भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Indian Institute of Technology Hyderabad

Department of Electrical Engineering

EE2220 – Control Systems

Assignment 02 – (Stability in Frequency Domain)

Submission Deadline: None

Key Learning from the Assignment:

- Nyquist Plot
- Nyquist Stability
- M and N Circle

Instructions: RN = last two digits of your roll number.
Use Graph paper for all plots/ sketches.

1. Using Nyquist criterion, find out whether each of the system below are stable or not.

a. $$G(s)=\frac{50}{s(s+3)(s+6)}$$ $$H(s)=1$$

b. $$G(s)=\frac{RN}{s^2(s+3)}$$ $$H(s)=(s+4)$$

c. $$G(s)=\frac{20}{s(s+1)}$$ $$H(s)=\frac{(s+3)}{(s+4)}$$

d. $$G(s)=\frac{100(s+5)}{s(s^2+4)(s+3)}$$ $$H(s)=1$$

2. Using Nyquist criterion, find out the range of K for which the closed loop system will be stable.

a. $$G(s)=\frac{K}{s(s+6)}$$ $$H(s)=\frac{1}{(s+9)}$$

b. $$G(s)=\frac{K(s+2)(s+4)}{(s^2-3s+10)}$$ $$H(s)=\frac{1}{s}$$

c. $$G(s)=\frac{K}{(s+1)(s+3)}$$ $$H(s)=\frac{1}{(s+5)(s+7)}$$

3. For unity feedback (negative) systems given below, obtain closed loop frequency response using constant M and N circles.

   a. $G(s)=\dfrac{10}{s(s+1)(s+2)}$

   b. $G(s)=\dfrac{1000}{(s+3)(s+4)(s+5)(s+6)}$

   c. $G(s)=\dfrac{50(s+3)}{s(s+2)(s+4)}$

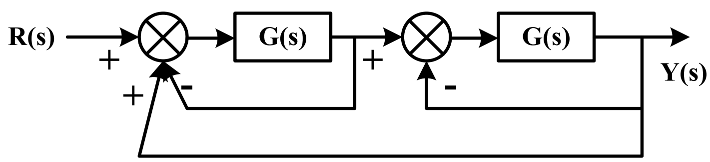
4. Repeat the above questions using Nichol's Chart. Also estimate the percentage overshoot that can be expected when a step input is given to the system.

5. The characteristic equation of a linear system is given by: $s\left(s^3+2s^2+s+1\right)+K\left(s^2+s+1\right)=0$. Apply Nyquist criterion to determine the values of K for system stability. Check the answers by means of Routh-Hurwitz criterion.

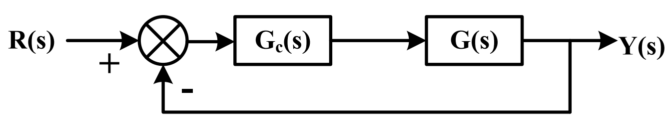
6. In the block diagram shown below, $G(s)=\dfrac{K}{(s+4)(s+5)}$.

   a. Apply Nyquist criterion to determine the range of K for stability.

   b. Check the answer obtained in part (a) with the Routh-Hurwitz criterion.



7. Consider the system shown in the figure below. Sketch the Nyquist plot of this system when $G_c(s) = 1$ and determine maximum value of K for stability. Further, if $G_c(s)$ is modified to $(1+1/s)$, what will be the maximum value of K for stability? Take $G(s)=\dfrac{K}{s(1+s)(1+4s)}$.



8. Sketch the Nyquist plot for a closed loop system having the open-loop transfer function $G(s)H(s)=\dfrac{2e^{-s\tau}}{s(1+s)(1+0.5s)}$. Determine the maximum value of τ for the system to be stable.