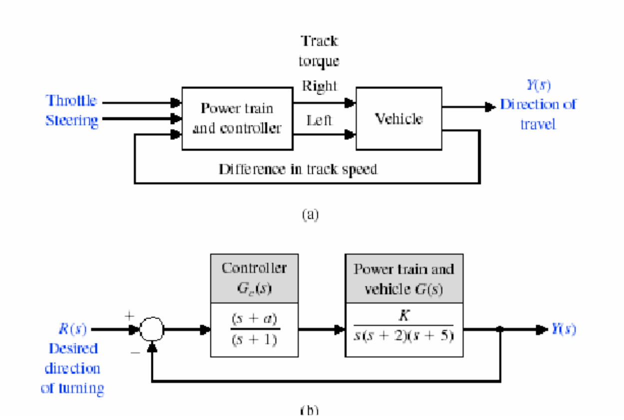
Assignment 3

1. Design the turning control for a tracked vehicle by Selecting *K* and *a* so that the system is stable. The system is modeled below.



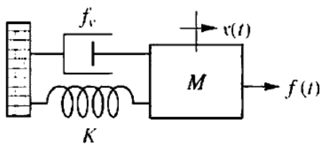
2. Given the system Find out how many poles in the LHP, RHP and on the imaginary axis using Routh Hurwitz criteria.

$$\dot{X} = \begin{bmatrix} 0 & 3 & 1 \\ 2 & 8 & 1 \\ -10 & -5 & -2 \end{bmatrix} X + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} X$$

3. Factor the polynomial $s^4 + 3s^3 + 30s^2 + 30s + 200$ using Routh Hurwitz criteria.

4. Consider the translational mechanical system shown in Figure . A 1-pound force, *f(t)*, is applied at t = 0. If $f_v = 1$, find K and M such that the response is characterized by a 4-second settling time and a 1-second peak time. Also, what is the resulting percent overshoot?



5. For each of the transfer functions shown below, find the locations of the poles and zeros, plot them on the s-plane, and then write an expression for the general form of the step response without solving for the inverse Laplace transform. State the nature of each response (overdamped, underdamped, and so on).

a. $T(s) = \dfrac{2}{s+2}$

b. $T(s) = \dfrac{5}{(s+3)(s+6)}$

c. $T(s) = \dfrac{10(s+7)}{(s+10)(s+20)}$

d. $T(s) = \dfrac{20}{s^2+6s+144}$

e. $T(s) = \dfrac{s+2}{s^2+9}$

f. $T(s) = \dfrac{(s+5)}{(s+10)^2}$

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6. Find the damping ratio and natural frequency for each second-order system of Problem 5 and show that the value of the damping ratio conforms to the type of response (underdamped, overdamped, and so on) predicted in that problem.

7. For each pair of second-order system specifications that follow, find the location of the second-order pair of poles.
   a. %OS = 12%; Ts = 0.6 second
   b. %OS = 10%; Tp = 5 seconds
   c. Ts = l seconds; Tp = 3 seconds

8. Upper motor neuron disorder patients can benefit and regain useful function through the use of functional neuroprostheses. The design requires a good understanding of muscle dynamics. In an experiment to determine muscle responses, the identified transfer function is

$$M(s) = \frac{2.5e^{-0.008s}(1+0.172s)(1+0.008s)}{(1+0.07s)^2(1+0.05s)^2}$$

Find the impulse, unit step and unit ramp response of this transfer function. Discuss the stability of this system.

9. Solve the following state equation and output equation for y(t), where u(t) is the unit step.

$$\dot{\mathbf{x}} = \begin{bmatrix} -3 & 1 & 0 \\ 0 & -6 & 1 \\ 0 & 0 & -5 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u(t)$$

$$y = [0\ \ 1\ \ 1]\,\mathbf{x};\ \mathbf{x}(0) = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

10. Find the response of the first order system for the inputs ramp and parabolic.

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