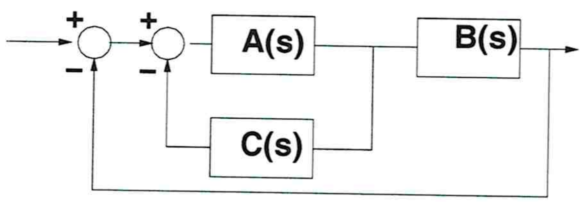
University of Massachusetts Lowell
Department of Electrical and Computer Engineering
16.413 Linear Feedback (5)

1. Given the system in the diagram



where $A(s) = M/(s+2)$, $B(s) = 1/s$ and $C(s) = K$ find the M and K such that the damping ratio if equal to 0.7 and the undamped natural frequency is equal to 4 rad/sec.

2. Determine the conditions on K for stability

   a. $s^4 + 6^3 + 11s^2 + 6s + K = 0$

   b. $s^3 + (4+K)s^2 + 6s + 16 + 8K = 0$

3. Draw the complete root-locus of

$$GH = \frac{K}{(s^2+2s+2)(s^2+2s+5)}$$

4. Draw the complete root-locus of

$$GH = \frac{K(s+1)}{s(s-3)}$$

5. Consider the system

$$\underline{\dot{x}} = \begin{bmatrix} 0 & 1 \\ -6 & 5 \end{bmatrix}\underline{x} + \begin{bmatrix} 1 & 1 \\ 3 & 3 \end{bmatrix}\underline{u}$$

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

   a. Determine the eigenvectors and eigenvlaues of the system.

   b. Determine the state-transition matrix and $\underline{y}$ given that $\underline{u}(t) = [\delta(t), 0]^T$.

   c. Determine if the system is controllable.

   d. Determine if the system is observable.

6. Consider the negative feedback system having the open-loop gain

$$GH = \frac{K(s+4)}{s(s+1)(s+2)}$$

a. Draw the real line root locus.

b. Calculate the asymptotes and their intercept.

c. Determine the gain K and vlaues of s of the $j\omega$ intercept.

d. Determine the equation governing the breakaway pt.

e. Draw the complete properly labeled root-locus diagram.

7. Consider system

$$G(s) = \frac{1}{s^2(s+2)}; \quad H(s) = 4s + K$$

for the negative feedback system.

a. Find the characteristic equation of the closed-loop system.

b. Determine the conditions on the gain K for stability.

c. For what value of the gain for marginal stability. What is the frequency of oscillation.