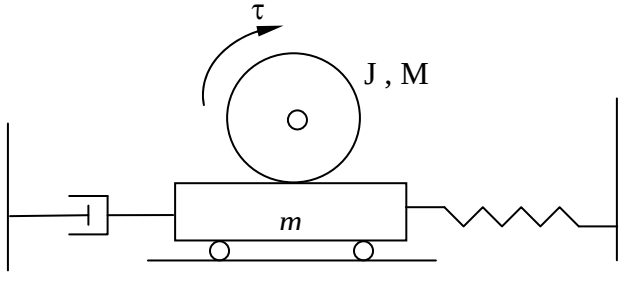




2) For the following system, size/design/find the maximum spring value without allowing the transient response to oscillate.



3) Design the suspension (k and b) for the rack and pinion to have a 1 second settle time (1%) and a rise time of 0.2 seconds.

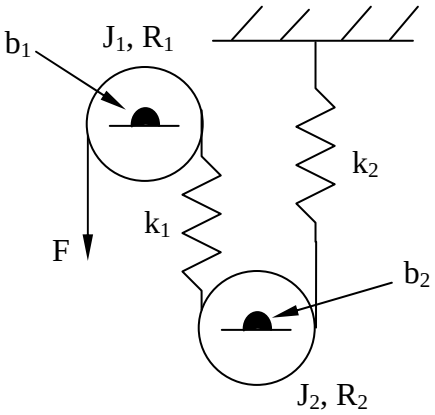


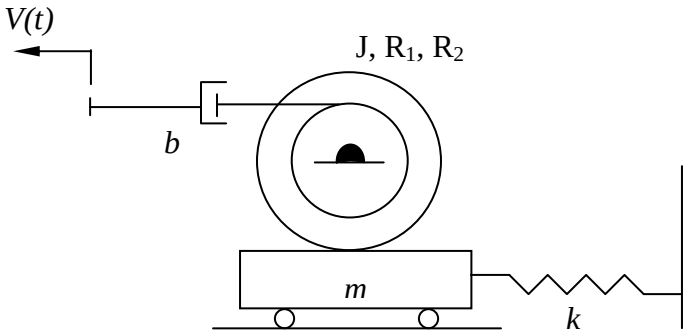
More Modeling Problems (if you need them)

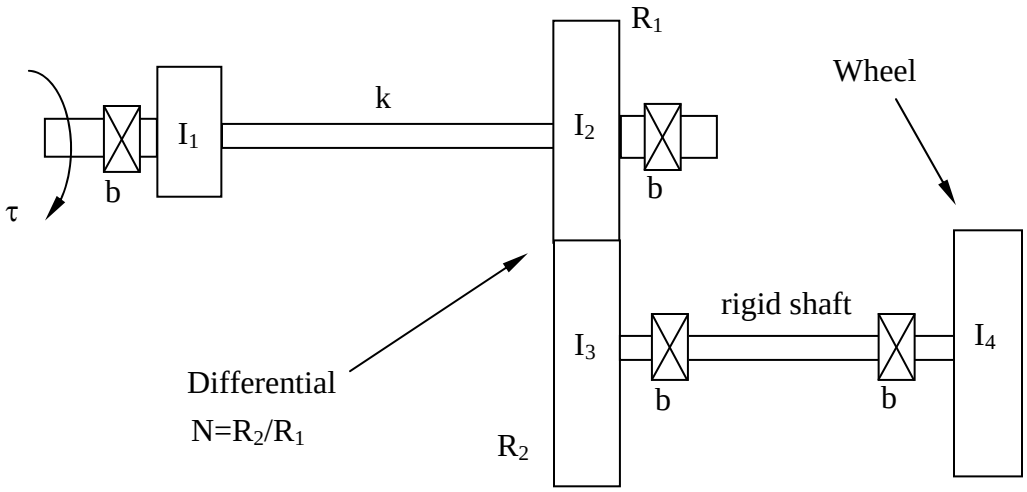
(Note: You should be able to find the eigenvalues of the system that are first or second order, transient response, etc.). If there are any old HW problems you have not worked – I suggest working them – there are some good problems in there!

B-3-14**,** B-4-7

Derive the EOM for the following systems (get the eigenvalues and transient response).







Matlab Assignment (Due 10/19/2011)

1. A 5 kg pendulum of length 1 meter (with negligible damping) oscillates at 1/2 Hz.
   a) Develop the non-linear model of the system
   b) Develop the solution for the system starting from rest from an initial angle offset
   c) Where are the eigenvalues for this system.
   d) Size a rotational damper such that the system a damping ratio of 0.707. What are the eigenvalues of this new system? What is the natural frequency? Damped frequency? Plot the damped system starting from 20 deg.