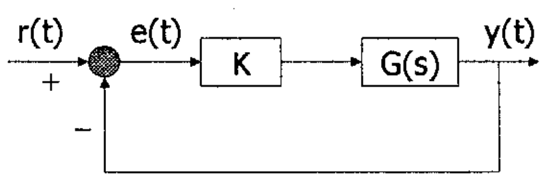
1. (25%) Given a system represented by a transfer function $G(s)$, please describe how you will estimate the following properties of the system.
   (a) (5%) bounded-input-bounded-output (BIBO) stability
   (b) (5%) percent overshoot if the property exists
   (c) (5%) 2%-settling time if the property exists
   (d) (5%) steady state error due to unit step input if the property exists
   (e) (5%) bandwidth if the property exists

2. (25%) Consider the system represented by

$$G(s) = \frac{9}{s^3 + 7s^2 + 12s + 10}$$

   Please follow the procedure that you have outlined in Problem#1 above to estimate the following properties of the system.
   (a) (5%) bounded-input-bounded-output (BIBO) stability
   (b) (5%) percent overshoot
   (c) (5%) 2%-settling time
   (d) (5%) steady state error due to unit step response
   (e) (5%) bandwidth

3. (25%) Consider the following unit feedback system with $G(s) = \dfrac{(s+3)}{s(s+1)(s+2)(s+4)}$ and $K > 0$.

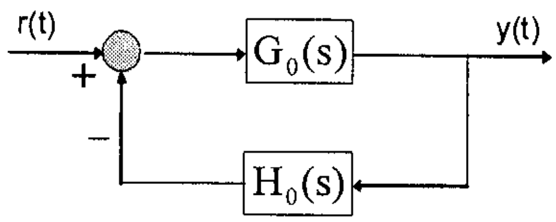


   (a) (5%) Briefly discuss the theoretical basis of the root-locus sketch.
   (b) (10%) Determine the real-axis breakaway point(s) and discuss why they are determined in the way you just used.
   (c) (10%) Determine the behavior of the root-locus at infinity and discuss why it can be determined in the way you just used. Remember to discuss not only the slopes but also the real-axis intercept of the asymptotes.

4. (25%) About Nyquist stability theorem

(a) (5%) State the principle of argument and describe why the principle holds.

(b) (5%) Describe how to apply the principle of argument to determine the closed-loop stability of the following system.



(c) (10%) Let $G_0(s) = \frac{K(s+5)}{s-4}$, $H_0(s) = \frac{s+3}{s-2}$, and $K > 0$. Draw the Nyquist plot for $K = 1$.

You may need the following numerical results:

$$\tan^{-1}(3.3/3) + \tan^{-1}(3.3/5) + \tan^{-1}(3.3/2) + \tan^{-1}(3.3/4) \approx \pi$$

$$\sqrt{19.89} \approx 4.5,\ \sqrt{35.89} \approx 6.0,\ \sqrt{14.89} \approx 3.9,\ \text{and}\ \sqrt{26.89} \approx 5.2$$

(d) (5%) Use the result of (c) to determine the range of K for stable closed-loop system.