भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Indian Institute of Technology Hyderabad

Department of Electrical Engineering

EE2220 – Control Systems

Assignment 01 – (Frequency Response Analysis)

Submission Deadline: None

Key Learning from the Assignment:

- Polar Plot
- Bode Plot
- Gain margin and Phase margin

Instructions: RN = last two digits of your roll number.

Use Graph/semi-log paper for all plots/ sketches.

1. Sketch polar plot for the following
   a. $G(s)=\dfrac{1}{(1+s)(1+2s)}$
   b. $G(s)=\dfrac{1}{s^2(1+s)(1+2s)}$
   c. $G(s)=\dfrac{1}{s(1+s^2)}$
   d. $G(s)=\dfrac{(1+s/RN)(1+0.025s)}{s^3(1+0.005s)(1+0.001s)}$
   e. $G(s)=\dfrac{1}{(s+1)(s+2)(s+3)}$
   f. $G(s)=\dfrac{100(s+5)}{s(s+3)(s^2+4)}$
2. Sketch direct and inverse polar plots for a unity feedback system with open loop transfer function $G(s)=\dfrac{1}{s(s+1)^2}$. Also find the frequency at which $|G(j\omega)| = 1$ and corresponding phase angle $\angle G(j\omega)$.
3. Sketch the Bode magnitude and phase plots for the following systems. Also compute gain margin and phase margin for each of them.
   a. $G(s)=\dfrac{10}{s(1+0.5s)(1+0.01s)}$
   b. $G(s)=\dfrac{75(1+0.2s)}{s(s^2+16s+100)}$
   c. $G(s)=\dfrac{Ks^2}{(1+0.2s)(1+0.02s)}$; such that magnitude is 0db at RN rad/sec.
   d. $G(s)=\dfrac{(1+0.2s)(1+0.025s)}{s^3(1+0.005s)(1+0.001s)}$

e. $G(s)=\dfrac{50(s+3)(s+5)}{s(s+2)(s+4)(s+6)}$

f. $G(s)=\dfrac{K(s+2)(s+4)}{\left(s^2-3s+10\right)}$ and $H(s)=\dfrac{1}{s}$ for close loop (negative feedback) system. Consider K = 600, 100 and RN.

4. Draw error vs log ω for complex conjugate poles with ζ values equal to 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.6, 0.8, and 1. Also plot exact bode plot and asymptotic approximation for these values of ζ. Take $\omega_n = 1$. Use Matlab/ Scilab for answering this question. Submit a print of figures and the code you have written.
5. Obtain transfer function from the frequency response data given below.

Freq (rad/s)	Mag (db)	Freq (rad/s)	Mag (db)	Freq (rad/s)	Mag (db)	Freq (rad/s)	Mag (db)
0.1	34	1.0	8	4.0	-10	20	-17.5
0.2	28	1.5	1.5	5.0	-12.5	35	-17.5
0.3	24.6	2.0	-3.5	6.0	-14.7	50	-18
0.7	14.2	2.5	-7.2	9.0	-16.0	100	-18.5

6. Derive an expression for the closed loop bandwidth in terms of ζ and ω_n of a two-pole system.
7. Consider transfer functions of Q 3-e and Q 3-b are used in two different unity feedback (negative) systems. Estimate transient response of these systems from their respective bode plots.