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By filling out the names above, the group members acknowledge that a) they have jointly authored this submission, b) this work represents their original work, c) that they have not been provided with nor examined another person's assignment, either electronically or in hard copy, and d) that this work has not been previously submitted for academic credit.			

LAB 5. LEAD AND LAG COMPENSATOR DESIGN

Always include this page at the beginning of your prelab and postlab submission.

Select your lab session:		☐ morning lab; ☒ afternoon lab; ☒ Tue; ☐ Wed; ☐ Thu
Assigned plant number:		GroupNumber - rounddown(GroupNumber/52.5, 0) * 52 45
Plant parameters found on LEARN in the Lab5 folder:	a	1.5
	b	8
	T	100
	K_i	40
Design specification 1: compensated phase-margin (±3°)		44
Design specification 2: closed-loop step-tracking e_{ss}		20%

	Calculated	Experimental	Error
Natural Frequency	178.89	-	-
Time to First Peak	0.019	0.019	0
Overshoot	23	18	21

Table 1: Verification data for P(s)

Figure 1: Plant verification response

1 Question 1

We did not have to revise our prelab values.

$$\mathrm{C(S)} = 4\frac{\frac{s}{27.48}+1}{\frac{s}{12.82}+1}$$

These values (with small rounding errors) produced the below images.

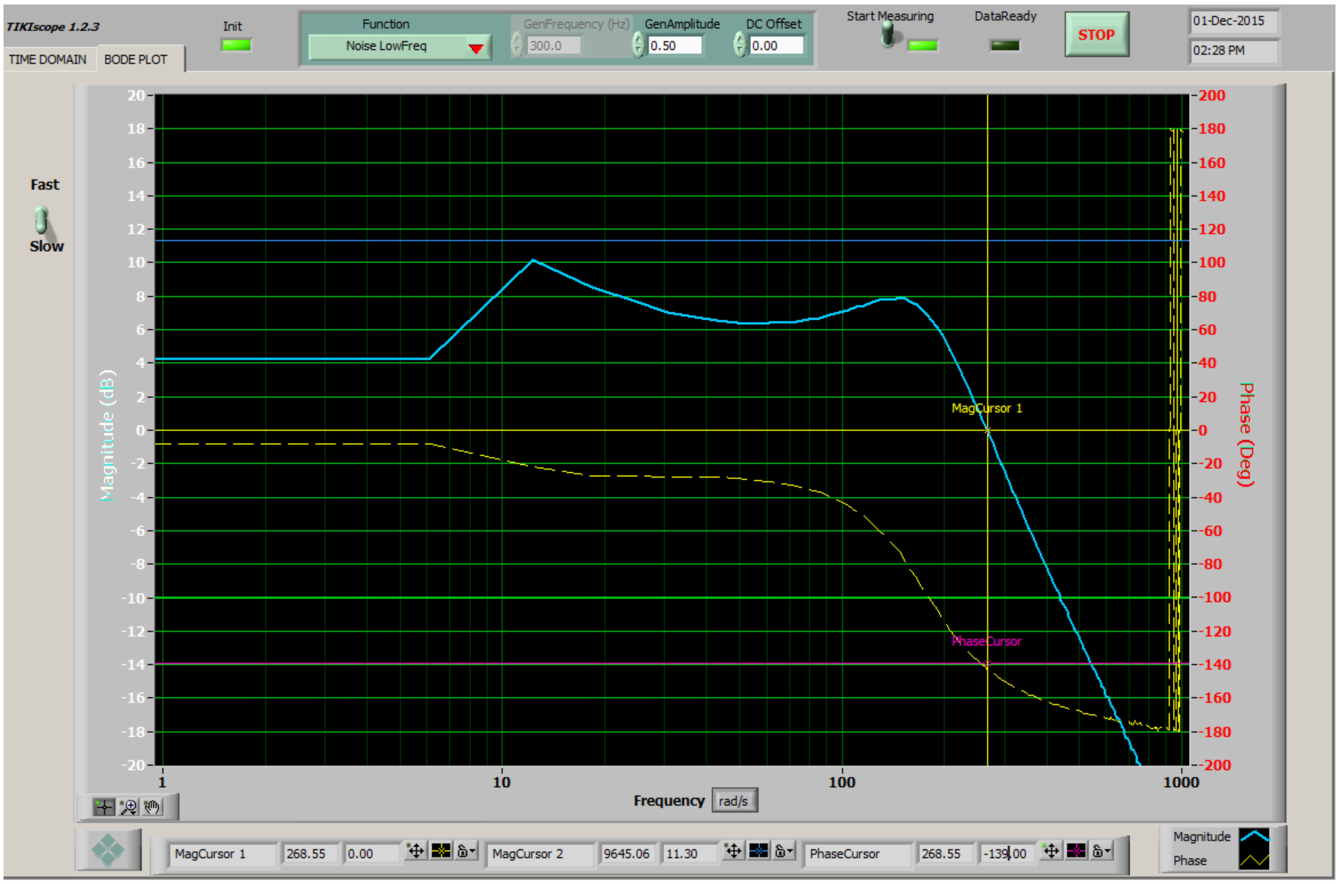

Figure 2: Lag Bode Plot

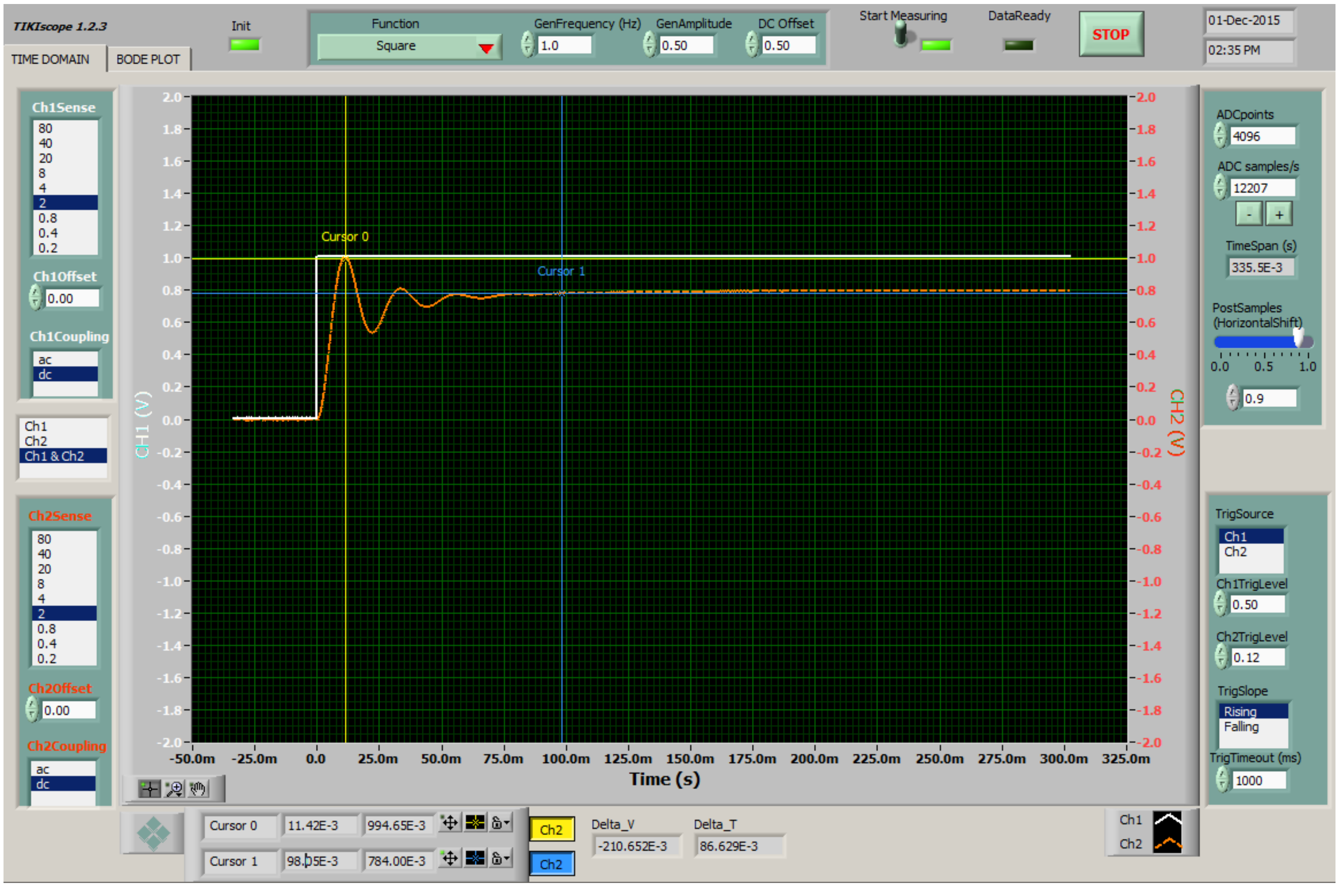

Figure 3: Lag Step Response

2 Question 2

We did not have to revise our prelab values.

$$\mathrm{C(S)} = 4\frac{\frac{s}{252.3}+1}{\frac{s}{602.41}+1}$$

These values (with small rounding errors) produced the below images.

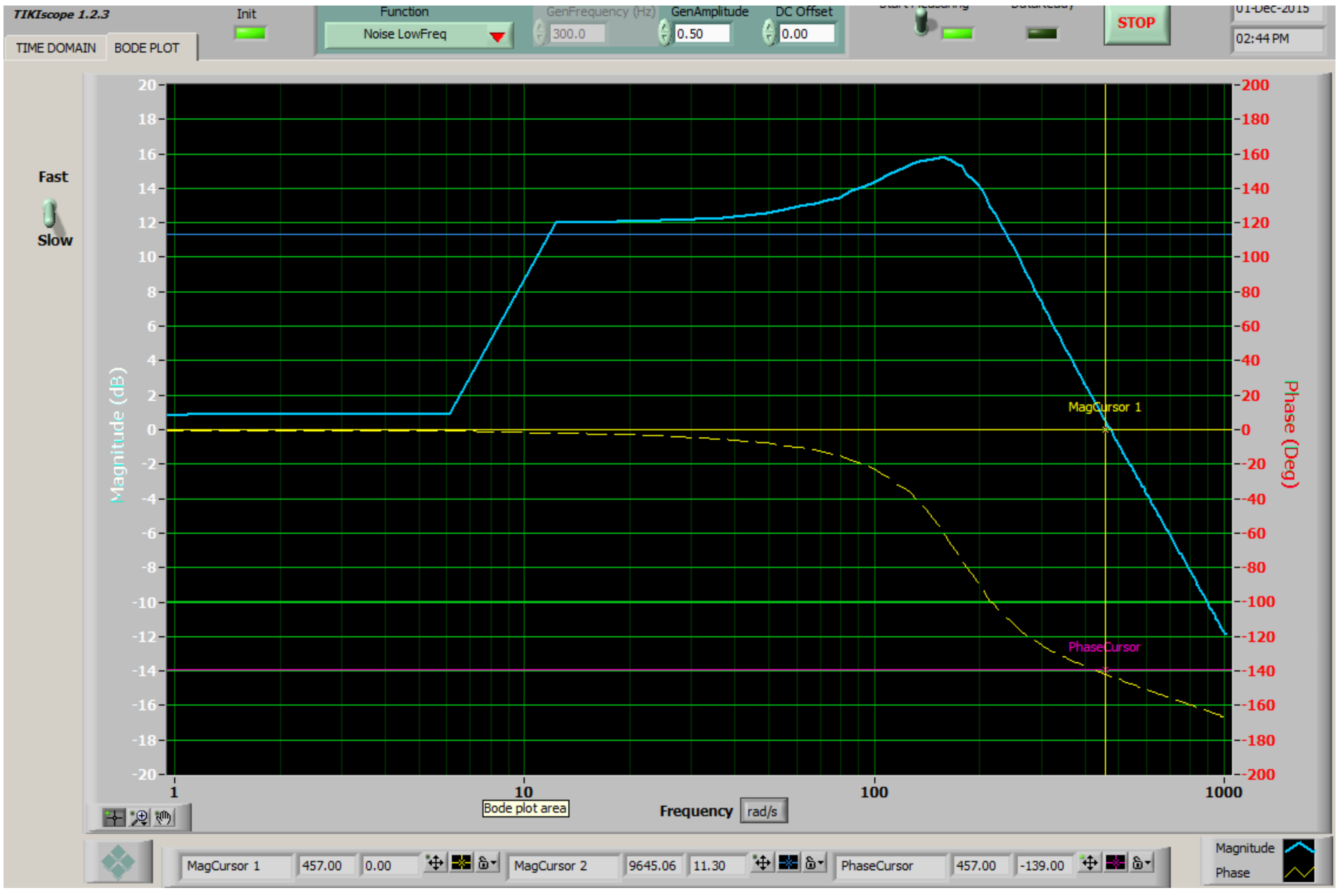

Figure 4: Lead Bode Plot

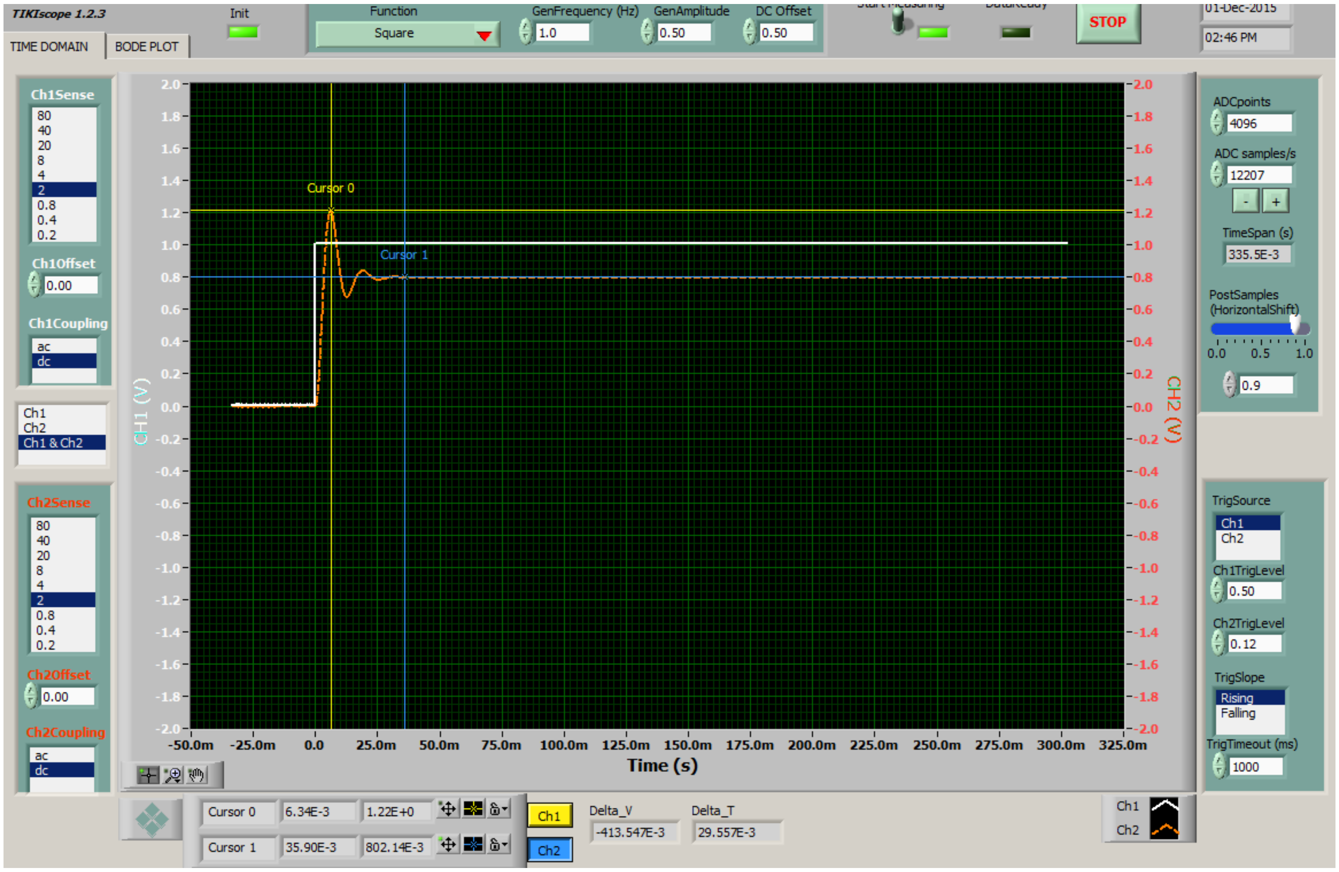

Figure 5: Lead Step Response

3 Question 3

	Lag	Lead
Height of First Peak	0.995	1.22
Time to First Peak	0.011	0.006
Overshoot	21	52
Settling time	0.098	0.035
Steady State Error	21	20
Low Frequency Gain	4	0.8

Table 2: Data for trends

This table shows that the lag compensator is much slower (resulting in a larger settling time) than the lead compensator but has lower overshoot (resulting in a lower height of first peak). Both compensators achieved the correct steady state error and phase margins (within small error windows).

4 Question 4

The lag compensator improves the steady state error without making the system become unstable because it does not effect the overshoot (the overshoot for the lag compensated system is almost the same as the overshoot for the uncompensated system).

5 Question 5

5.1 a)

The phase margin when designing the lag compensated system is increased by five degrees to account for lag compensators not being ideal. As can be seen in the above image the dip in the phase of the lag compensator now lines up with how we want to shift the cross over frequency of the uncompensated system to shift to fit the desired phase margin.

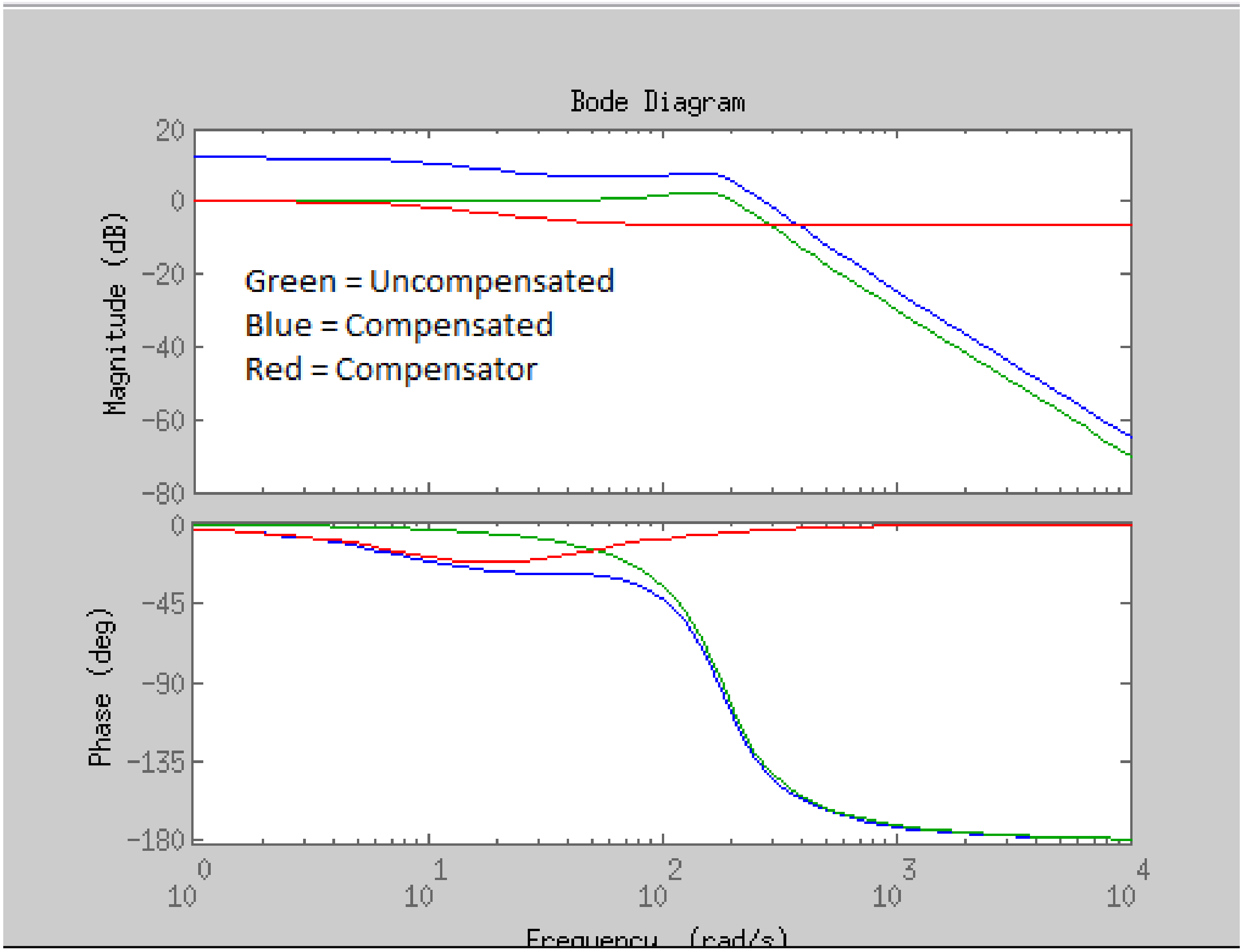

Figure 6: Lag System Overlays

5.2 b)

The phase margin when designing the lag compensated system is increased by five degrees to account for lead compensators not being ideal. The above image shows the crest of the phase of the lead compensator lining up with how we want to

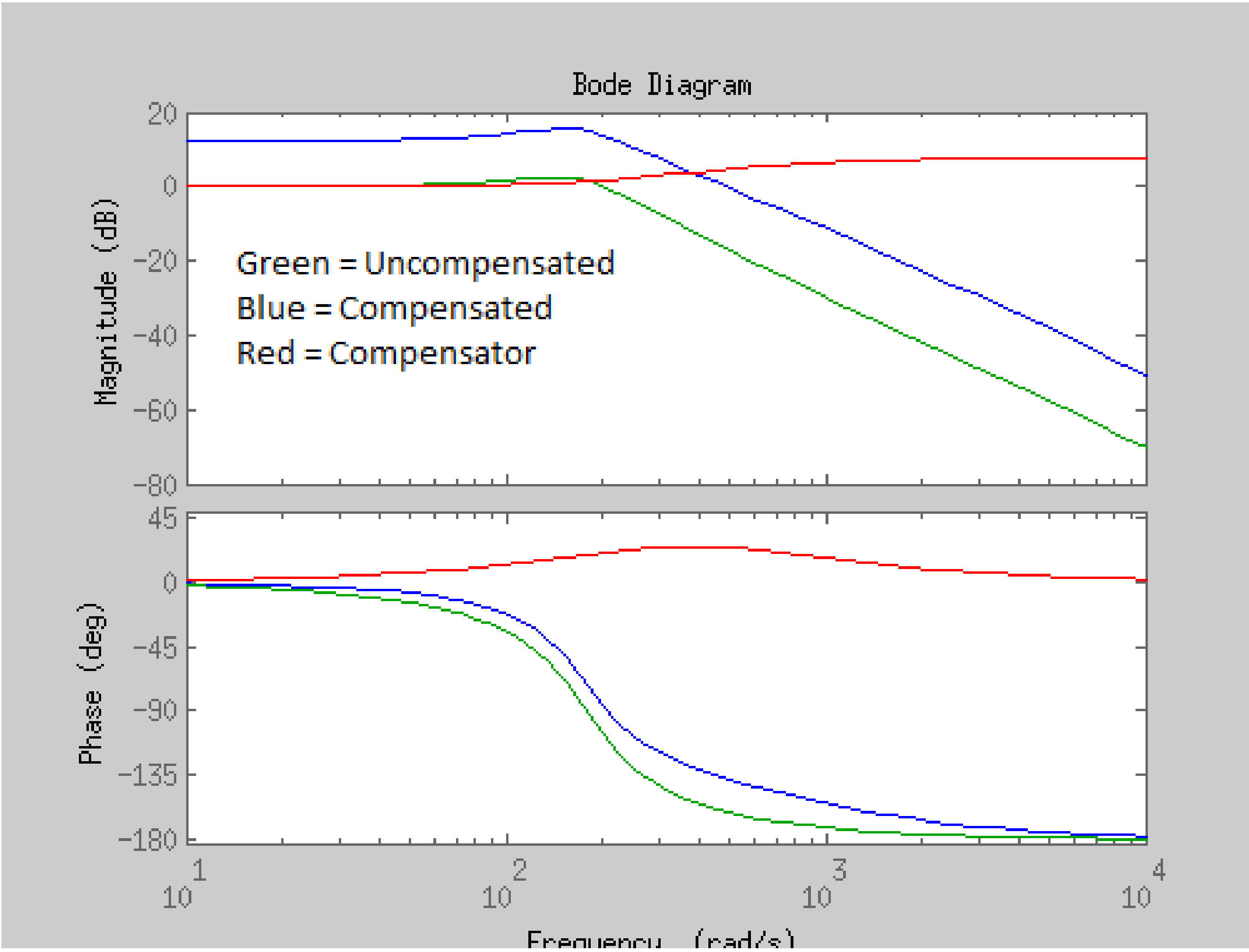

Figure 7: Lead System Overlays

shift the phase of the uncompensated system to match the desired phase margin.

6 Question 6

The lead compensator speeds up the response of a system as seen by its decreased settling time and time to first peak.