



SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

Approved by AICTE & Affiliated to Anna University
Accredited by NBA & Accredited by NAAC with 'A+' Grade,
Recognized by UGC saravanampatti (post), Coimbatore-641035.



Department of Biomedical Engineering

Course Name: Biocontrol System

II Year : IV Semester

Unit III – Frequency Response Analysis

Topic : Bode Plot



Rules for Constructing Bode plot



- Represent the open loop transfer function in the standard time constant form.
- Substitute, $s=j\omega$ 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.



Stability Analysis using Bode Plots



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

Vision Tit 2

Vision Title 3

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



Stability Analysis using Bode Plots



Phase Cross over Frequency

- The frequency at which the phase plot is having the phase of -180° 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.



Stability Analysis using Bode Plots



- 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.



Stability Analysis using Bode Plots



Gain Margin

- Gain margin GM is equal to negative of the magnitude in dB at phase cross over frequency.
- $GM = 20 \log(1/M_{pc})$
- Where, M_{pc} is the magnitude at phase cross over frequency. The unit of gain margin (GM) is dB.

Vision Tit 2

Phase Margin

- The formula for phase margin PM is
- $PM = 180^\circ + \phi_{gc}$
- Where, ϕ_{gc} is the phase angle at gain cross over frequency. The unit of phase margin is degrees.



Stability Analysis using Bode Plots



- 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.

Vision Tit 2