MENG366 SYSTEM DYNAMICS AND CONTROL LABORATORY
LABORATORY 10: FREQUENCY RESPONSE ANALYSIS USING BODE PLOT

1. OBJECTIVE

To analyze the stability of the given linear system using Bode plot .

2. COMPONENTS & EQUIPMENT

PC with MATLAB and Simulink toolbox installed.

3. BACKGROUND

The bode plot is a frequency response plot of the transfer function of a system. A bode plot consists of two graphs. One is plot of the magnitude of a sinusoidal transfer function versus log ω . The other is plot of the phase angle of a sinusoidal transfer function versus logω .The main advantage of the bode plot is that multiplication of magnitude can be converted into addition. Also, a simple method for sketching an approximate log magnitude curve is available.

4. DESIGN PROCEDURE/ DESIGN CALCULATIONS:

The open loop transfer function of a unity feedback system:

$$G(s)=K/s(s^2+2s+3)$$

a) Draw the asymptotic Bode Plot to find:
   - (i) Gain Margin.
   - (ii) Phase Margin.
   - (iii) Gain cross over frequency.
   - (iv) Phase cross over frequency.
   - (v) Resonant Peak.
   - (vi) Resonant Frequency.
   - (vii) Bandwidth and check the same results using MATLAB Software. (Assume K=1)

b) Use MATLAB and SIMULINK to find:
   (viii) Gain Margin.
   (ix) Phase Margin.
   (x) Gain cross over frequency.
   (xi) Phase cross over frequency.
   (xii) Resonant Peak.
   (xiii) Resonant Frequency.
   (xiv) Bandwidth and check the same results using MATLAB Software. (Assume K=1)

MATLAB Program:

%Draw the Bode Plot for the given transfer functionG(S)=1/S(S2+2S+3) %Find (i)Gain Margin (ii) Phase Margin (iii) Gain Cross over Frequency %(iv) Phase Cross over Frequency (v)Resonant Peak (vi)Resonant %Frequency (vii)Bandwidth

```
num=[1 ];
den=[1 2 3 0]; w=logspace(-1,3,100);
figure(1);
bode(num,den,w);
title('Bode Plot for the given transfer function G(s)=1/s(s^2+2s+3)') grid;
[Gm Pm Wcg Wcp] =margin(num,den);
Gain_ Margin_dB=20*log10(Gm)
Phase_Margin=Pm
Gaincrossover_Frequency=Wcp
Phasecrossover_Frequency=Wcg
[M P w]=bode(num,den);
[Mp i]=max(M);
Resonant_PeakdB=20*log10(Mp)
Wp=w(i);
Resonant_Frequency=Wp    for
i=1:1:length(M);
if M(i)<=1/(sqrt(2));
 Bandwidth=w(i)
break; end;
end;
```

Prelab questions:

- Define frequency response analysis.

- What is the Gain margin and phase margin?

Postlab questions:

- What are the advantages and disadvantages of Bode plot?

- How can you analyze the stability of the system with Bode plot?