Sections (A) and (B) of this question are independent of one another.

(A) [40 - 10 points each] The transfer function of a systems is given as follows:

\[ G = \frac{-2s + 4}{s^2 + 0.5s + 4} \]

i) Figure 1 depicts the Bode plots of several systems. Circle the Bode plot that corresponds to this system? Your selection must be backed up by appropriate calculations.

ii) Figure 2 depicts the Polar plots of several systems. Circle the Polar plot that corresponds to this system? Your selection must be backed up by appropriate calculations.

iii) The solid lines in Figure 3 describe the steady state response of various systems to sinusoidal inputs, which are shown as dashed lines. Circle the steady state response that corresponds to this system? Your selection must be backed up by appropriate calculations.

iv) Which of the responses depicted in Figure 4 best corresponds to a unit step input for \( G = \frac{1}{s^2 + 0.2s + 1} \)? Your selection must be backed up by appropriate calculations.

Figure 1: Bode Plots
Figure 2: Polar Plots

Figure 3: Steady state responses to a sine wave
Figure 4: Step responses
(B) [60 points] The Bode plot of a stable system $G(s)$ is given in Figure 5. The system is controlled in closed loop as shown in Figure 6.

![Bode plot of a stable system $G(s)$](Image)

**Figure 5:** Bode plot of a stable system $G(s)$

![Closed loop system](Image)

**Figure 6:** Closed loop system

[15 points each] Assume that the controller $G_c(s)$ is proportional: $G_c(s) = K$

1. Find the gain and phase margins of the system $G(s)$. Show clearly your result graphically.
2. In Figure 7, the pole-zero configurations of two systems are given. Which one of the pole-zero configurations corresponds to the given system $G(s)$? Explain!
3. Sketch the Root Locus for the pole-zero configuration you have selected.
4. For $K=2$, calculate the closed-loop steady-state response $Y_{ss}$ when the following $r(t)$ and $d(t)$ are applied simultaneously: $r(t) = 0.5 \cdot 1(t - 4)$, $d(t) = \sin(0.06t)$

![Pole-zero configurations of two systems](Image)

**Figure 7:** Pole-zero configurations of two systems