Midterm (2)

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(Due date: Sunday May 15th at 10:00 pm)

Question 1 [2 Marks]

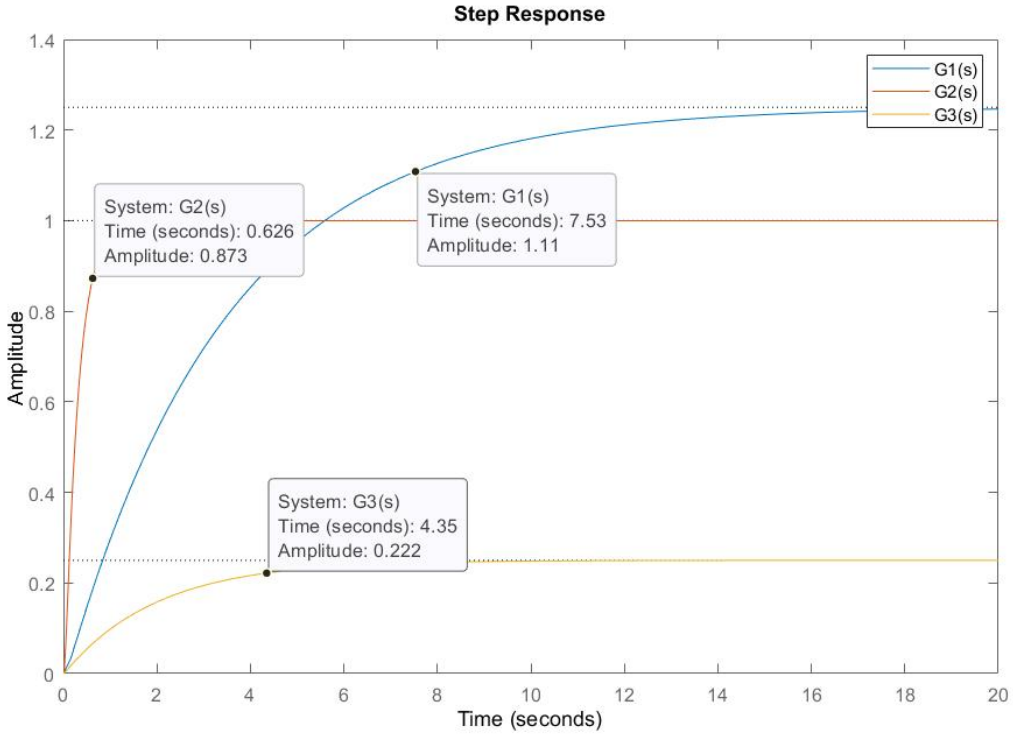
Plot the step response of the three transfer functions below on ONE figure.

1- Add a Legend on the figure.
2- Show the rising time value of each response on the figure.

$$G1(s) = \frac{50}{10\,s^2 + 140\,s + 40} \quad ; \quad G2(s) = \frac{80}{s^2 + 26\,s + 80} \quad ; \quad G3(s) = \frac{10}{s^2 + 80\,s + 40}$$

- Your answer must include the following:

1- Add screenshot of the figure.



Question 2 [3 Marks]

Design a PID controller using PID tuner app to meet the following requirements of the plant below:

1-Rise time less that 0.5
2- Overshoot % below: 8%

$$Q2 = \frac{0.1s + 1}{s^3 + 9s^2 + 7s + 1}$$

1- Complete the table below.
2- Provide a screenshot(s) of your design showing (Step response, Show parameter windows).

	Uncompensated	**Compensated**
Kp	0	33.8
Ki	0	9.4
Kd	0	30.3

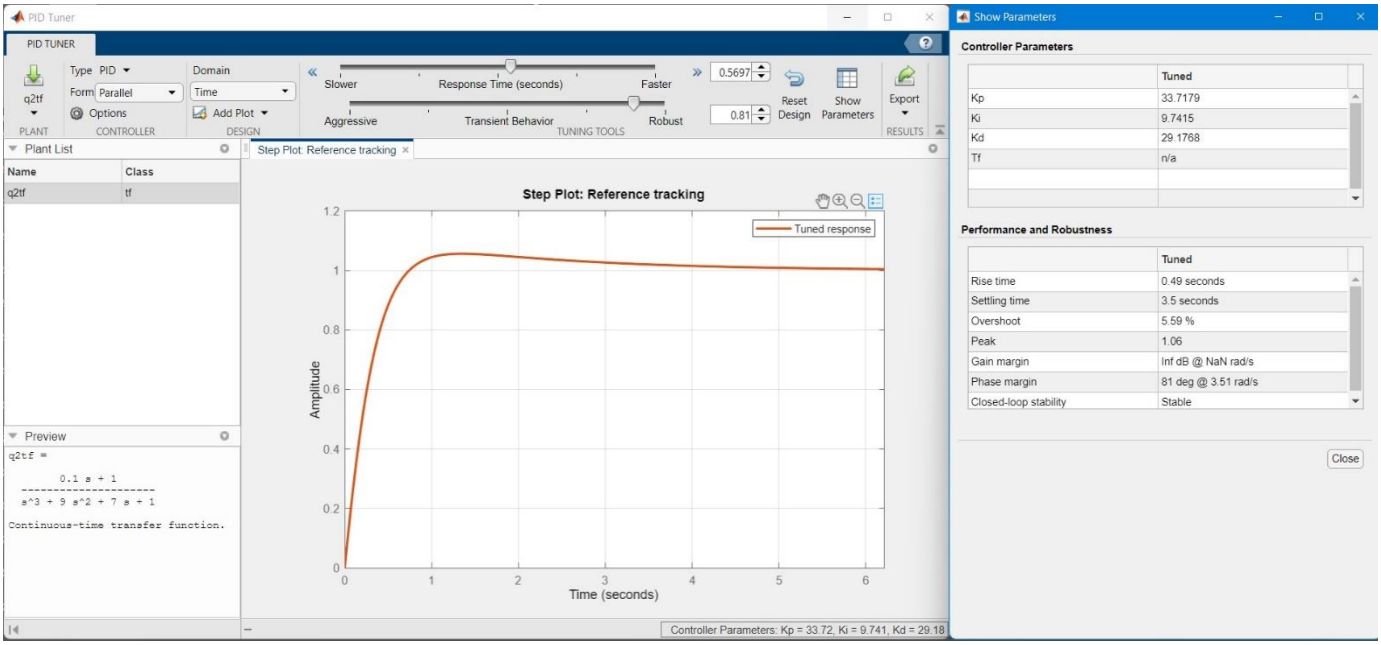


Figure 1 - Question 2. Compensated response

Question 3 [Marks 5]

Feedback Design via Root Locus

Design a compensator via **Root Locus** on the **Control System Designer** app to meet the following design requirements for the plant below.

$$Q3(s) = \frac{5(s+2)}{s\,(s+1)(s+5)}$$

Design requirements:

- Rise time of **less than 0.5** second
- Overshoot of **less than 2%**

➢ Your answer MUST include the following:

1- Complete the table below.
2- Provide a screenshot(s) of your design showing (Root locus, step response, transfer function, and compensator).
3- Save your design and send the (.mat) file.

	Uncompensated	**Compensated**
Rise time	0.942 s	5.21 s
Overshoot %	14%	0%
Damping ratio	0.588	0.98
Natural frequency	1.55 rad/s	1.42 rad/s

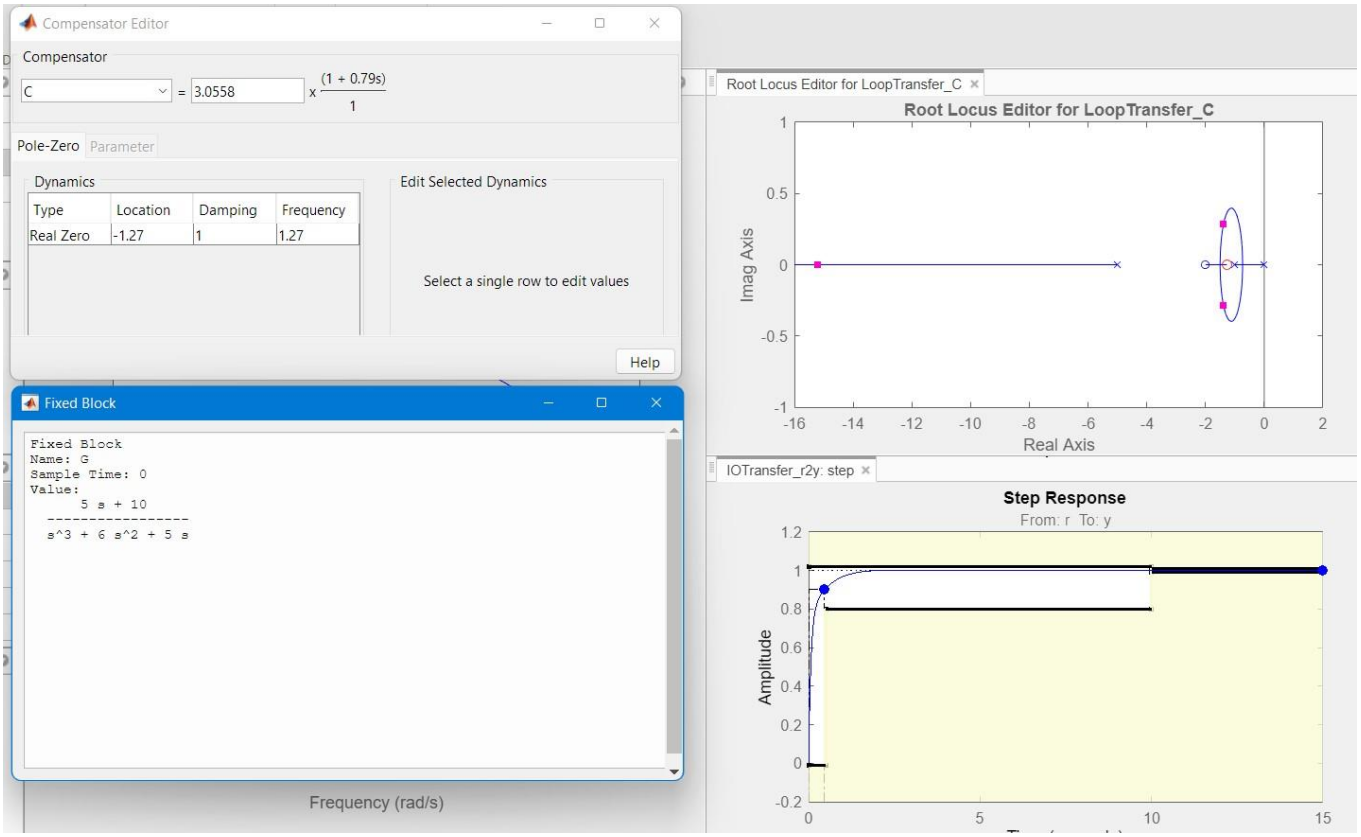


Figure 2 - Question 3. Compensated response

Question 4 [5 marks]

Feedback Design via Frequency Response

Design a compensator via **Frequency Response** (Bode Diagram) on the **Control System Designer** app to meet the following design requirements for the plant below.

$$Q4(s) = \frac{5}{s^2 + 14\,s + 4}$$

- Rise time of **less than 1** second
- Overshoot of **less than 20%**
- **Eliminate** steady-state error.
- Gain margin **greater than 20 dB**
- Phase margin **greater than 50 degrees**

➢ Your answer MUST include the following:

1. Complete the table below.
2. Provide a screenshot(s) of your design showing (Bode plot, step response, transfer function, and compensator).
3. Save your design and send the (.mat) file.

	Uncompensated	Compensated
Rise Time	7.53 s	0.35 s
Overshoot Percent	0	5 %
Steady state error	0.207	0.034
Gain Margin	inf	27.2 dB
Phase Margin	148 deg	62.2 deg

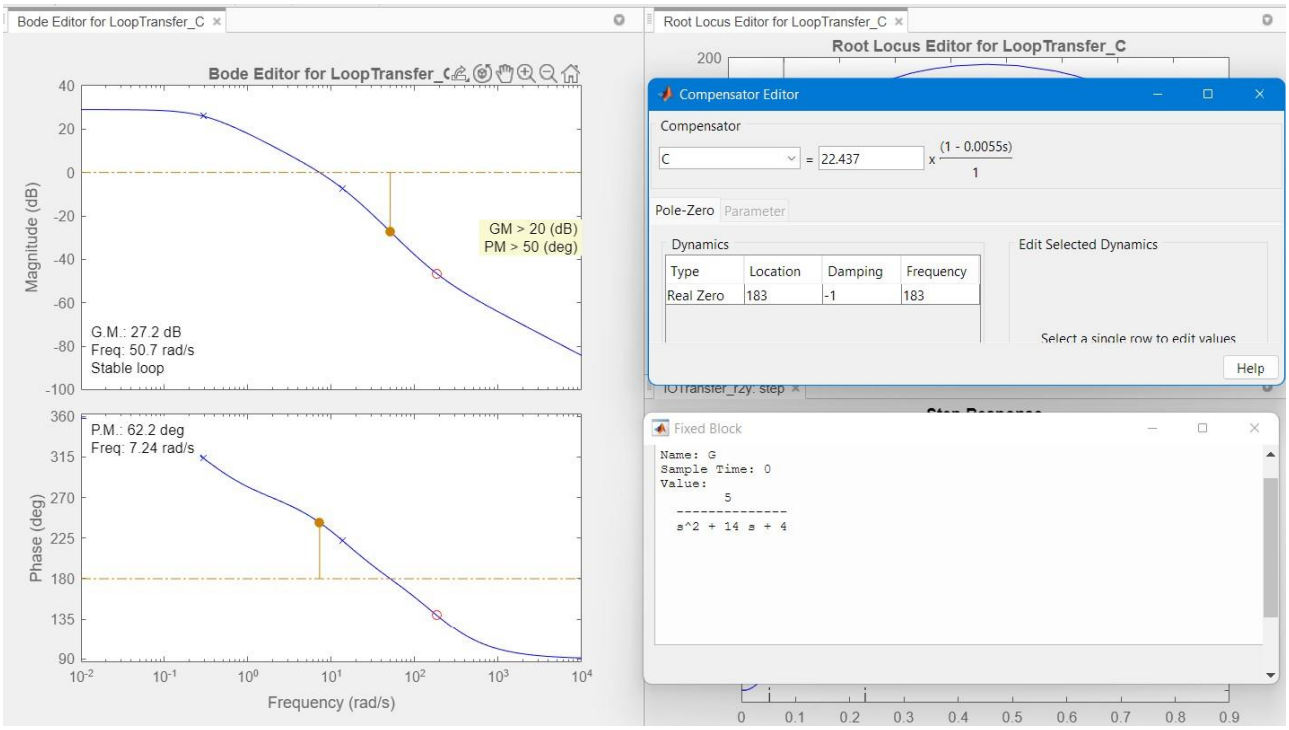


Figure 3 - Question 4. Compensated response

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Complete the tables add screenshots below each table to verify your results.

Question 2

	Compensated
Kp	33.8
Ki	9.4
Kd	30.3
Rise time	0.486
Overshoot %	4.92%

Question 3

	Uncompensated	Compensated
Rise time	0.942 s	5.21 s
Overshoot %	14%	0%
Damping ratio	0.588	0.98
Natural frequency	1.55 rad/s	1.42 rad/s

Question 4

	Uncompensated	Compensated
Rise Time	7.53 s	0.35 s
Overshoot Percent	0	5 %
Steady state error	0.207	0.034
Gain Margin	inf	27.2 dB
Phase Margin	148 deg	62.2 deg