FSBE III (Electrical)
MATLAB-based Lab **assignment-3** for Control System Engineering

Prob. 1:

Consider a system $G_1(s) = 4 / (s^2 + 1.6s + 4)$ with another subsystem $G_2(s)$ in cascade with it. Using MATLAB generate the Bode plots and obtain the stability margins for the overall system and compare them with that of $G_1(s)$ in each case when $G_2(s)$ is:

i. A pure integrator - $G_2(s) = 1/s$
ii. A real pole - $G_2(s) = 10/(2s+1)$
iii. A real zero - $G_2(s) = (2s+1)$

Comment on the results. Obtain the Bode plots for G_1 and G_1G_2 on the same figure for each G_1G_2 combination.

Prob. 2:

Consider a unity-feedback system with open-loop transfer function ***G(s) = K/s(10s+1)***. Use ***rltool*** to find the value of gain K for the system to have a phase margin of greater than 40 degrees.

Prob. 3:

A PI controller $\boldsymbol{G_c(s) = K\,(1+0.1/s)}$ is used to control the system ***G(s) = (s+5) / s(10s+1)***
Use ***rltool*** to find a value for K to give a closed-loop damping ratio of 0.5.

Prob. 4:

Consider the second-order system $\boldsymbol{G(s) = 1/(s^2+2\zeta s+1)}$. Write an M-file to plot the gain response of G(s) for ζ = 0.2, 0.4, 0.6, 0.8, 1.0 and 2.0 on the same figure window. Use your plots to state a trend between the maximum of the gain response and the damping ratio.

Prob. 5:

Using the ***Nichols***, ***ngrid('new')*** and ***logspace*** functions, obtain the Nichols chart with a grid for the following transfer functions, where 0.1 ≤ω ≤ 10:

a) $G(s) = 1 / (s+0.1)$
b) $G(s) = 1 / (s^2+2s+1)$
c) $G(s) = 24 / (s^3+9s^2+26s+24)$

Determine the approximate phase and gain margins from the Nichols charts and label the charts accordingly.

Prob. 6:

Control system for a paper making machine is a unity-feedback system having a controller **$G_c(s)$=K (s+50) / (s+20)** in cascade with the machine having the transfer function

G(s) =1/ s(s+10).

Using MATLAB, obtain a plot of the bandawidth of the closed-loop system as K varies in the interval $1 \le K \le 50$.

Prob. 7:

For a unity-feedback control system having loop transfer function

G(s)H(s) = 10 / s(1+0.2s)(1+0.02s)

Using MATLAB, obtain the Nyquist plot with a selection of appropriate frequency range from the Bode plot. Determine GCF, PCF, GM and ΦM from both the plots.

Prob. 8:

For a unity-feedback control system having loop transfer function

G(s)H(s) = K / s(1+s)(s+5)

Determine the stability using Bode and root locus plots using MATLAB for (i) K =10, (ii) K = 100.

Prob. 9:

Use MATLAB to generate the Bode and root locus plots to determine the range of values of ***K*** for which a unity-feedback system having the following open-loop transfer functions would remain stable:

a) *G(s) = K / (s+2) (s+4) (s+5)*
b) *G(s) = K / (1+0.2s) (1+0.02s)*

Prob. 10:

For a feedback control system having loop transfer function ***G(s)H(s) = 199 / s(s+1.71)(s+100)*** use MATLAB to obtain gain crossover frequency, phase margin, peak overshoot and settling time.

Prob. 11:

Using MATLAB for a negative feedback control system having loop transfer function

G(s)H(s) =4/s(s+1)(s+2)

a) Obtain Bode plot and find the gain crossover frequency and the phase margin.

b) How should the gain be adjusted to obtain a ΦM of 50^{o}?
c) Using second-order correlations between time and frequency domain measures estimate the peak overshoot and settling time of the step response.
d) Determine the ***bandwidth*** of the gain-compensated system.

Prob. 12:

Using MATLAB for a unity-feedback control system having open-loop transfer function

$$G(s) = 5 / s(1+s)(s^2+2s+5)$$

a) Obtain Bode plot and evaluate GCF, PCF, GM and ΦM from it.
b) Determine the open-loop gain to obtain gain margin of 10 dB.
c) Determine the open-loop gain so that the gain crossover frequency becomes 1.27 rad/sec.
d) Determine the open-loop gain to obtain phase margin of 45 degrees.

Prob. 13:

Using MATLAB for a unity-feedback control system having open-loop transfer function

$$G(s) = K / s(10+s)(s+2)$$

Determine the value of ***K*** such that the system remains stable with (i) $\Phi M \geq 45$ degrees and (ii) GCF as large as possible.