SNS COLLEGE OF TECHNOLOGY

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Department of Biomedical Engineering

Course Name: Control Systems

III Year : V Semester

Unit III –Frequency Response

Topic : Bode Plot

Rules for Constructing Bode plot

- Represent the open loop transfer function in the standard time constant form.

- Substitute, s=jω in the above equation.

- Find the corner frequencies and arrange them in ascending order.

- Consider the starting frequency of the Bode plot as 1/10th of the minimum corner frequency or 0.1 rad/sec whichever is smaller value and draw the Bode plot upto 10 times maximum corner frequency.

- Draw the magnitude plots for each term and combine these plots properly.

- Draw the phase plots for each term and combine these plots properly.

From the Bode plots, we can say whether the control system is stable, marginally stable or unstable based on the values of these parameters.

- Gain cross over frequency and phase cross over frequency
- Gain margin and phase margin

Phase Cross over Frequency

- The frequency at which the phase plot is having the phase of -180º is known as phase cross over frequency. It is denoted by ω_{pc}. The unit of phase cross over frequency is rad/sec.

Gain Cross over Frequency

- The frequency at which the magnitude plot is having the magnitude of zero dB is known as gain cross over frequency. It is denoted by ω_{gc}. The unit of gain cross over frequency is rad/sec.

- The stability of the control system based on the relation between the phase cross over frequency and the gain cross over frequency is listed below.

- If the phase cross over frequency ω_{pc} is greater than the gain cross over frequency ω_{gc}, then the control system is stable.

- If the phase cross over frequency ω_{pc} is equal to the gain cross over frequency ω_{gc}, then the control system is marginally stable.

- If the phase cross over frequency ω_{pc} is less than the gain cross over frequency ω_{gc}, then the control system is unstable.

Gain Margin

- Gain margin GM is equal to negative of the magnitude in dB at phase cross over frequency.

- GM=20log(1/ Mpc)

- Where, Mpc is the magnitude at phase cross over frequency. The unit of gain margin (GM) is dB.

Phase Margin

- The formula for phase margin PM is

- PM=180°+ϕ_{gc}

- Where, ϕ_{gc} is the phase angle at gain cross over frequency. The unit of phase margin is degrees.

- If both the gain margin GM and the phase margin PM are positive, then the control system is stable.

- If both the gain margin GM and the phase margin PM are equal to zero, then the control system is marginally stable.

- If the gain margin GM and / or the phase margin PM are/is negative, then the control system is unstable.