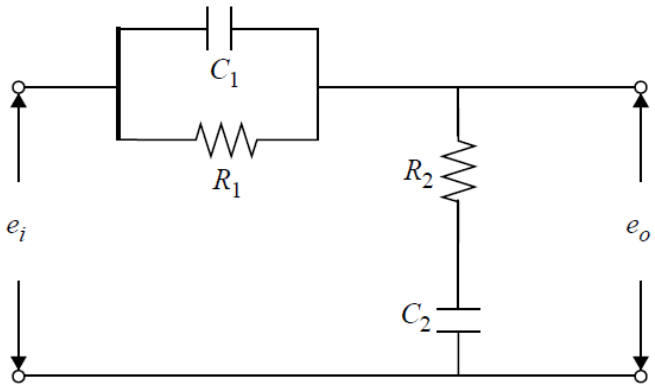
XMUT315 Control Systems Engineering

Assignment 3: Compensators, Controllers, and Analysis with Bode Plots

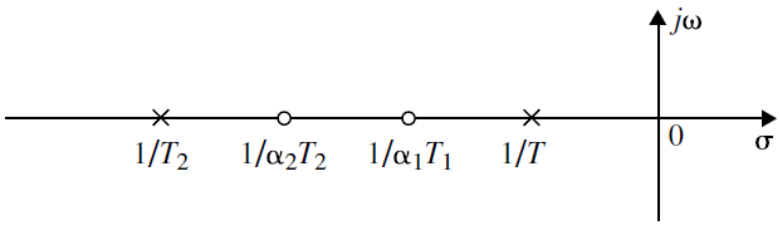
Due Date: Monday, 15th June 2026 (online submission to XMUT315 wiki website at VUW)

A. Controllers and Compensators

1. The Figure 1 below shows the electric network and the poles and zeros in the s-plane diagram of a lag-lead compensator. Derive the transfer function equation for the compensator in terms of the values of the components in its electric network. [15 marks]



a. Electric network of a lag-lead compensator.



b. The pole and zeros in the s-plane diagram of a lag-lead compensator.

B. Analysis of Compensator and Controller

2. The block diagram shown in Figure 2 below illustrates a mechanical control system that consists of a mass and a damper. The given system has an implementation of a proportional controller (k) in the minor (inside) feedback loop.

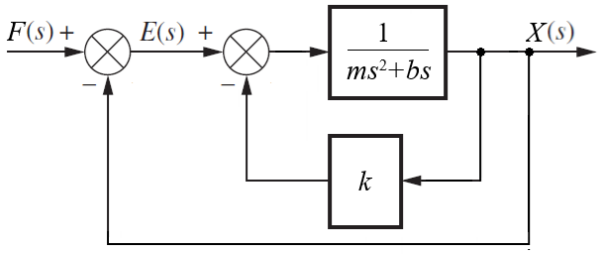


Figure 1: Block diagram of the mechanical control system

For the given system, perform the following tasks:

a. Evaluate the steady-state performance of the system. [10 marks]

b. For the transient response analysis, suggest the setup of the system, so its settling time (2% standard) is less than 1 second and its damping ratio $\zeta > 0.5$. [10 marks]

C. Frequency Response Analysis

3. Given below is an open-loop transfer function equation of a control system.

$$G(s) = \frac{(s+3)}{(s+0.1)(s^2+25)(s^2+2s+50)}$$

a. Sketch the Bode magnitude and phase plots of the system. [10 marks]

b. Determine the gain and phase margins of the system. [10 marks]

4. You are given the following open-loop control systems:

i. System 1: $G_1(s) = \frac{1}{s(s+2)(s+4)}$

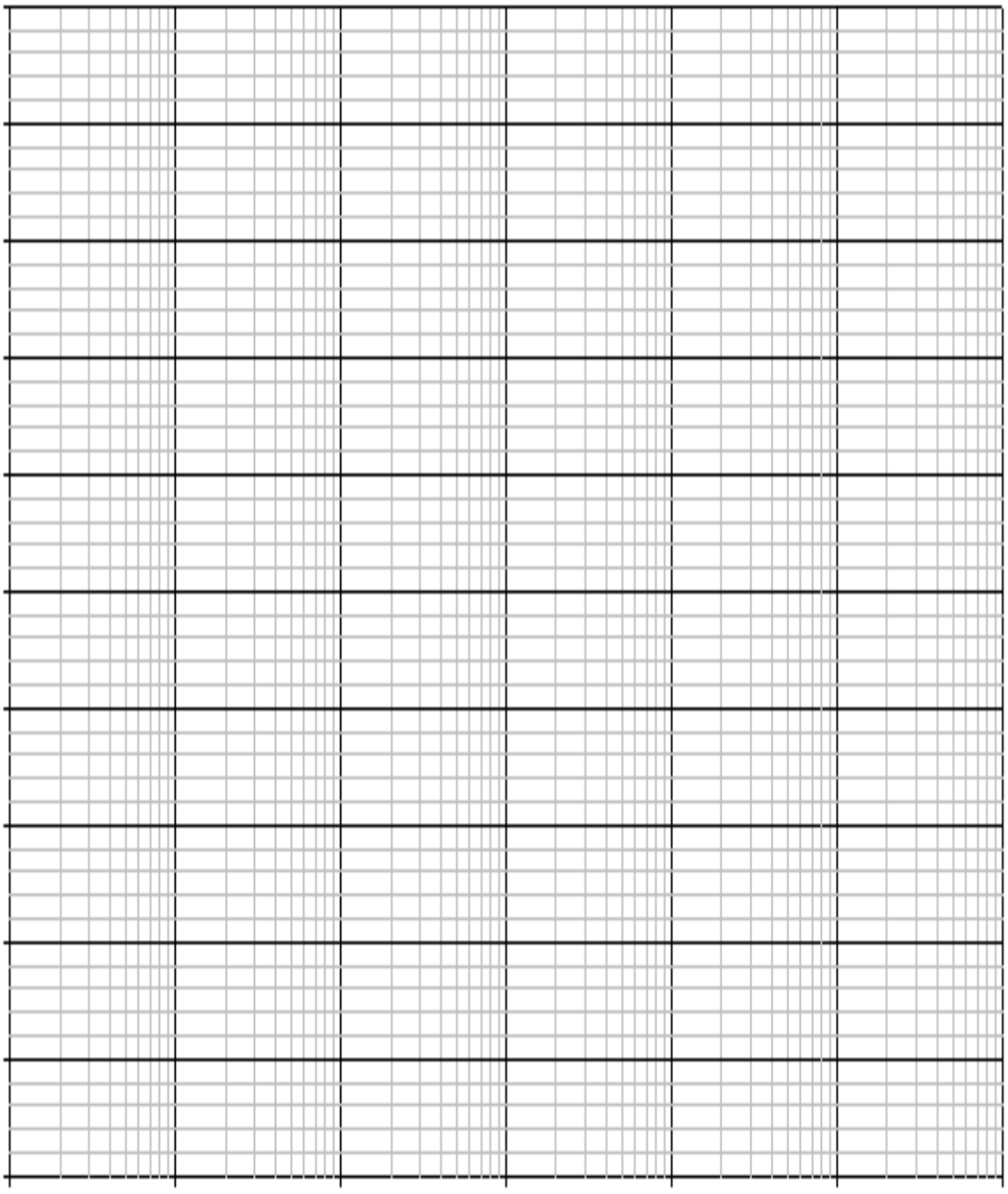
ii. System 2: $G_2(s) = \frac{(s+5)}{(s+2)(s+4)}$

iii. System 3: $G_3(s) = \frac{(s+3)(s+5)}{s(s+2)(s+4)}$

a. For each system, sketch the Bode magnitude and phase plots. [30 marks]

b. Using the sketches in part (a), describe the frequency response, stability, and steady-state characteristics of each system. [15 marks]

Appendix - Log-log Graph Worksheet



Marking Schedule

Student ID : _____

Student Name : _____

No	Description	Mark	Your Mark	Remarks
A	**Controller and Compensators**			
1	Derivation of the transfer function equation of the lag-lead compensator in the terms of values of components of the electric network.	15		
B	**Analysis of Controllers and Compensators**			
2a	Steady-state analysis of the system with proportional controller.	10		
2b	Transient response analysis of the system with proportional controller.	10		
C	**Bode Plot Analysis**			
3a	Sketch of the Bode plots (magnitude and phase) of the given system.	10		
3b	Gain and phase margins of the system.	10		
4a	Sketch of Bode plots (magnitude and phase) for systems.	30		
4b	Comparison of frequency response, stability and steady-state characteristics of the systems.	15		
	Total	100		

Comment: