SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

Accredited by NBA-AICTE and Accredited by NAAC – UGC with A++ Grade
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME: 19EEB301/ CONTROL SYSTEMS

III YEAR / V SEMESTER

Unit III – FREQUENCY RESPONSE

Topic : Bode Plot

Bode Plot

- A graph is called as Bode plot which is frequently used in control system engineering to assess a control system's stability.
- The Bode plot or the Bode diagram consists of two plots
  - Magnitude plot
  - Phase plot
- The magnitude of the open loop transfer function in dB is -

$$M=20\log|G(j\omega)H(j\omega)|$$

- The phase angle of the open loop transfer function in degrees is

$$\phi=\angle G(j\omega)H(j\omega)$$

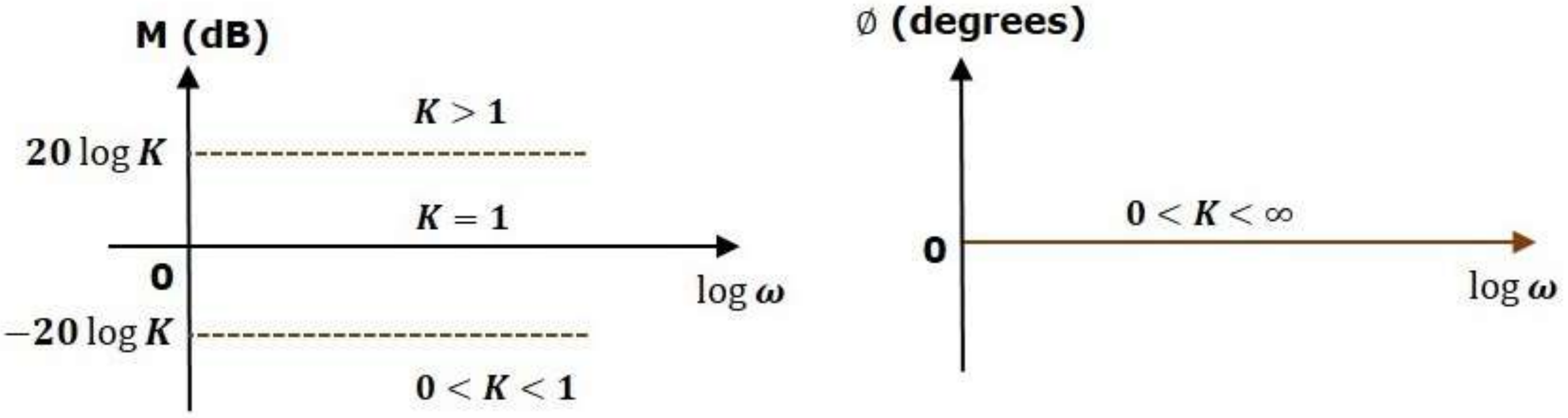
Rules for Construction of Bode Plots

- Represent the open loop transfer function in the standard time constant form.
- Substitute, s=jω in the given 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.

Type of term	G(jω)H(jω)	Slope(dB/dec)	Magnitude (dB)	Phase angle(degrees)
Constant	K	0	$20\log K$	0
Zero at origin	$j\omega$	20	$20\log\omega$	90
'n' zeros at origin	$(j\omega)^n$	$20\,n$	$20\,n\log\omega$	$90\,n$
Pole at origin	$\frac{1}{j\omega}$	-20	$-20\log\omega$	$-90\ or\ 270$
'n' poles at origin	$\frac{1}{(j\omega)^n}$	$-20\,n$	$-20\,n\log\omega$	$-90\,n\ or\ 270\,n$
Simple zero	$1+j\omega r$	20	$0\ for\ \omega < \frac{1}{r}$ $20\ \log\omega r\ \ for\ \omega > \frac{1}{r}$	$0\ for\ \omega < \frac{1}{r}$ $90\ for\ \omega > \frac{1}{r}$
Simple pole	$\frac{1}{1+j\omega r}$	-20	$0\ for\ \omega < \frac{1}{r}$ $-20\ \log\omega r\ \ for\ \omega > \frac{1}{r}$	$0\ for\ \omega < \frac{1}{r}$ $-90\ or\ 270\ for\ \omega > \frac{1}{r}$

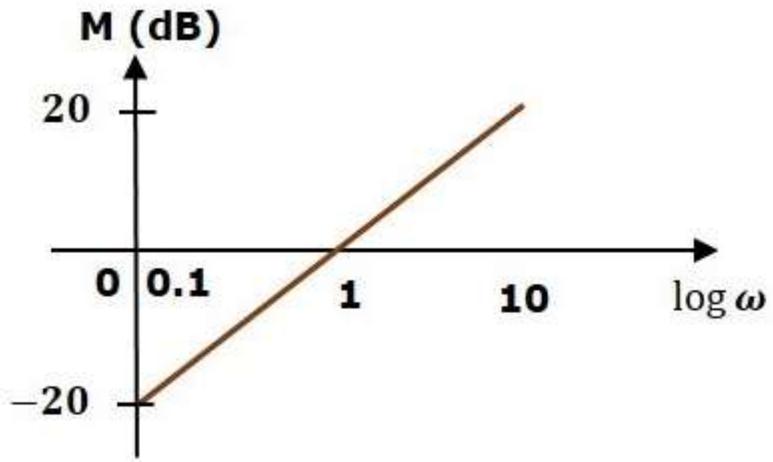
Bode Plot

- Consider the open loop transfer function G(s)H(s)=K
- Magnitude M=20logK
- Phase angle ϕ=0 degrees
- If K=1, then magnitude is 0 dB.
- If K>1, then magnitude will be positive.
- If K<1, then magnitude will be negative.
- The following figure shows the corresponding Bode plot.



Bode Plot

- Consider the open loop transfer function G(s)H(s)=s
- Magnitude M=20logω dB
- Phase angle ϕ=90°
- At ω=0.1ω=0.1 rad/sec, the magnitude is -20 dB.
- At ω=1ω=1 rad/sec, the magnitude is 0 dB.
- At ω=10ω=10 rad/sec, the magnitude is 20 dB.
- The following figure shows the corresponding Bode plot.



Thank You