XMUT315 Control Systems Engineering

Tutorial 6: Analysis with Bode Plots

1. You are given the following control systems as follows.

   i. System (i)

$$G_1(s) = \frac{1}{s+2}$$

   ii. System (ii)

$$G_2(s) = \frac{K(s+3)}{s(s+1)(s+2)}$$

   iii. System (iii)

$$G_3(s) = \frac{s+3}{(s+2)(s^2+2s+25)}$$

   a. Find the analytical expression and plots for the gain and phase of the frequency response of the systems above. [20 marks]

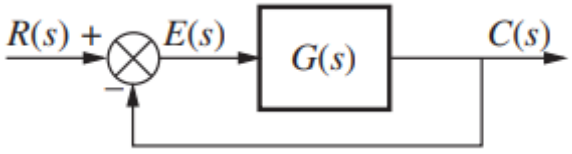
   b. Describe each system in terms of its frequency response, transient characteristics, stability and steady-state behaviours. [20 marks]

2. Let the transfer function equation of a plant given as follow for a unity feedback system shown in the figure below.

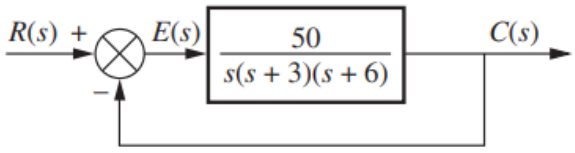
$$G(s) = \frac{K}{(s+2)(s+4)(s+5)}$$

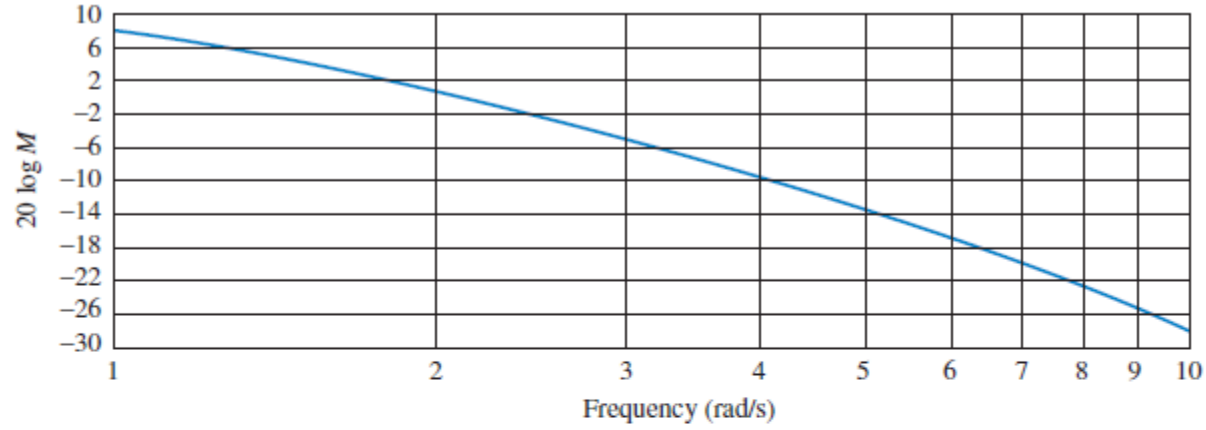
   a. Use Bode plots to determine the range of K within which the system is stable. [16 marks]

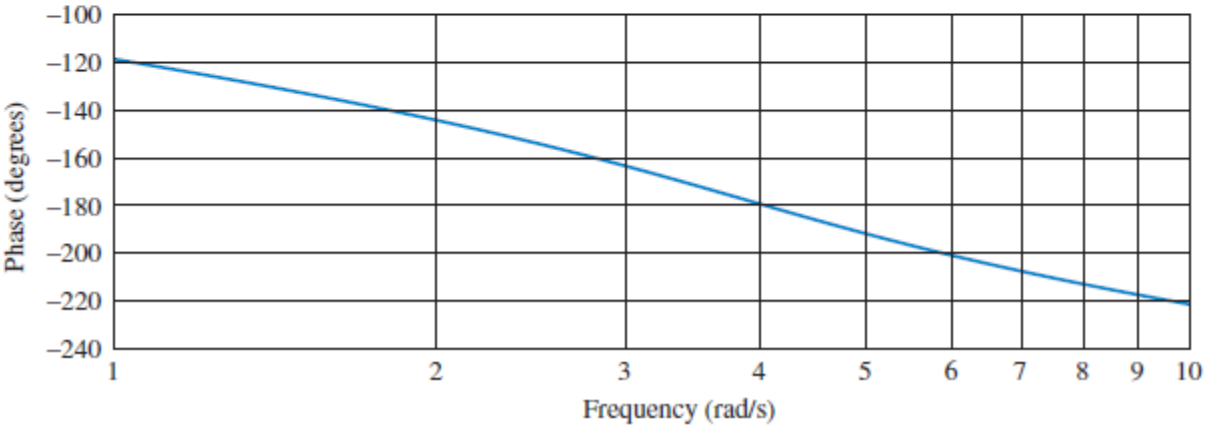
   b. If K = 200, find the gain margin and the phase margin. [12 marks]



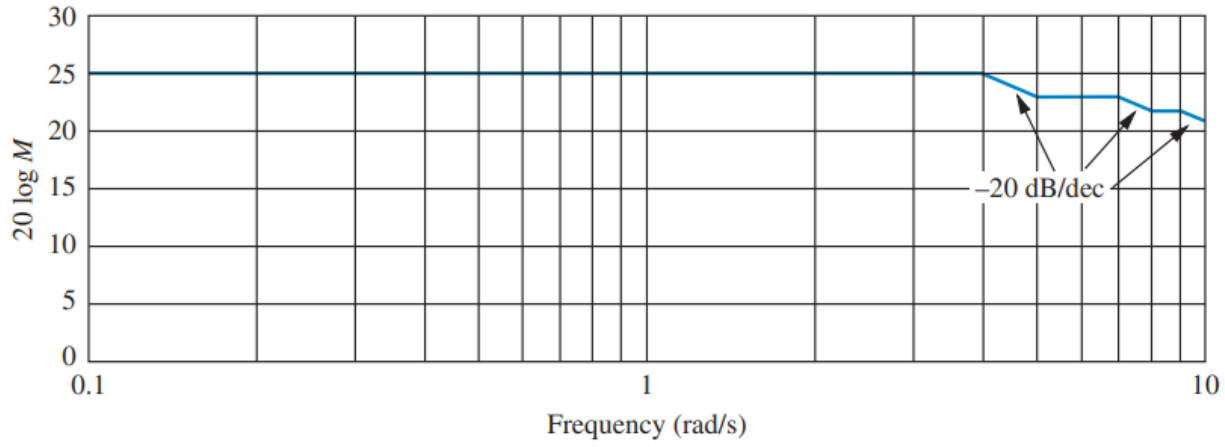
3. Given the block diagram of a unity gain feedback closed loop control system and the Bode plots of the system as shown below, estimate the settling time and peak time. [8 marks]



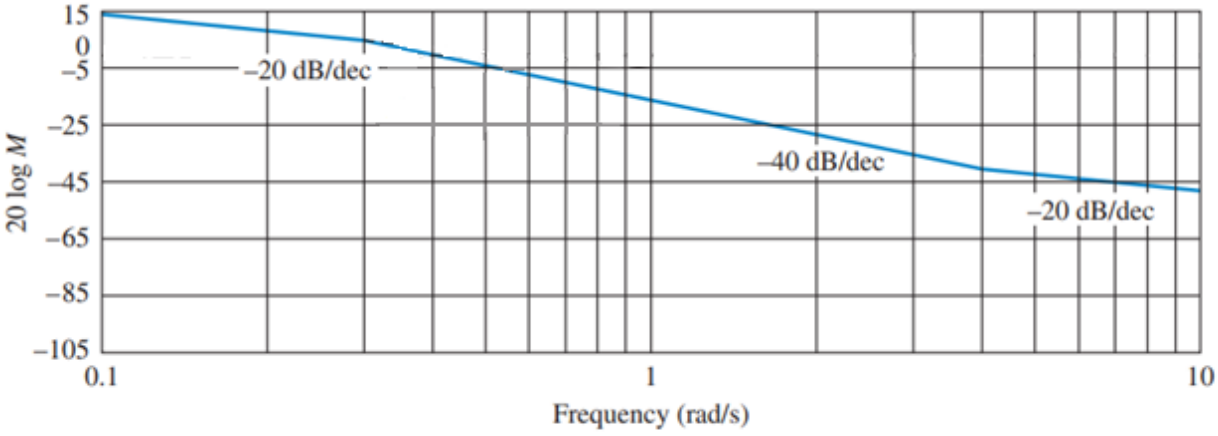




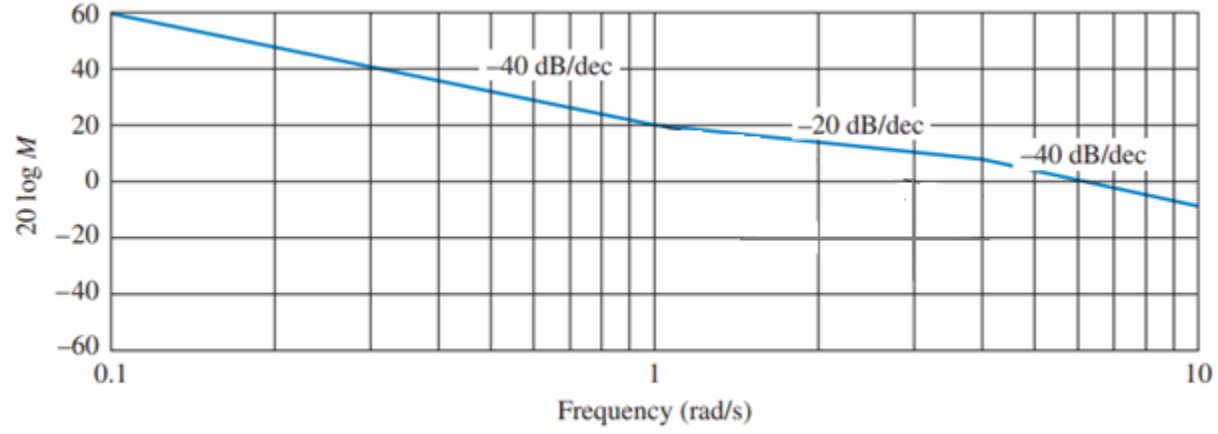
4. Referring to each un-normalized and unscaled Bode log-gain plot of three control systems as shown in the figures below, find the system types and the value of the appropriate static error constants. [12 marks]


30
25
20
15
10
5
0
20 log M
–20 dB/dec
0.1
1
10
Frequency (rad/s)

(*a*)


15
0
–5
–25
–45
–65
–85
–105
20 log M
–20 dB/dec
–40 dB/dec
–20 dB/dec
0.1
1
10
Frequency (rad/s)

(*b*)


60
40
20
0
–20
–40
–60
20 log M
–40 dB/dec
–20 dB/dec
–40 dB/dec
0.1
1
10
Frequency (rad/s)

(*c*)