Homework assignment 2

Basics of Automation and Control 1

ANW123

December 15, 2020

Contents

Homework policy

- During the fall there are two homework assignments.
- The deadline for submitting the solutions is announced on the course website.
- The homework assignments are published on the course website in a PDF format. The PDF file contains one hundred problem sets, which are numbered from 1 to 100.
- Each student should choose the appropriate problem set number that corresponds with the two last digits of the student's registration book (SRB) number. The exception from that rule is the problem set no. 100, which corresponds to the SRB number that ends with 00.
- The answer boxes of the chosen problem set should be fully completed.
- Be sure to write legibly.
- Enclose the solutions and your final answer to each problem in a box so that it may be clearly identified.
- These outcomes are evaluated and affect the total grade from the course.
- The solutions should be delivered before the deadline to the designated place.
- Homework submitted after the due date will not be honored.
- Copying homework from another student or other source is cheating and will not be tolerated.

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 1

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/60sec$, and $T_3 = 1/300sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

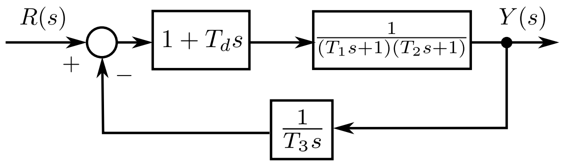

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/5)(s+10)(s+60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

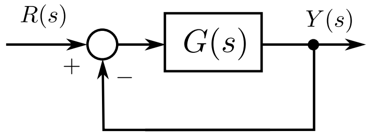

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+54}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 81\frac{rad}{sec}$. *Plot the step response*.

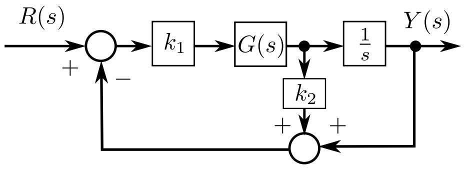

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.71728\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.50476\frac{Ns}{m}$, and $k = 6.28971\frac{N}{m}$.

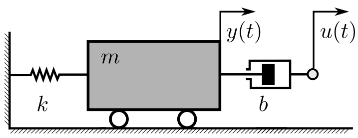

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ °

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

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Name and surname (legibly): ________________

Student's registration book number: ________________

Field of study: ________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 2

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/40sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

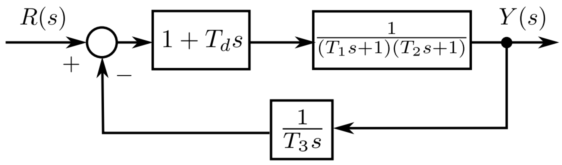

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ________________ sec $\omega_{osc} =$ ________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/10)(s + 9)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

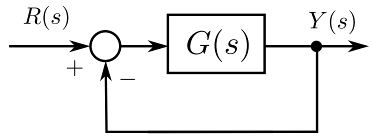

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+32}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 48\frac{rad}{sec}$. *Plot the step response*.

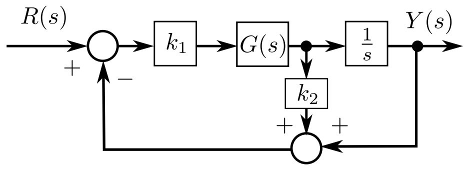

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ________________ $k_2 =$ ________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.12031\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.12184\frac{Ns}{m}$, and $k = 4.16041\frac{N}{m}$.

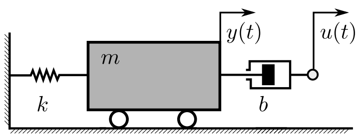

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ________________ dB $\varphi(\omega) =$ ________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 3

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/60sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

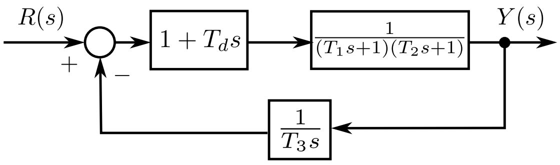

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 2/5)(s + 8)(s + 60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

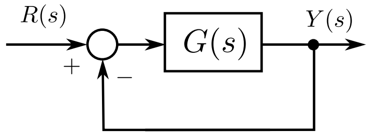

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+42}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 63\frac{rad}{sec}$. *Plot the step response.*

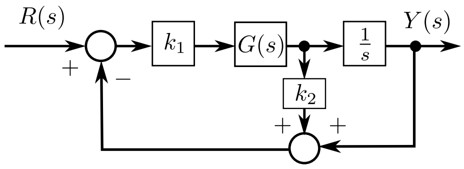

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.64758\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.24467\frac{Ns}{m}$, and $k = 6.19677\frac{N}{m}$.

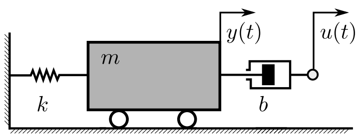

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 4

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/70sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

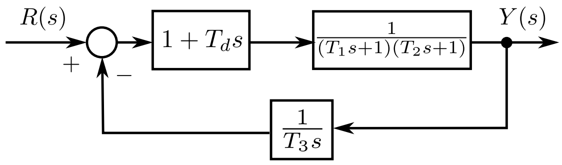

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+4/5)(s+4)(s+50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

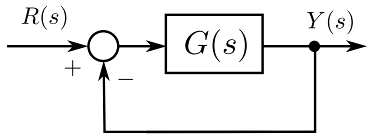

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+21}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 31.5\frac{rad}{sec}$. *Plot the step response.*

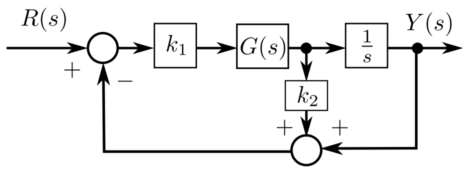

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.31008\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.798254\frac{Ns}{m}$, and $k = 7.0801\frac{N}{m}$.

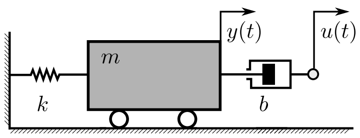

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 5

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/60sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

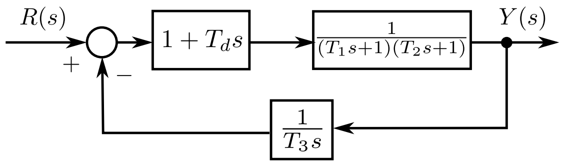

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/2)(s+7)(s+60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

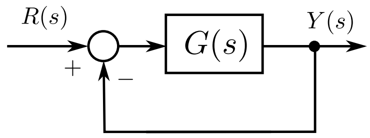

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+36}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 54\frac{rad}{sec}$. *Plot the step response*.

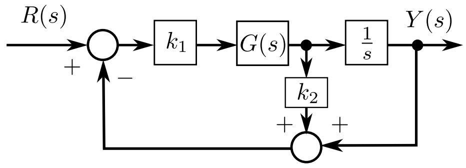

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.61842\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.11668\frac{Ns}{m}$, and $k = 6.1579\frac{N}{m}$.

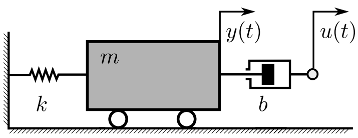

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 6

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/50sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

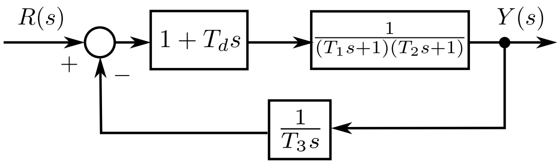

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/5)(s + 6)(s + 70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

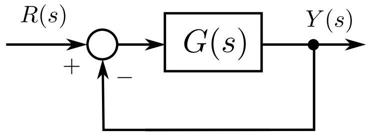

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+25}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 37.5\frac{rad}{sec}$. *Plot the step response.*

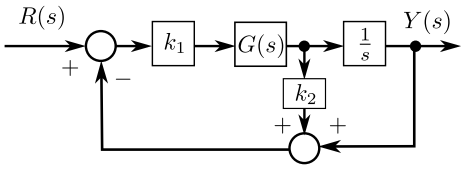

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.82733\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.903602\frac{Ns}{m}$, and $k = 5.1031\frac{N}{m}$.

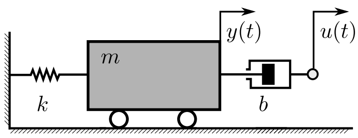

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 7

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/90sec$, and $T_3 = 1/340sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

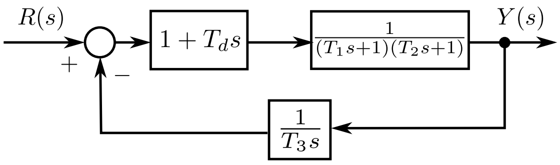

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/10)(s+9)(s+30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

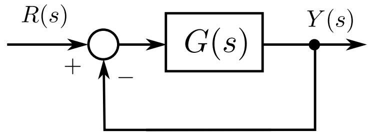

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+72}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 108\frac{rad}{sec}$. *Plot the step response*.

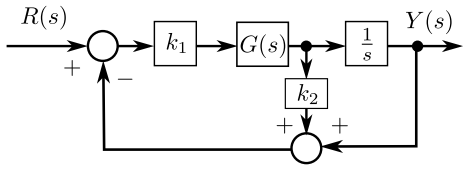

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.02069\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.68276\frac{Ns}{m}$, and $k = 9.36092\frac{N}{m}$.

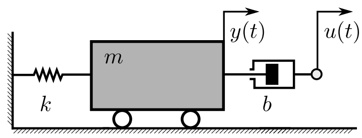

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 8

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/40sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

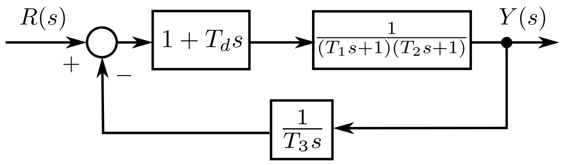

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

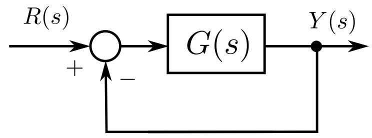

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+36}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 54\frac{rad}{sec}$. *Plot the step response*.

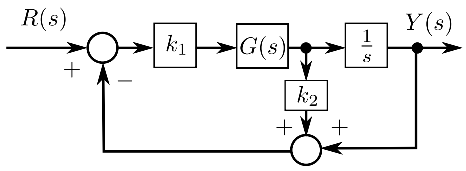

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.14485\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.22863\frac{Ns}{m}$, and $k = 4.19314\frac{N}{m}$.

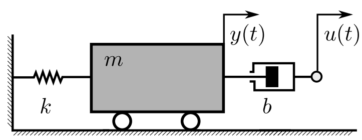

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ °

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 9

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/90sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

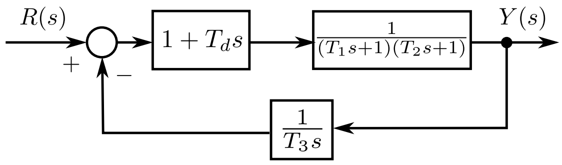

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+9/10)(s+3)(s+30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

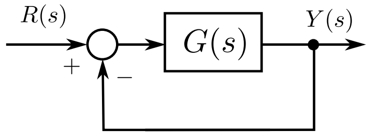

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+18}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 27\frac{rad}{sec}$. *Plot the step response*.

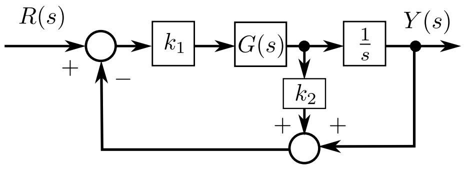

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.80336\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.752959\frac{Ns}{m}$, and $k = 9.07115\frac{N}{m}$.

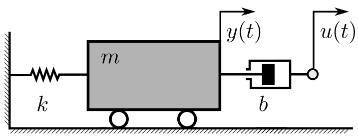

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 10

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/100sec$, and $T_3 = 1/360sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

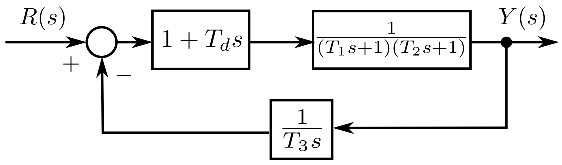

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/10)(s + 9)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

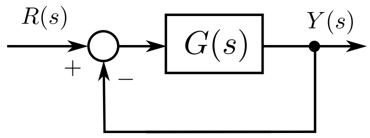

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+80}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 120\frac{rad}{sec}$. *Plot the step response*.

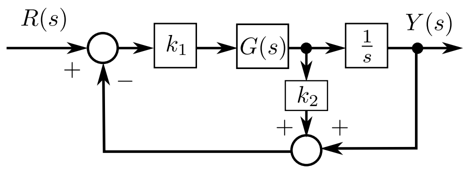

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.80076\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.77378\frac{Ns}{m}$, and $k = 10.401\frac{N}{m}$.

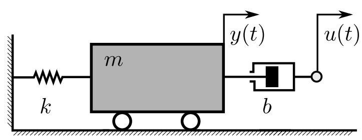

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 11

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/20sec$, and $T_3 = 1/100sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

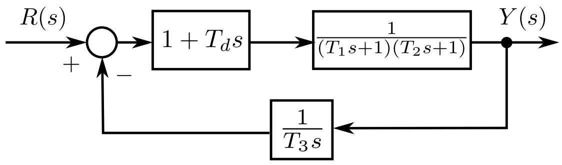

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 4/5)(s + 4)(s + 100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

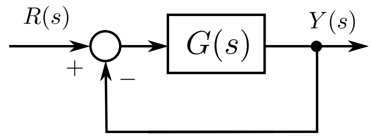

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+6}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 9\frac{rad}{sec}$. *Plot the step response*.

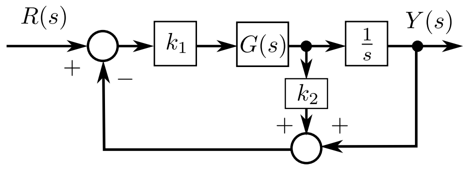

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.51717\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.426685\frac{Ns}{m}$, and $k = 2.02289\frac{N}{m}$.

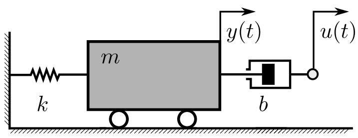

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 12

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/10sec$, and $T_3 = 1/60sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

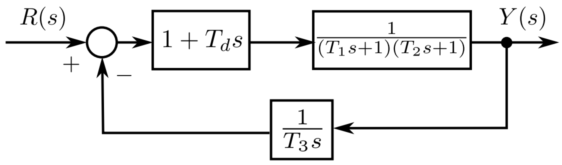

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

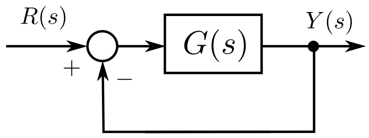

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+2}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 3\frac{rad}{sec}$. *Plot the step response*.

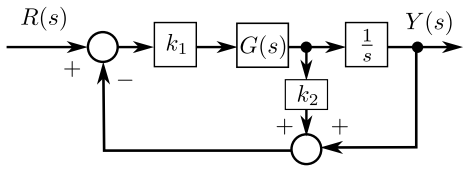

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.755929\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.250986\frac{Ns}{m}$, and $k = 1.00791\frac{N}{m}$.

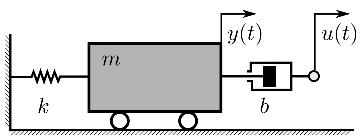

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 13

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/90sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

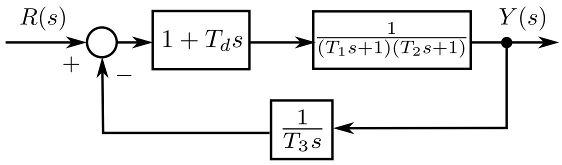

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+4/5)(s+4)(s+30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

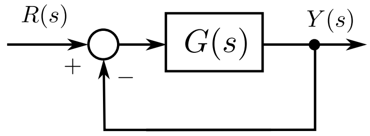

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+27}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 40.5\frac{rad}{sec}$. *Plot the step response*.

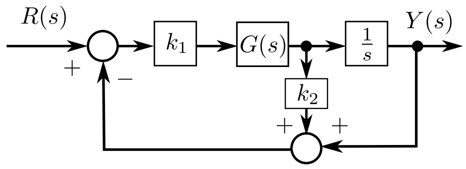

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.82724\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.905135\frac{Ns}{m}$, and $k = 9.10299\frac{N}{m}$.

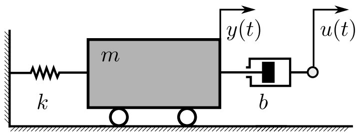

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 14

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/60sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

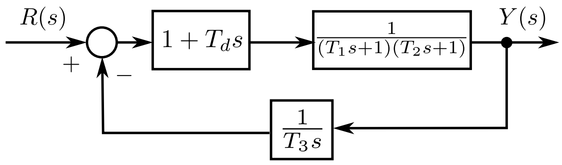

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/5)(s+6)(s+60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

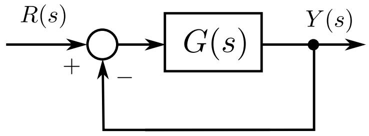

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+30}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 45\frac{rad}{sec}$. *Plot the step response*.

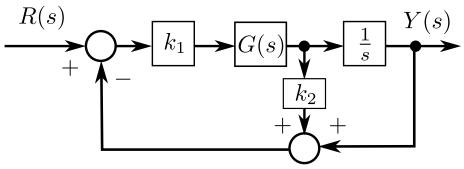

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.59279\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.989846\frac{Ns}{m}$, and $k = 6.12372\frac{N}{m}$.

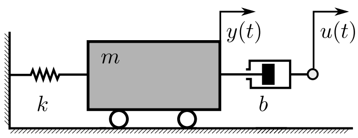

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______

Student's registration book number: ______

Field of study: ______

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 15

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/100sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

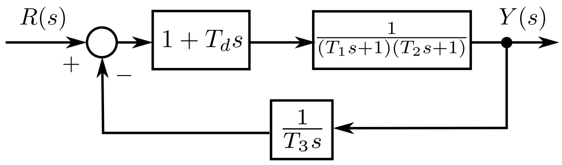

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______sec $\omega_{osc} =$ ______ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

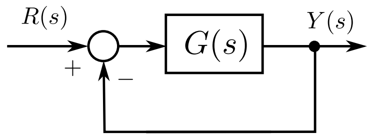

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+10}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 15\frac{rad}{sec}$. *Plot the step response*.

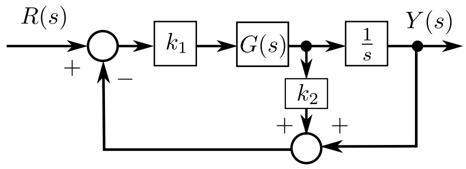

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______ $k_2 =$ ______

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.53778\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.634047\frac{Ns}{m}$, and $k = 10.0504\frac{N}{m}$.

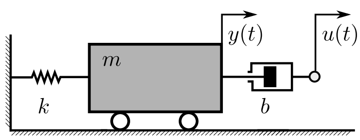

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______dB $\varphi(\omega) =$ ______°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 16

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/90sec$, and $T_3 = 1/380sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

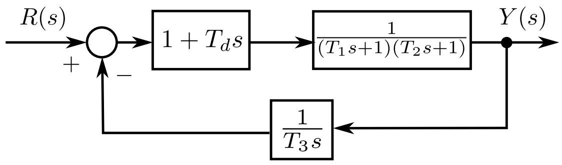

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/10)(s+11)(s+30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

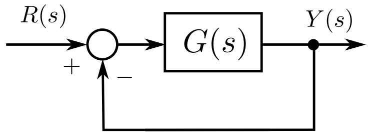

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+90}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 135\frac{rad}{sec}$. *Plot the step response*.

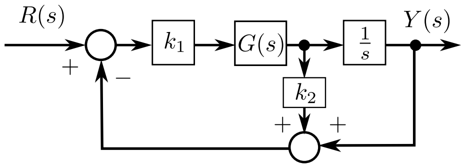

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.13746\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 2.00519\frac{Ns}{m}$, and $k = 9.51662\frac{N}{m}$.

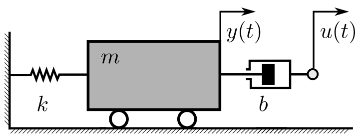

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 17

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/10sec$, and $T_3 = 1/100sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

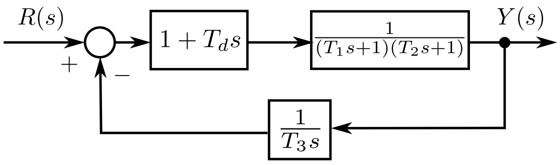

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ________________sec $\omega_{osc} =$ ________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

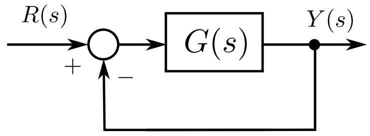

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+4}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 6\frac{rad}{sec}$. *Plot the step response*.

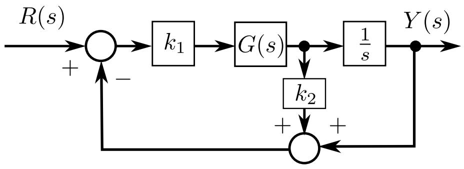

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ________________ $k_2 =$ ________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.761755\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.352732\frac{Ns}{m}$, and $k = 1.01567\frac{N}{m}$.

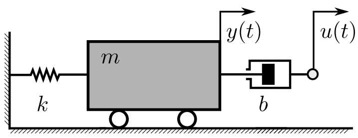

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ________________dB $\varphi(\omega) =$ ________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ________________________________

Student's registration book number: ________________________________

Field of study: ________________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 18

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/20sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

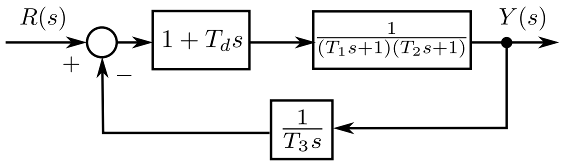

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ________________ sec $\omega_{osc} =$ ________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

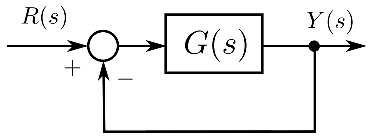

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+18}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 27\frac{rad}{sec}$. *Plot the step response*.

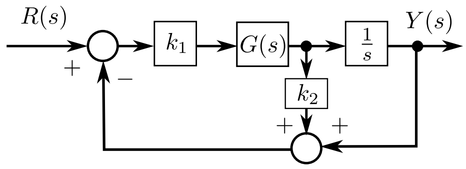

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ________________ $k_2 =$ ________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.57243\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.868772\frac{Ns}{m}$, and $k = 2.09657\frac{N}{m}$.

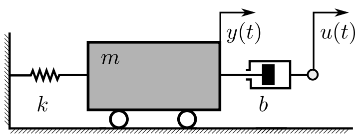

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ________________ dB $\varphi(\omega) =$ ________________ °

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 19

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/90sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

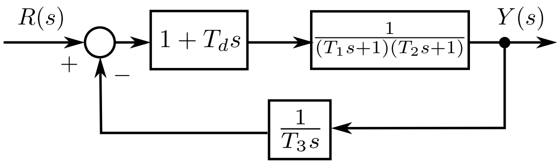

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

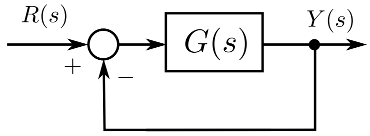

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+36}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 54\frac{rad}{sec}$. *Plot the step response*.

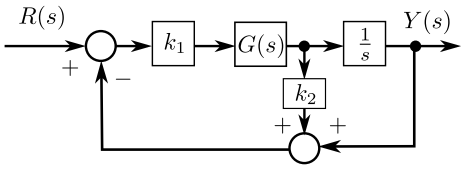

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.8558\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.0582\frac{Ns}{m}$, and $k = 9.14106\frac{N}{m}$.

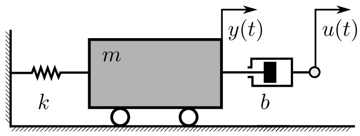

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 20

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/20sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

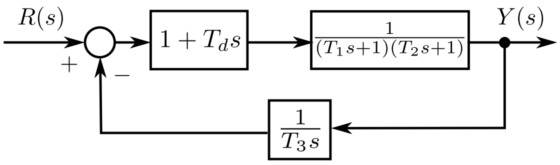

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/10)(s + 9)(s + 100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

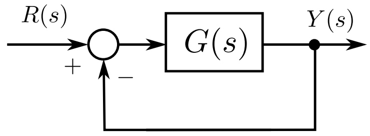

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+16}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 24\frac{rad}{sec}$. *Plot the step response.*

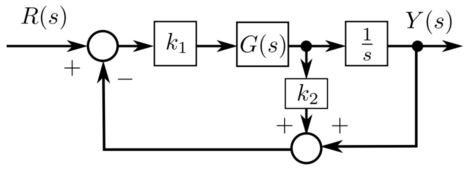

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.56015\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.79326\frac{Ns}{m}$, and $k = 2.0802\frac{N}{m}$.

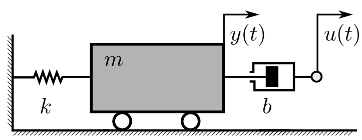

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 21

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/90sec$, and $T_3 = 1/280sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

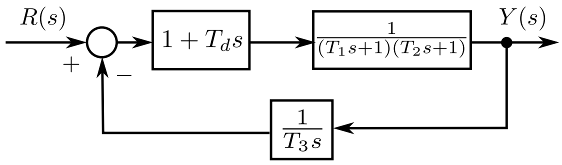

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/5)(s+6)(s+30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

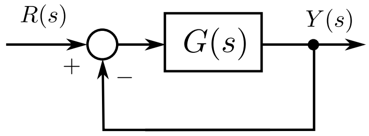

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+45}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 67.5\frac{rad}{sec}$. *Plot the step response.*

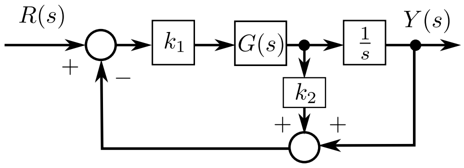

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.88919\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.21231\frac{Ns}{m}$, and $k = 9.18559\frac{N}{m}$.

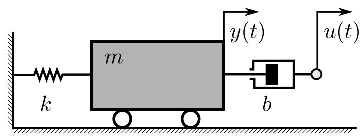

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 22

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/60sec$, and $T_3 = 1/140sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

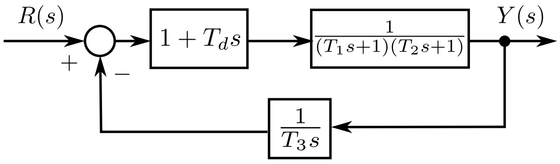

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

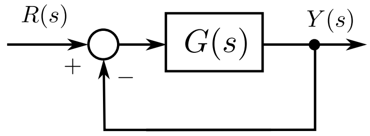

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+6}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 9\frac{rad}{sec}$. *Plot the step response*.

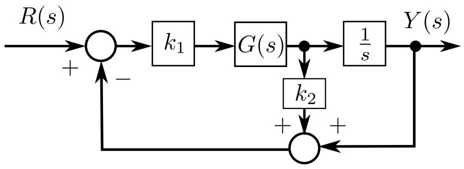

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.52267\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.49113\frac{Ns}{m}$, and $k = 6.03023\frac{N}{m}$.

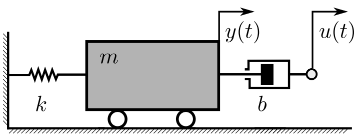

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 23

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/70sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

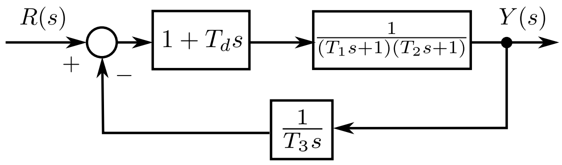

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

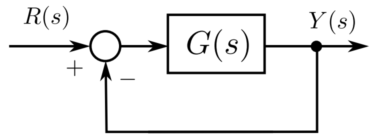

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+14}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 21\frac{rad}{sec}$. *Plot the step response*.

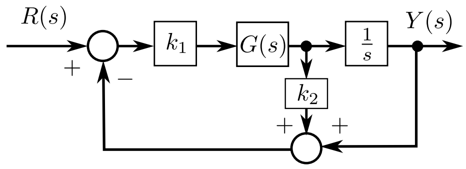

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.2915\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.664047\frac{Ns}{m}$, and $k = 7.05534\frac{N}{m}$.

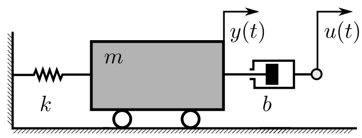

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 24

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/40sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

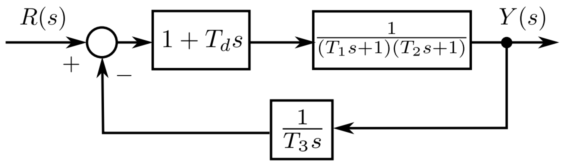

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/2)(s+7)(s+80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

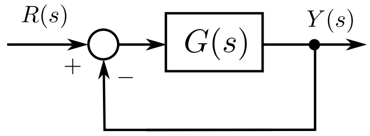

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+24}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 36\frac{rad}{sec}$. *Plot the step response*.

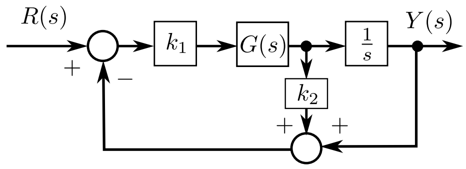

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.07895\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.911765\frac{Ns}{m}$, and $k = 4.10526\frac{N}{m}$.

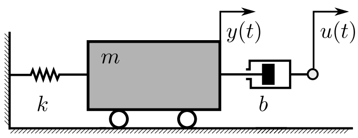

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______

Student's registration book number: ______

Field of study: ______

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 25

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/10sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

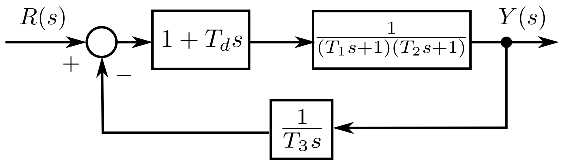

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______sec $\omega_{osc} =$ ______ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/10)(s + 9)(s + 110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

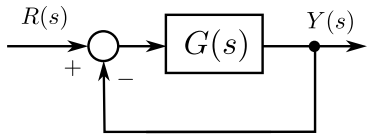

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+8}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 12\frac{rad}{sec}$. *Plot the step response*.

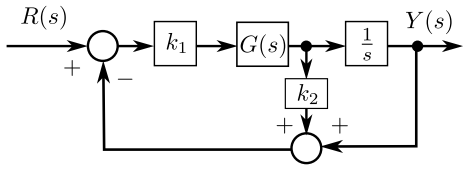

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______ $k_2 =$ ______

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.780076\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.56092\frac{Ns}{m}$, and $k = 1.0401\frac{N}{m}$.

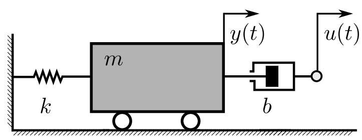

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______dB $\varphi(\omega) =$ ______ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 26

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/40sec$, and $T_3 = 1/280sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

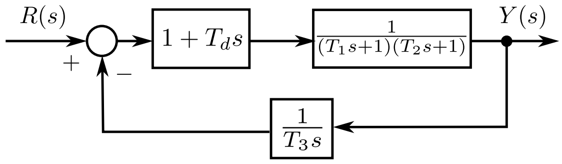

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/10)(s + 11)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

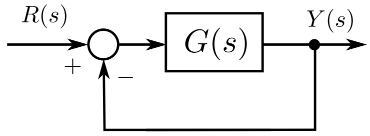

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+40}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 60\frac{rad}{sec}$. *Plot the step response*.

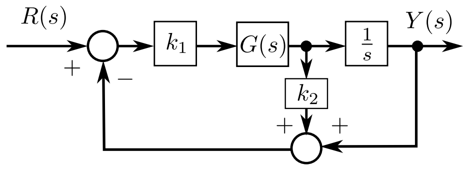

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.17221\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.33679\frac{Ns}{m}$, and $k = 4.22961\frac{N}{m}$.

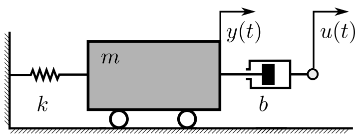

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______

Student's registration book number: ______

Field of study: ______

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 27

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/20sec$, and $T_3 = 1/160sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

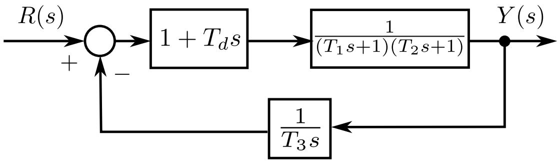

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______sec $\omega_{osc} =$ ______$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/2)(s+7)(s+100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

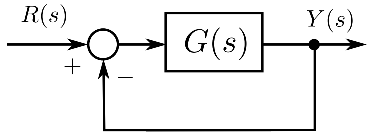

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+12}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 18\frac{rad}{sec}$. *Plot the step response*.

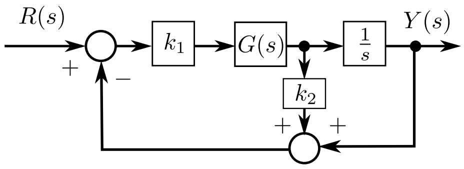

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______ $k_2 =$ ______

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.53947\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.644715\frac{Ns}{m}$, and $k = 2.05263\frac{N}{m}$.

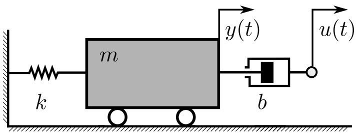

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______dB $\varphi(\omega) =$ ______°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 28

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/40sec$, and $T_3 = 1/100sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

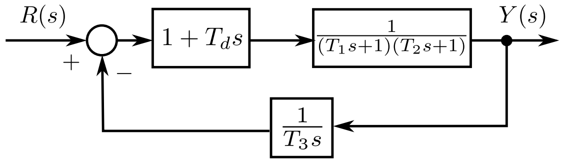

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

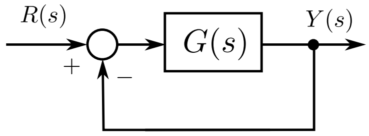

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+4}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 6\frac{rad}{sec}$. *Plot the step response.*

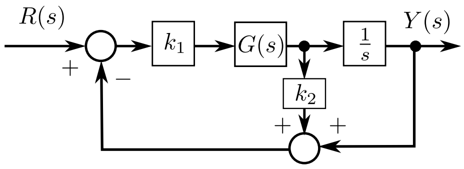

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.01511\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.401006\frac{Ns}{m}$, and $k = 4.02015\frac{N}{m}$.

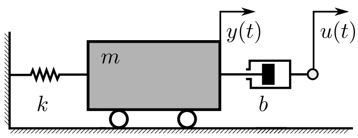

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 29

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/60sec$, and $T_3 = 1/320sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

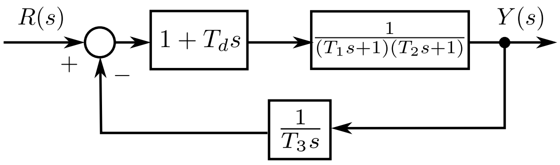

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/10)(s+11)(s+60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

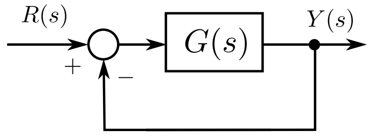

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+60}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 90\frac{rad}{sec}$. *Plot the step response*.

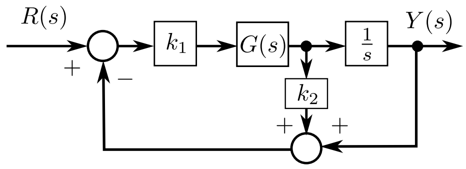

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.75831\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.63723\frac{Ns}{m}$, and $k = 6.34441\frac{N}{m}$.

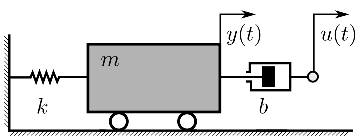

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 30

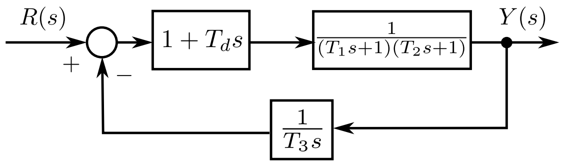

Figure 1: *Feedback control system in Problem 1*

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/70sec$, and $T_3 = 1/160sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

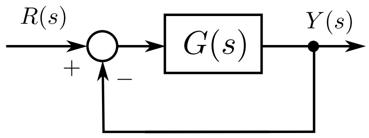

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+7}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 10.5\frac{rad}{sec}$. *Plot the step response*.

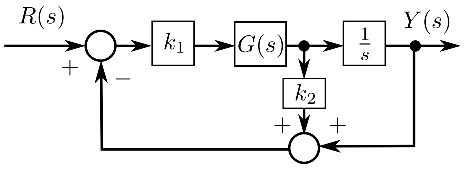

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.27645\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.530481\frac{Ns}{m}$, and $k = 7.03526\frac{N}{m}$.

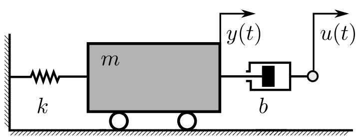

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 31

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/50sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

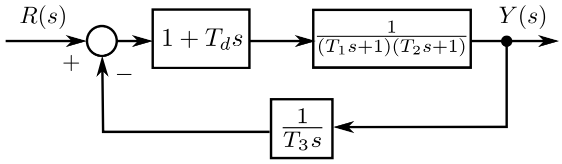

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/10)(s+9)(s+70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

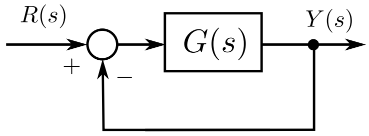

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+40}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 60\frac{rad}{sec}$. *Plot the step response*.

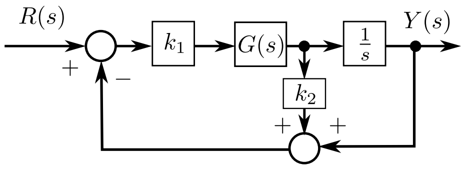

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.90038\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.25425\frac{Ns}{m}$, and $k = 5.20051\frac{N}{m}$.

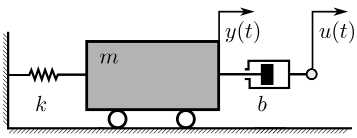

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 32

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60 sec$, $T_2 = 1/50 sec$, and $T_3 = 1/220 sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

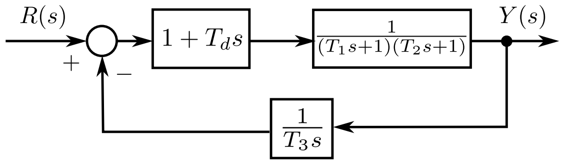

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/2)(s + 7)(s + 70)}.$$

Analitically find the gain K such that the gain margin is less than $10 dB$. *Plot the Nyquist plot for the calculated gain K.*

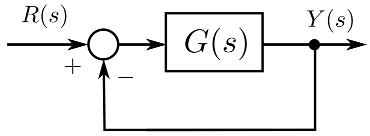

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+30}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 45 \frac{rad}{sec}$. *Plot the step response*.

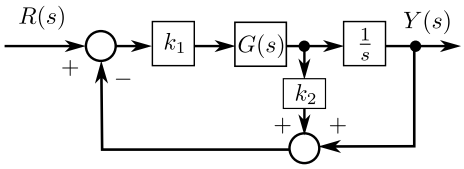

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.84869 \frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.01938 \frac{Ns}{m}$, and $k = 5.13158 \frac{N}{m}$.

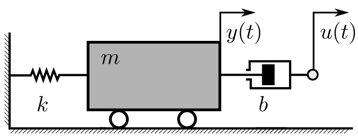

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________
Student's registration book number: ____________________
Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 33

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/100sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

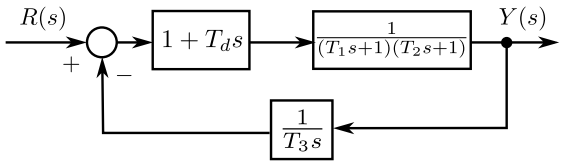

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ________________sec $\omega_{osc} =$ ________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

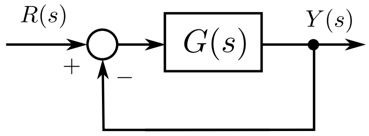

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+20}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 30\frac{rad}{sec}$. *Plot the step response.*

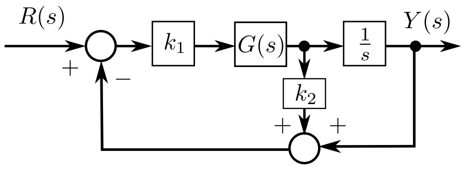

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ________________ $k_2 =$ ________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.55929\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.793688\frac{Ns}{m}$, and $k = 10.0791\frac{N}{m}$.

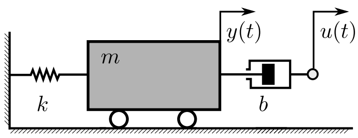

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ________________dB $\varphi(\omega) =$ ________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 34

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/50sec$, and $T_3 = 1/120sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

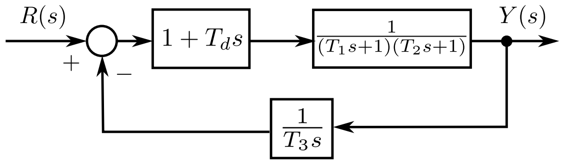

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+70)}.$$

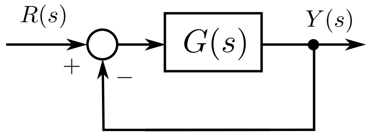

Figure 2: *Feedback control system in Problem 2*

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+5}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 7.5\frac{rad}{sec}$. *Plot the step response*.

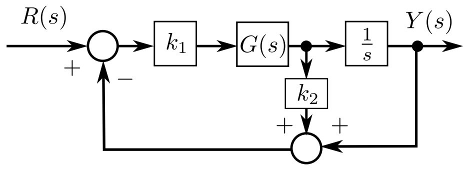

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.76889\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.448339\frac{Ns}{m}$, and $k = 5.02519\frac{N}{m}$.

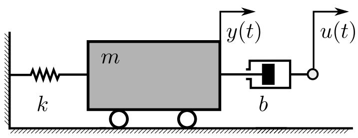

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 35

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/50sec$, and $T_3 = 1/140sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

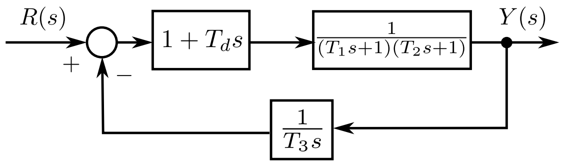

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

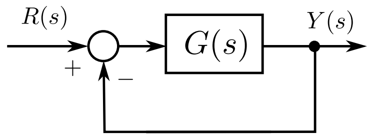

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+10}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 15\frac{rad}{sec}$. *Plot the step response*.

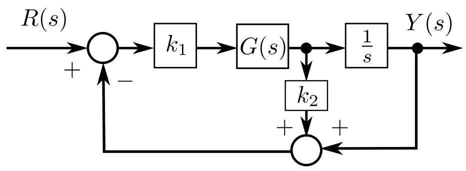

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.77964\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.561222\frac{Ns}{m}$, and $k = 5.03953\frac{N}{m}$.

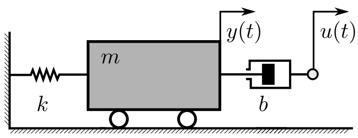

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 36

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/80sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

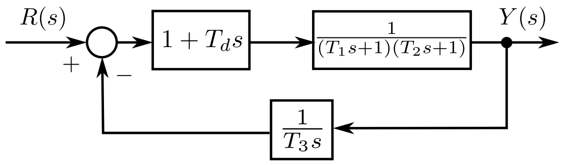

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

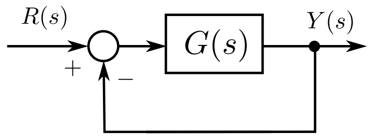

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+8}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 12\frac{rad}{sec}$. *Plot the step response.*

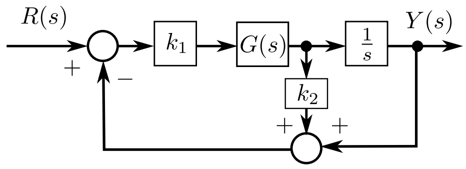

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.03023\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.567109\frac{Ns}{m}$, and $k = 8.0403\frac{N}{m}$.

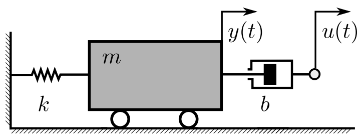

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 37

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/40sec$, and $T_3 = 1/120sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

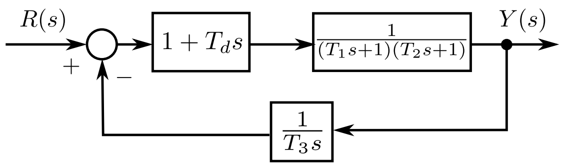

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

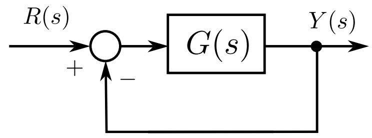

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+8}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 12\frac{rad}{sec}$. *Plot the step response*.

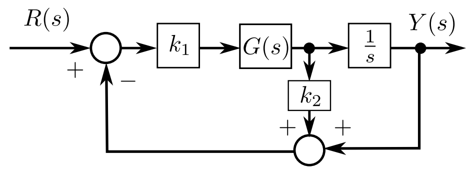

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.02372\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.501972\frac{Ns}{m}$, and $k = 4.03162\frac{N}{m}$.

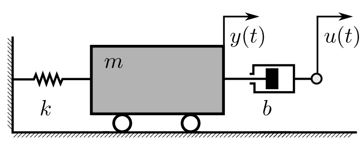

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 38

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/30sec$, and $T_3 = 1/140sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

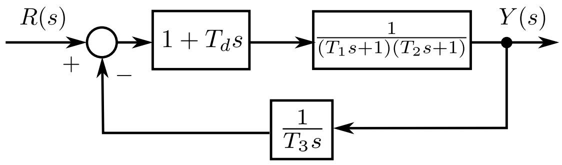

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________ sec $\omega_{osc} =$ ____________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

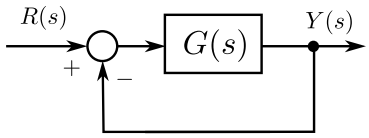

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+12}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 18\frac{rad}{sec}$. *Plot the step response*.

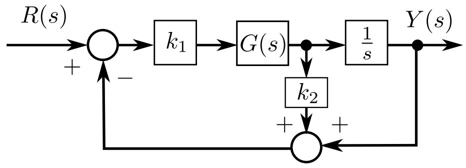

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________ $k_2 =$ ____________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.28527\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.61095\frac{Ns}{m}$, and $k = 3.04702\frac{N}{m}$.

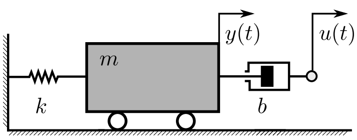

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________ dB $\varphi(\omega) =$ ____________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 39

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/40sec$, and $T_3 = 1/160sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

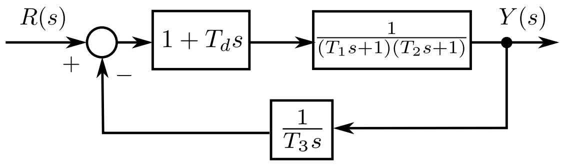

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

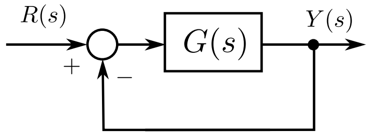

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+16}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 24\frac{rad}{sec}$. *Plot the step response*.

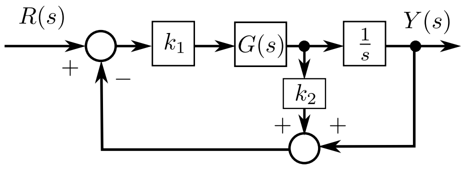

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.04702\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.705464\frac{Ns}{m}$, and $k = 4.06269\frac{N}{m}$.

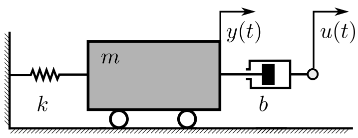

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ °

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 40

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/20sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

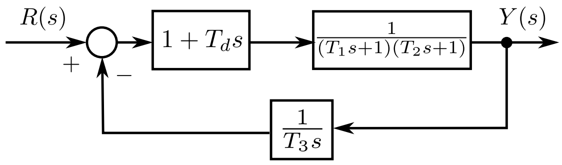

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/10)(s + 11)(s + 100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

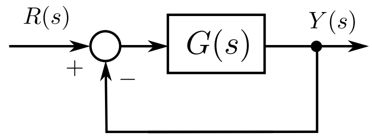

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+20}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 30\frac{rad}{sec}$. *Plot the step response*.

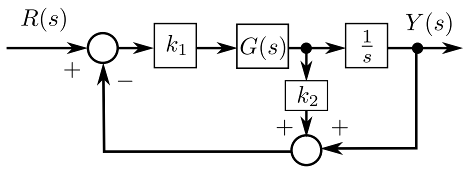

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.5861\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.945254\frac{Ns}{m}$, and $k = 2.1148\frac{N}{m}$.

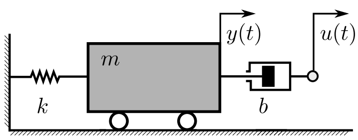

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________
Student's registration book number: ____________________
Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 41

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/80sec$, and $T_3 = 1/360sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

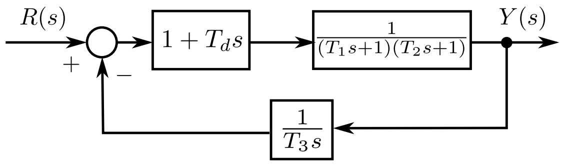

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ________________ sec $\omega_{osc} =$ ________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/10)(s + 11)(s + 40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

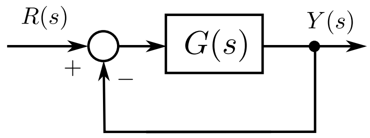

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+80}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 120\frac{rad}{sec}$. *Plot the step response.*

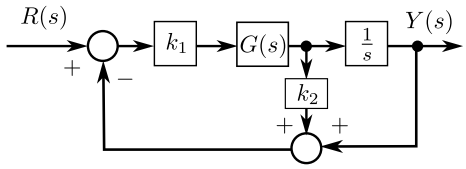

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ________________ $k_2 =$ ________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.34441\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.89051\frac{Ns}{m}$, and $k = 8.45922\frac{N}{m}$.

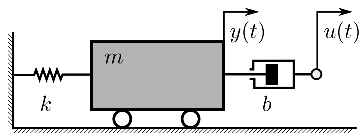

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ________________ dB $\varphi(\omega) =$ ________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______

Student's registration book number: ______

Field of study: ______

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 42

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/100sec$, and $T_3 = 1/300sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

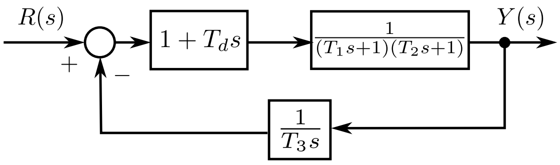

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______sec $\omega_{osc} =$ ______$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/5)(s+6)(s+20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

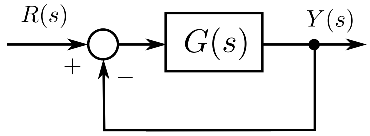

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+50}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 75\frac{rad}{sec}$. *Plot the step response*.

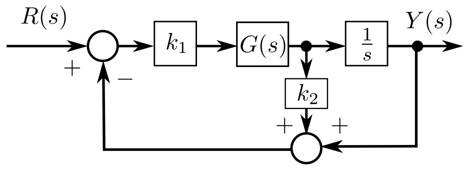

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______ $k_2 =$ ______

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.65466\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.27789\frac{Ns}{m}$, and $k = 10.2062\frac{N}{m}$.

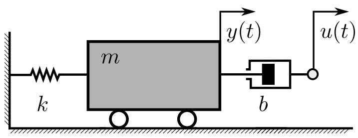

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______dB $\varphi(\omega) =$ ______$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 43

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/10sec$, and $T_3 = 1/120sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

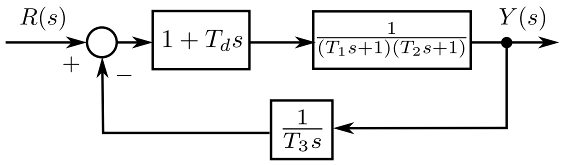

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/5)(s+6)(s+110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

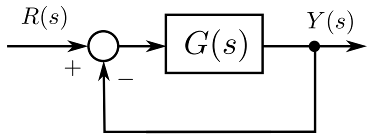

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+5}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 7.5\frac{rad}{sec}$. *Plot the step response*.

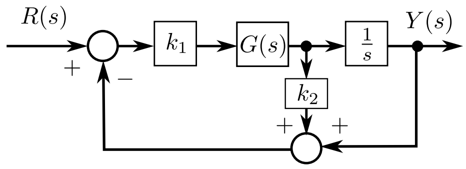

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.765466\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.404103\frac{Ns}{m}$, and $k = 1.02062\frac{N}{m}$.

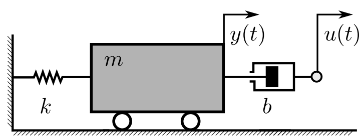

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 44

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/30sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

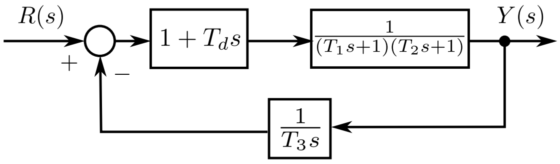

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/10)(s+11)(s+90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

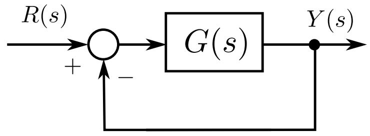

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+30}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 45\frac{rad}{sec}$. *Plot the step response*.

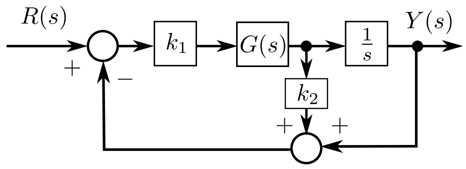

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.37915\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.15769\frac{Ns}{m}$, and $k = 3.17221\frac{N}{m}$.

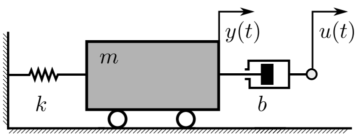

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 45

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/90sec$, and $T_3 = 1/360sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

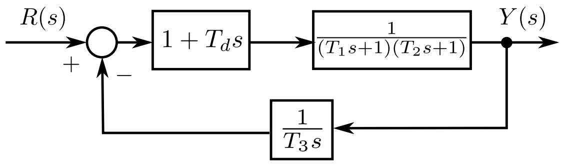

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

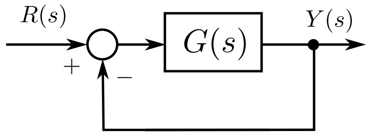

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+81}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 121.5\frac{rad}{sec}$. *Plot the step response*.

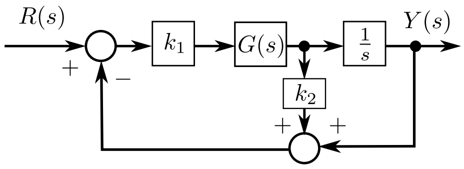

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.07592\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.84294\frac{Ns}{m}$, and $k = 9.43456\frac{N}{m}$.

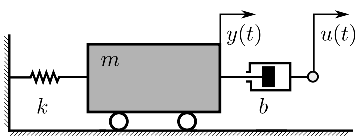

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 46

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/80sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

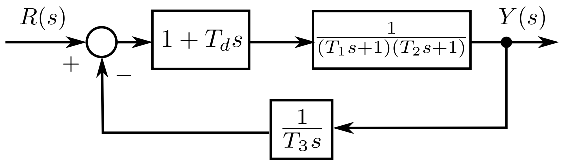

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+4/5)(s+4)(s+40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

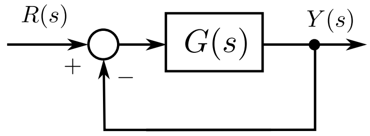

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+24}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 36\frac{rad}{sec}$. *Plot the step response*.

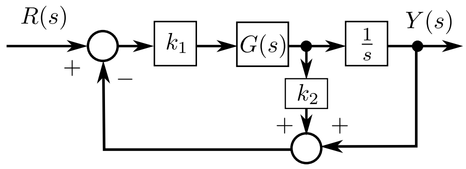

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.06866\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.853369\frac{Ns}{m}$, and $k = 8.09155\frac{N}{m}$.

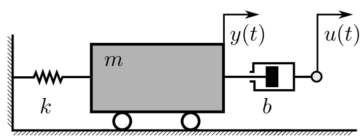

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 47

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70 sec$, $T_2 = 1/10 sec$, and $T_3 = 1/160 sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

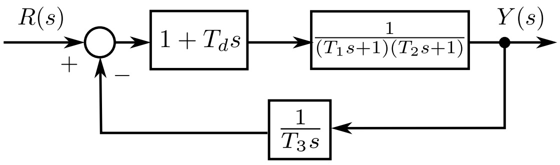

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 2/5)(s + 8)(s + 110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

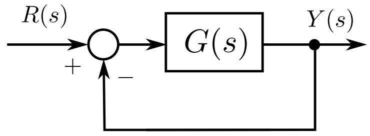

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+7}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 10.5 \frac{rad}{sec}$. *Plot the step response.*

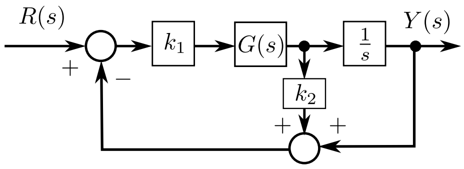

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.774597 \frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.508133 \frac{Ns}{m}$, and $k = 1.0328 \frac{N}{m}$.

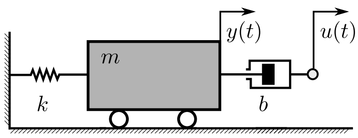

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____

Student's registration book number: ____________________________________

Field of study: ____

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 48

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/100sec$, and $T_3 = 1/400sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

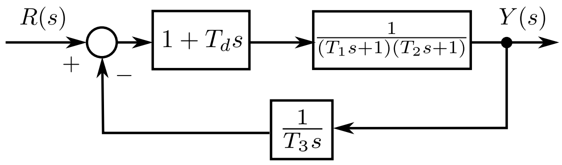

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/10)(s + 11)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

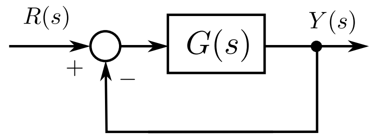

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+100}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 150\frac{rad}{sec}$. *Plot the step response*.

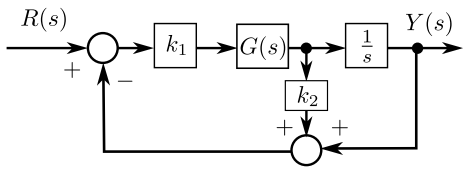

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.93052\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 2.11365\frac{Ns}{m}$, and $k = 10.574\frac{N}{m}$.

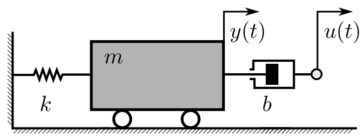

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______

Student's registration book number: ______

Field of study: ______

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 49

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/100sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

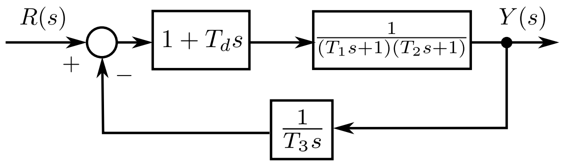

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______sec $\omega_{osc} =$ ______$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 4/5)(s + 4)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

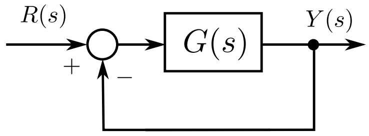

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+30}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 45\frac{rad}{sec}$. *Plot the step response.*

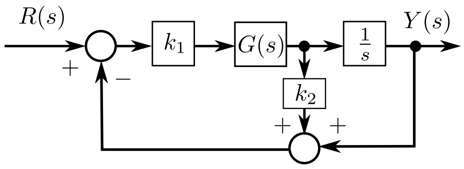

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______ $k_2 =$ ______

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.58583\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.954096\frac{Ns}{m}$, and $k = 10.1144\frac{N}{m}$.

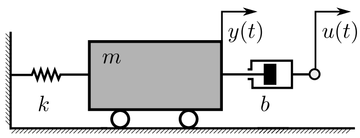

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______dB $\varphi(\omega) =$ ______$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 50

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/50sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

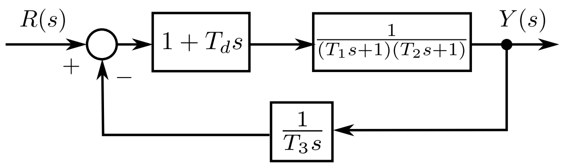

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+2/5)(s+8)(s+70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

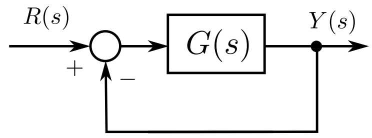

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+35}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 52.5\frac{rad}{sec}$. *Plot the step response*.

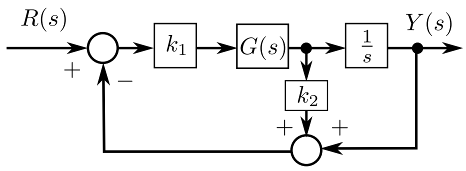

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.87298\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.13622\frac{Ns}{m}$, and $k = 5.16398\frac{N}{m}$.

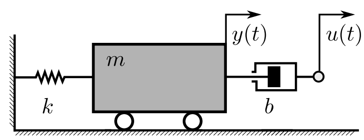

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 51

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/50sec$, and $T_3 = 1/160sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

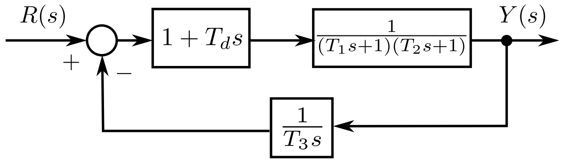

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+4/5)(s+4)(s+70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

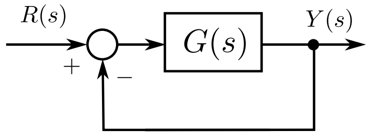

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+15}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 22.5\frac{rad}{sec}$. *Plot the step response*.

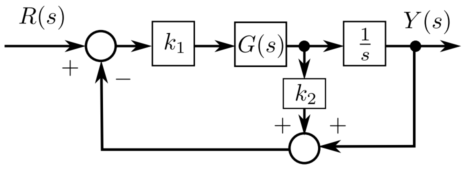

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.79291\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.674648\frac{Ns}{m}$, and $k = 5.05722\frac{N}{m}$.

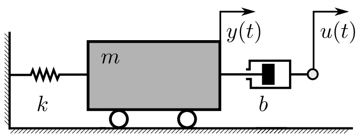

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 52

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/30sec$, and $T_3 = 1/80sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

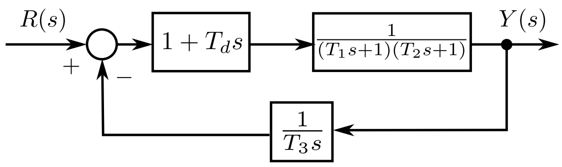

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

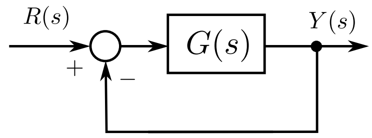

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+3}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 4.5\frac{rad}{sec}$. *Plot the step response*.

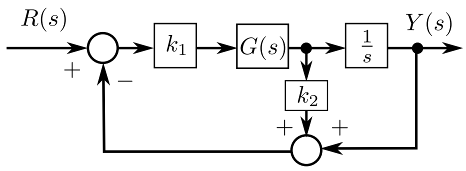

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.26134\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.347282\frac{Ns}{m}$, and $k = 3.01511\frac{N}{m}$.

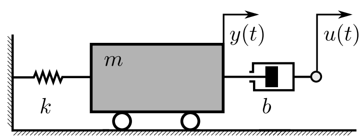

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 53

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/10sec$, and $T_3 = 1/140sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

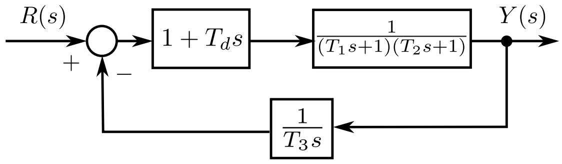

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/2)(s + 7)(s + 110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

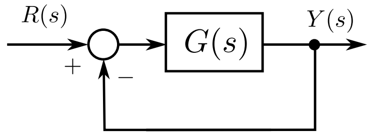

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+6}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 9\frac{rad}{sec}$. *Plot the step response*.

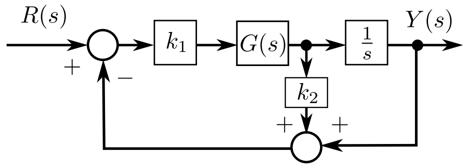

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.769737\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.455883\frac{Ns}{m}$, and $k = 1.02632\frac{N}{m}$.

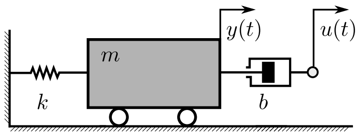

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 54

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/40sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

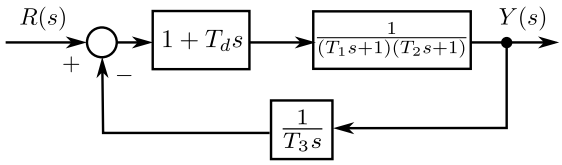

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 2/5)(s + 8)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

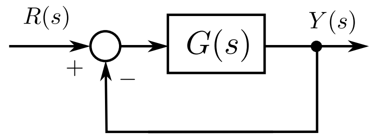

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+28}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 42\frac{rad}{sec}$. *Plot the step response*.

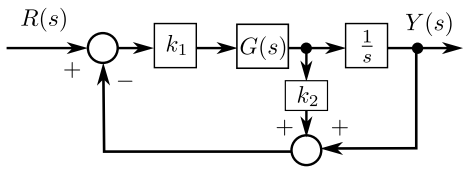

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.09839\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.01627\frac{Ns}{m}$, and $k = 4.13118\frac{N}{m}$.

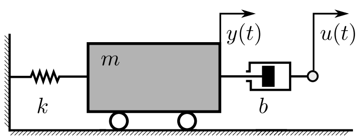

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 55

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/80sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

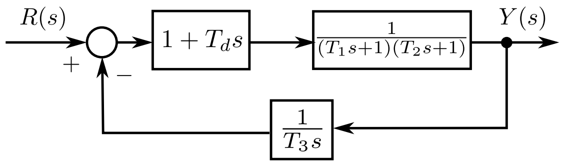

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/5)(s + 6)(s + 40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

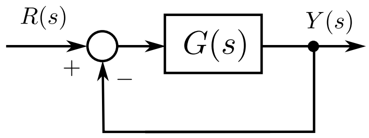

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+40}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 60\frac{rad}{sec}$. *Plot the step response*.

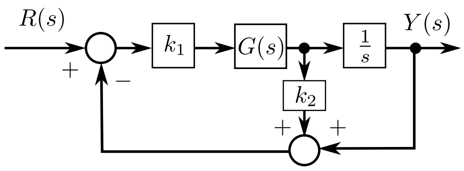

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.12372\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.14298\frac{Ns}{m}$, and $k = 8.16497\frac{N}{m}$.

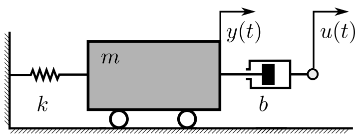

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 56

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/80sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

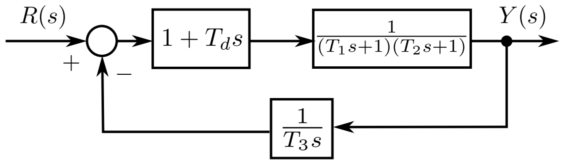

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

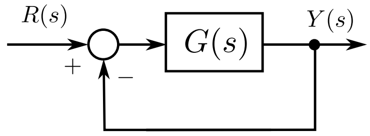

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+16}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 24\frac{rad}{sec}$. *Plot the step response*.

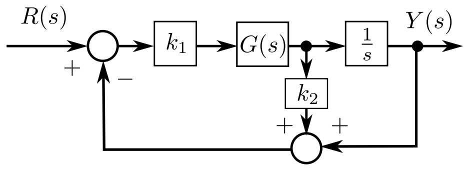

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.04743\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.709896\frac{Ns}{m}$, and $k = 8.06324\frac{N}{m}$.

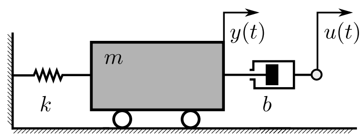

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 57

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/70sec$, and $T_3 = 1/260sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

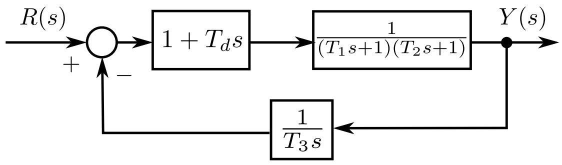

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/2)(s+7)(s+50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

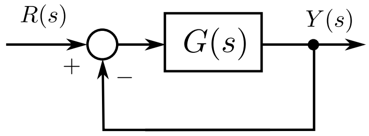

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+42}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 63\frac{rad}{sec}$. *Plot the step response*.

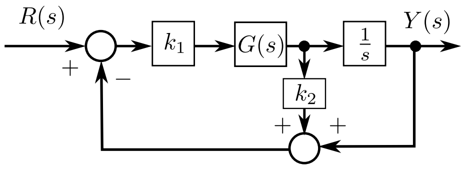

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.38816\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.20615\frac{Ns}{m}$, and $k = 7.18421\frac{N}{m}$.

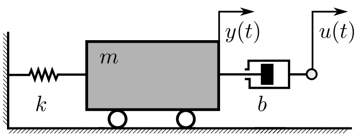

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 58

Problem 1
Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/30sec$, and $T_3 = 1/120sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

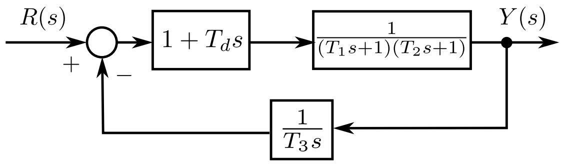

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2
Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+4/5)(s+4)(s+90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

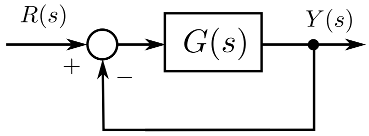

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3
A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+9}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 13.5\frac{rad}{sec}$. *Plot the step response.*

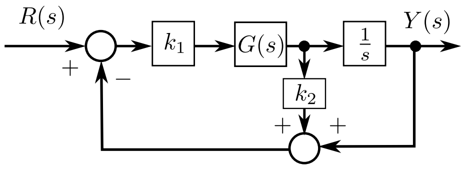

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4
A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.27575\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.52258\frac{Ns}{m}$, and $k = 3.03433\frac{N}{m}$.

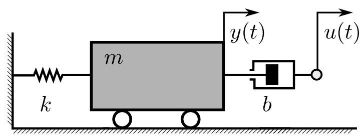

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 59

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/10sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

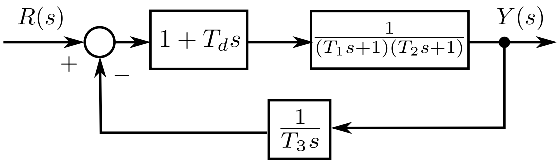

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/5)(s+10)(s+110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

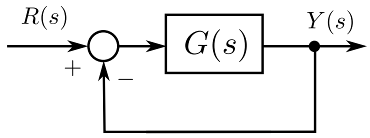

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+9}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 13.5 \frac{rad}{sec}$. *Plot the step response.*

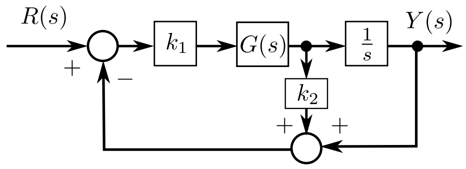

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.786214 \frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.614315 \frac{Ns}{m}$, and $k = 1.04828 \frac{N}{m}$.

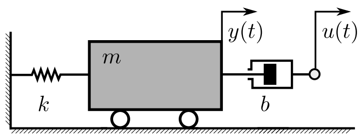

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 60

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/70sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

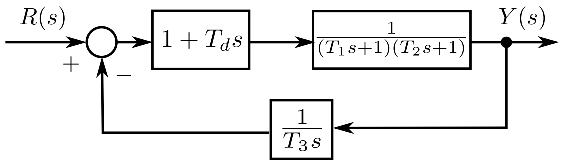

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

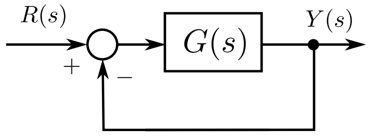

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+28}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 42\frac{rad}{sec}$. *Plot the step response*.

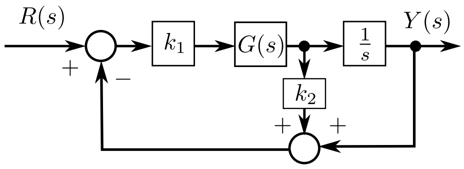

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.33229\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.933242\frac{Ns}{m}$, and $k = 7.10971\frac{N}{m}$.

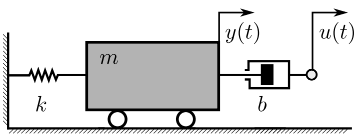

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 61

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/30sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

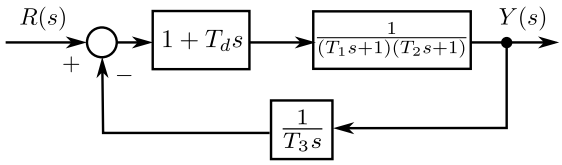

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/2)(s + 7)(s + 90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

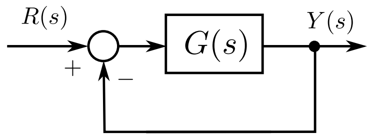

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+18}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 27\frac{rad}{sec}$. *Plot the step response*.

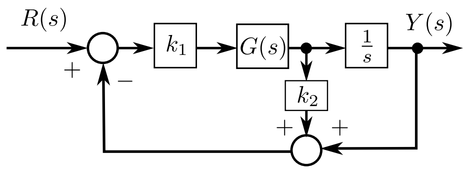

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.30921\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.789612\frac{Ns}{m}$, and $k = 3.07895\frac{N}{m}$.

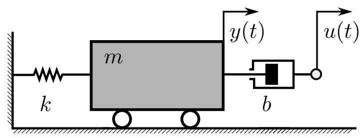

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 62

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/30sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

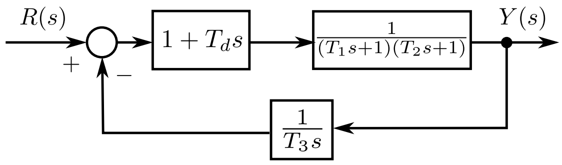

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/10)(s+9)(s+90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

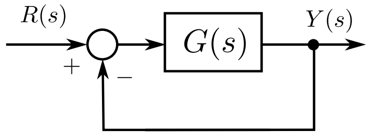

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+24}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 36\frac{rad}{sec}$. *Plot the step response*.

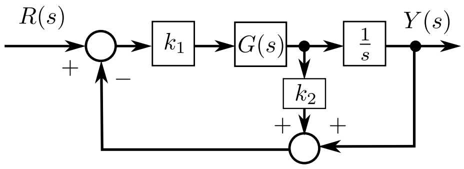

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.34023\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.971541\frac{Ns}{m}$, and $k = 3.12031\frac{N}{m}$.

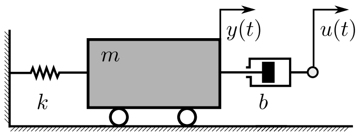

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____

Student's registration book number: __________________________________

Field of study: ____

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 63

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/100sec$, and $T_3 = 1/380sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

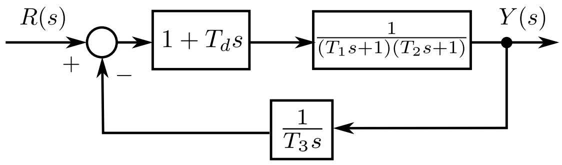

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

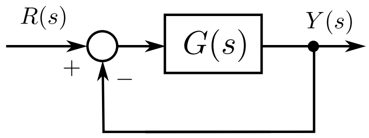

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+90}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 135\frac{rad}{sec}$. *Plot the step response*.

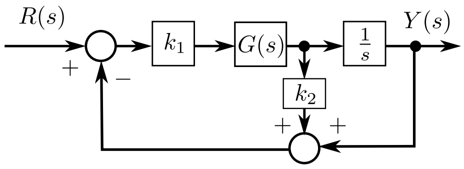

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.86214\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.94263\frac{Ns}{m}$, and $k = 10.4828\frac{N}{m}$.

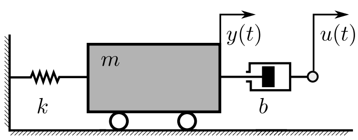

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 64

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/70sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

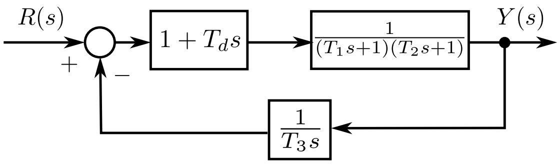

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/5)(s + 6)(s + 50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

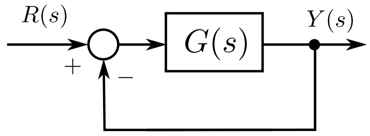

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+35}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 52.5\frac{rad}{sec}$. *Plot the step response.*

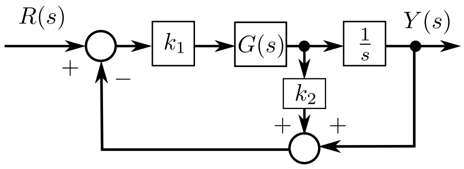

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.35826\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.06916\frac{Ns}{m}$, and $k = 7.14435\frac{N}{m}$.

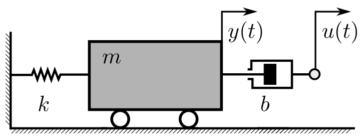

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 65

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/60sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

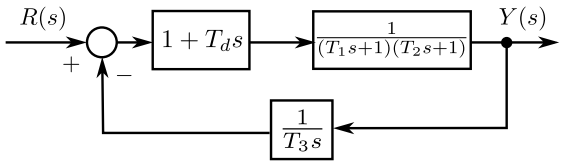

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

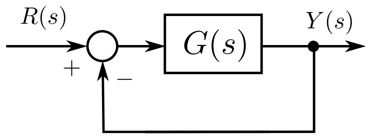

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+24}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 36\frac{rad}{sec}$. *Plot the step response.*

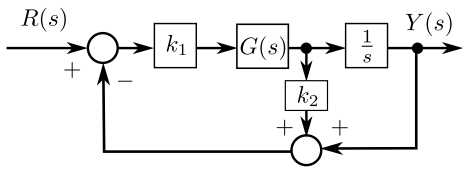

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.57053\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.864014\frac{Ns}{m}$, and $k = 6.09404\frac{N}{m}$.

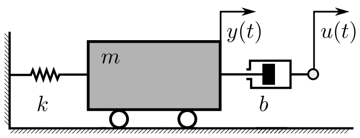

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 66

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/20sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

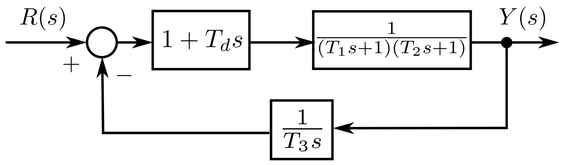

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 2/5)(s + 8)(s + 100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

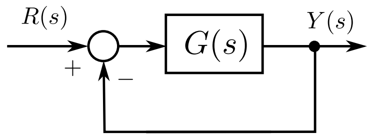

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+14}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 21\frac{rad}{sec}$. *Plot the step response*.

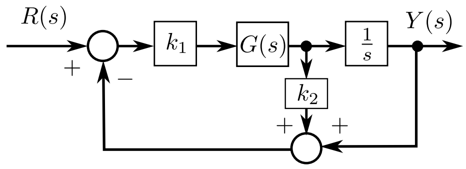

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.54919\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.718608\frac{Ns}{m}$, and $k = 2.06559\frac{N}{m}$.

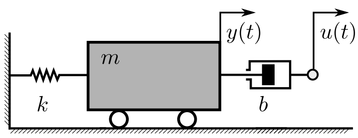

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 67

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/60sec$, and $T_3 = 1/160sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

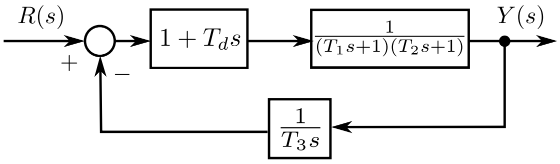

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ________________sec $\omega_{osc} =$ ________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

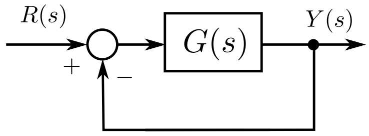

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+12}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 18\frac{rad}{sec}$. *Plot the step response.*

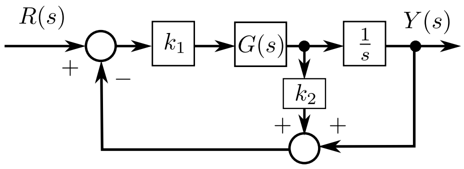

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ________________ $k_2 =$ ________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.53557\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.614788\frac{Ns}{m}$, and $k = 6.04743\frac{N}{m}$.

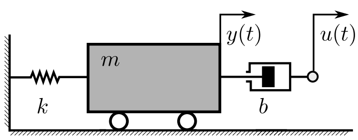

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ________________dB $\varphi(\omega) =$ ________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______

Student's registration book number: ______

Field of study: ______

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 68

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/60sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

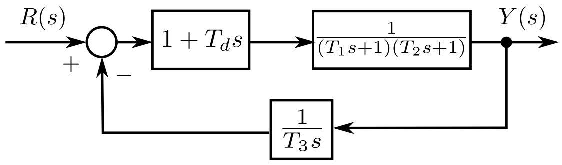

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______sec $\omega_{osc} =$ ______$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+4/5)(s+4)(s+60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

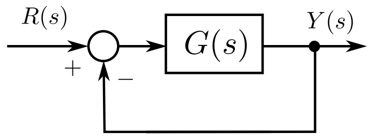

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+18}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 27\frac{rad}{sec}$. *Plot the step response*.

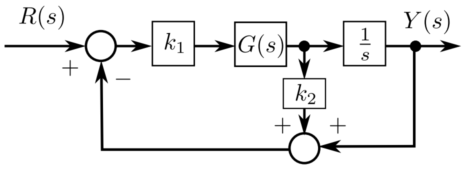

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______ $k_2 =$ ______

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.5515\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.73904\frac{Ns}{m}$, and $k = 6.06866\frac{N}{m}$.

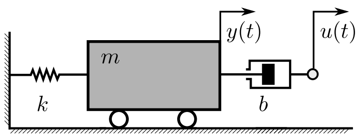

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______dB $\varphi(\omega) =$ ______$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 69

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40 sec$, $T_2 = 1/80 sec$, and $T_3 = 1/240 sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

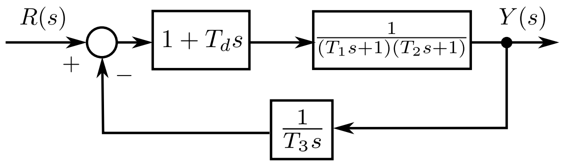

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

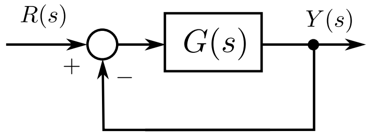

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+32}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 48 \frac{rad}{sec}$. *Plot the step response*.

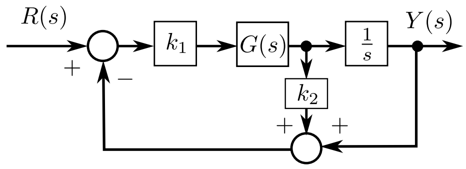

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.09404 \frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.997677 \frac{Ns}{m}$, and $k = 8.12539 \frac{N}{m}$.

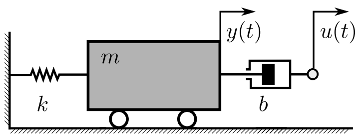

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 70

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/60sec$, and $T_3 = 1/280sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

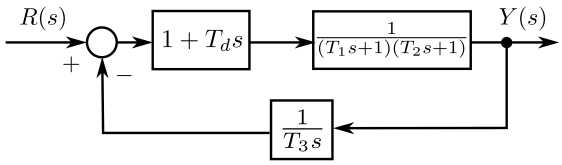

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/10)(s+9)(s+60)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

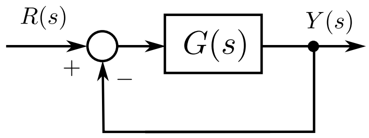

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+48}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 72\frac{rad}{sec}$. *Plot the step response*.

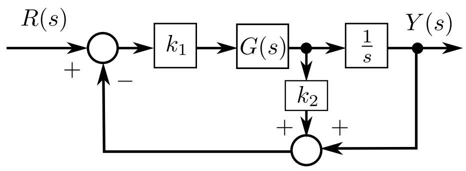

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 4.68046\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.37397\frac{Ns}{m}$, and $k = 6.24061\frac{N}{m}$.

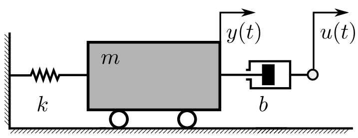

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 71

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/100sec$, and $T_3 = 1/320sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

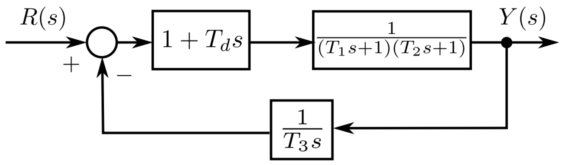

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/2)(s + 7)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

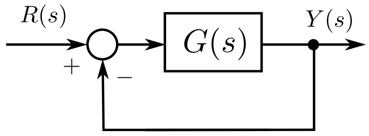

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+60}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 90\frac{rad}{sec}$. *Plot the step response*.

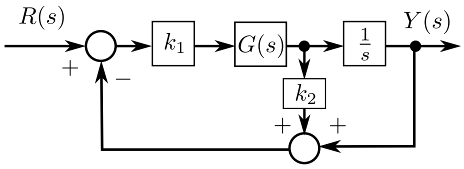

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.69737\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.44163\frac{Ns}{m}$, and $k = 10.2632\frac{N}{m}$.

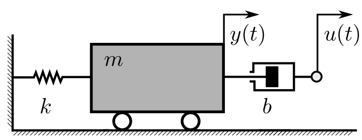

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 72

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/30sec$, and $T_3 = 1/100sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

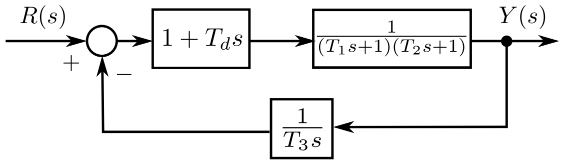

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

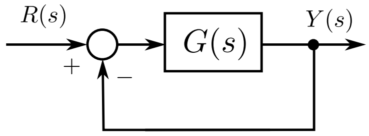

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+6}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 9\frac{rad}{sec}$. *Plot the step response*.

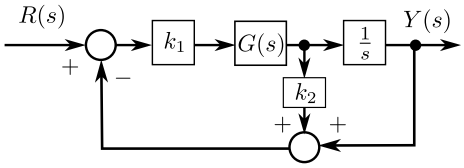

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.26779\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.434721\frac{Ns}{m}$, and $k = 3.02372\frac{N}{m}$.

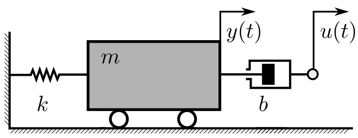

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 73

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/90sec$, and $T_3 = 1/320sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

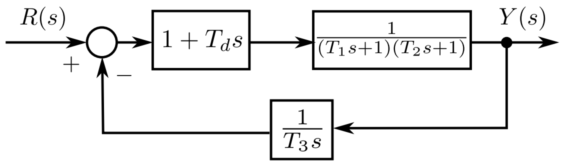

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+2/5)(s+8)(s+30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

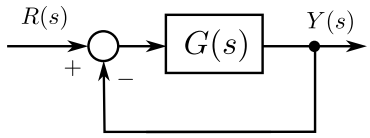

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+63}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 94.5\frac{rad}{sec}$. *Plot the step response.*

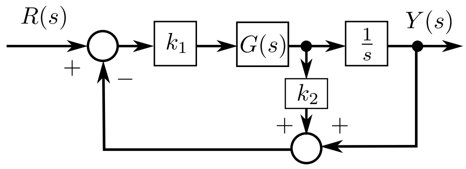

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.97137\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.5244\frac{Ns}{m}$, and $k = 9.29516\frac{N}{m}$.

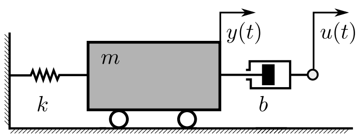

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ °

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 74

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/30sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

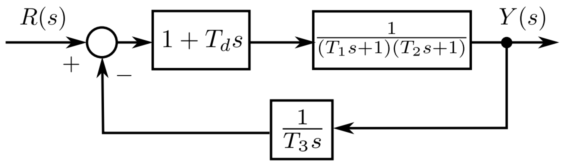

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+2/5)(s+8)(s+90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

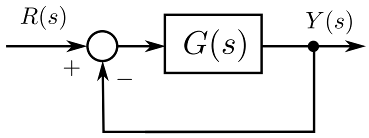

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+21}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 31.5\frac{rad}{sec}$. *Plot the step response*.

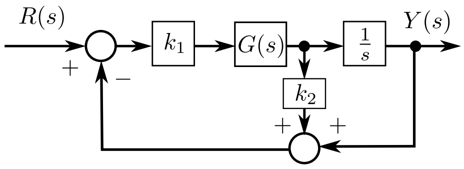

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin\omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.32379\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.880112\frac{Ns}{m}$, and $k = 3.09839\frac{N}{m}$.

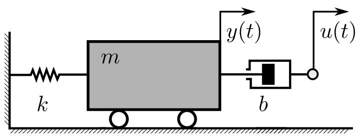

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 75

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/20sec$, $T_2 = 1/20sec$, and $T_3 = 1/80sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

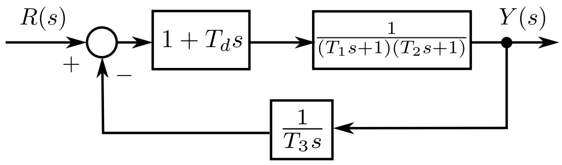

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 9/10)(s + 3)(s + 100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

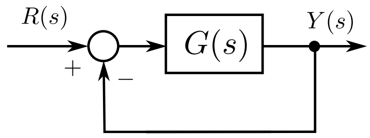

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+4}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 6\frac{rad}{sec}$. *Plot the step response*.

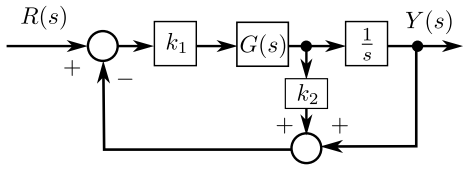

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.51186\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.354948\frac{Ns}{m}$, and $k = 2.01581\frac{N}{m}$.

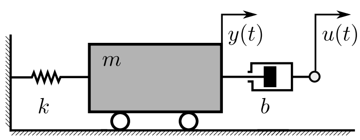

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 76

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/30sec$, and $T_3 = 1/160sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

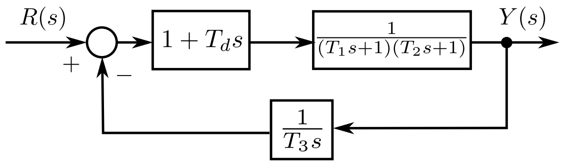

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/5)(s+6)(s+90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

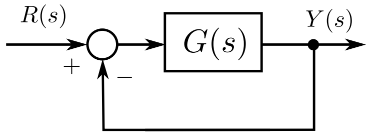

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+15}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 22.5\frac{rad}{sec}$. *Plot the step response*.

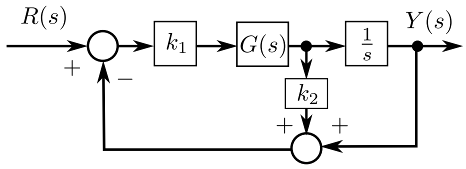

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.2964\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.699927\frac{Ns}{m}$, and $k = 3.06186\frac{N}{m}$.

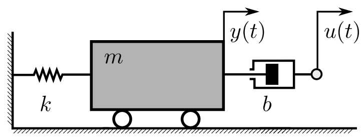

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 77

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/90sec$, and $T_3 = 1/300sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

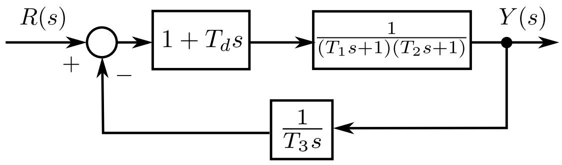

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/2)(s+7)(s+30)}.$$

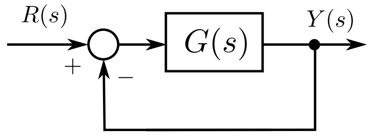

Figure 2: *Feedback control system in Problem 2*

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+54}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 81\frac{rad}{sec}$. *Plot the step response*.

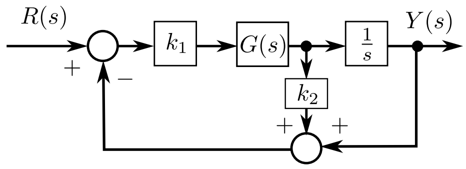

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.92763\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.36765\frac{Ns}{m}$, and $k = 9.23684\frac{N}{m}$.

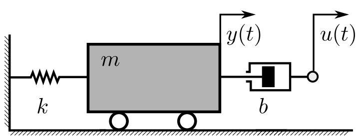

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 78

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/80sec$, and $T_3 = 1/320sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

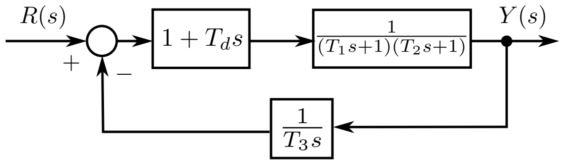

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/10)(s + 9)(s + 40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

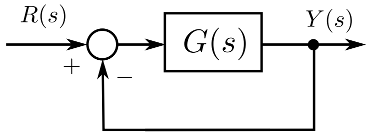

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+64}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 96\frac{rad}{sec}$. *Plot the step response*.

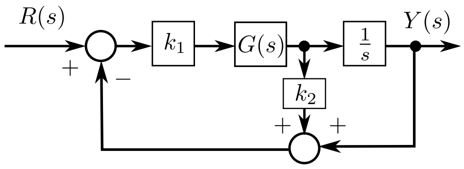

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.24061\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.58652\frac{Ns}{m}$, and $k = 8.32082\frac{N}{m}$.

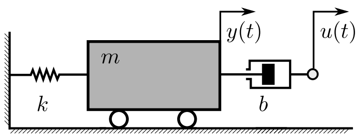

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 79

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50 sec$, $T_2 = 1/20 sec$, and $T_3 = 1/140 sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

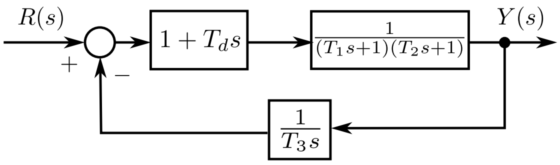

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/5)(s+6)(s+100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

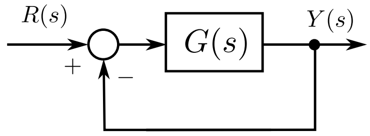

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+10}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 15 \frac{rad}{sec}$. *Plot the step response*.

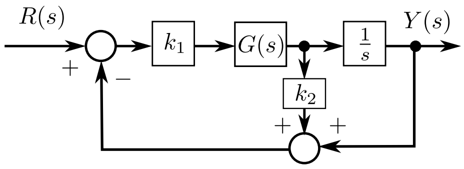

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.53093 \frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.571488 \frac{Ns}{m}$, and $k = 2.04124 \frac{N}{m}$.

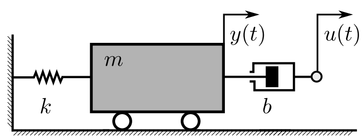

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ °

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 80

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/80sec$, and $T_3 = 1/300sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

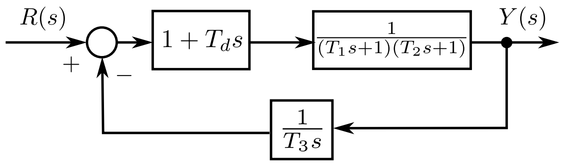

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 2/5)(s + 8)(s + 40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

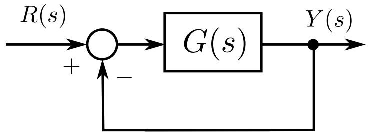

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+56}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 84\frac{rad}{sec}$. *Plot the step response*.

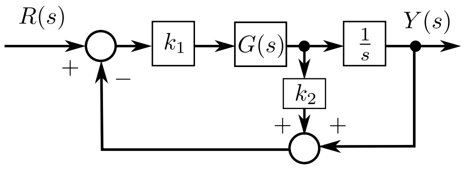

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.19677\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.43722\frac{Ns}{m}$, and $k = 8.26236\frac{N}{m}$.

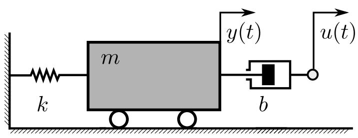

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 81

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/50sec$, and $T_3 = 1/280sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

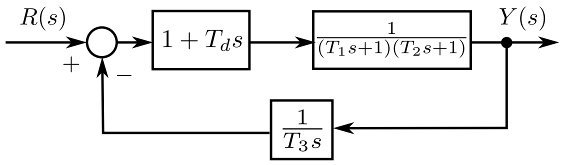

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

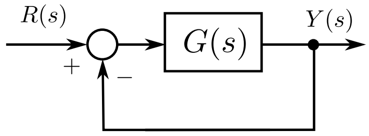

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+45}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 67.5\frac{rad}{sec}$. *Plot the step response*.

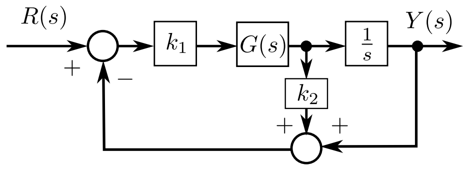

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.93107\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.37365\frac{Ns}{m}$, and $k = 5.24142\frac{N}{m}$.

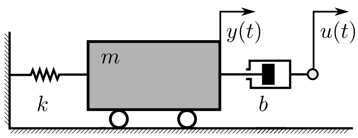

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 82

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/100sec$, and $T_3 = 1/280sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

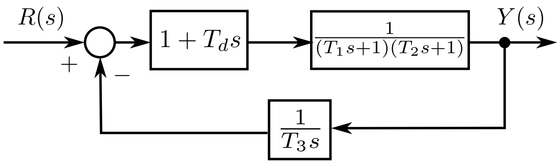

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________ sec $\omega_{osc} =$ ______________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

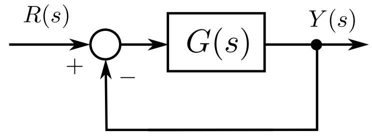

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+40}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 60\frac{rad}{sec}$. *Plot the step response.*

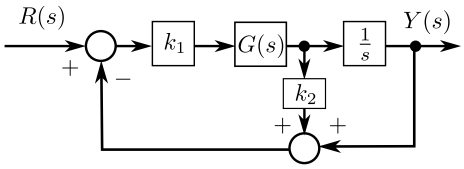

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________ $k_2 =$ ______________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.61755\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.11544\frac{Ns}{m}$, and $k = 10.1567\frac{N}{m}$.

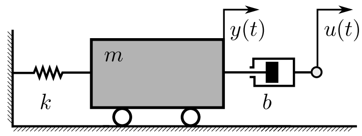

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________ dB $\varphi(\omega) =$ ______________ °

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 83

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/50sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

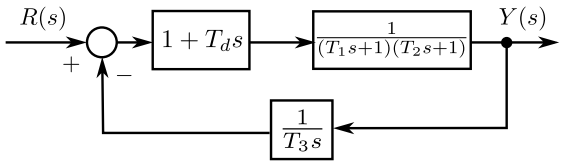

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

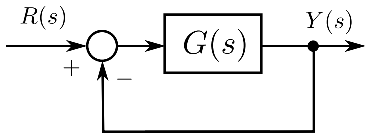

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+20}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 30\frac{rad}{sec}$. *Plot the step response*.

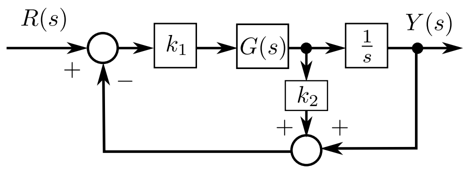

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.80878\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.788733\frac{Ns}{m}$, and $k = 5.07837\frac{N}{m}$.

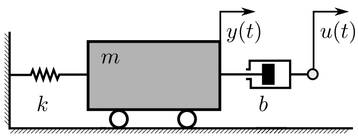

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 84

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/90sec$, and $T_3 = 1/200sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

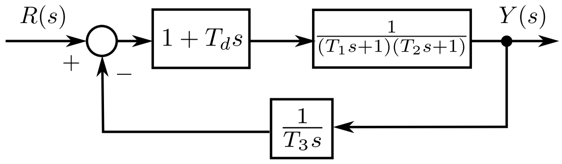

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+30)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

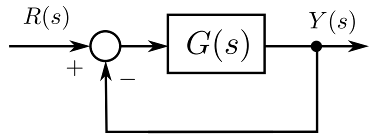

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+9}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 13.5\frac{rad}{sec}$. *Plot the step response.*

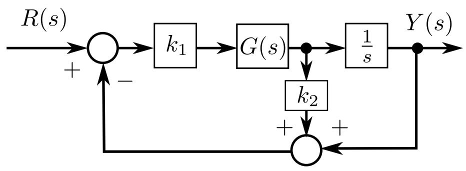

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.78401\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.601509\frac{Ns}{m}$, and $k = 9.04534\frac{N}{m}$.

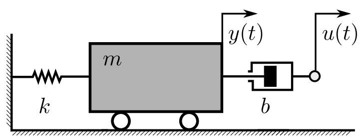

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 85

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90 sec$, $T_2 = 1/70 sec$, and $T_3 = 1/320 sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

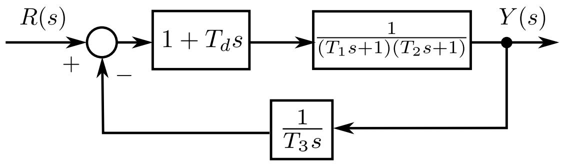

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

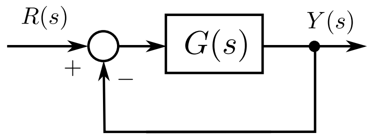

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+63}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 94.5 \frac{rad}{sec}$. *Plot the step response*.

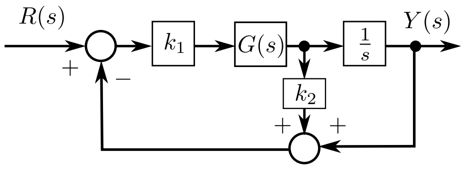

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.5035 \frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.62532 \frac{Ns}{m}$, and $k = 7.33799 \frac{N}{m}$.

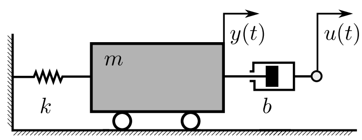

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 86

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/20sec$, and $T_3 = 1/60sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

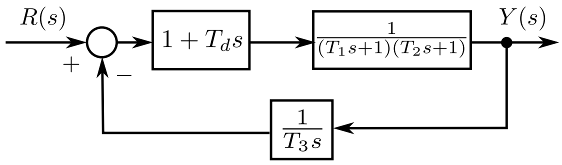

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ________________sec $\omega_{osc} =$ ________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

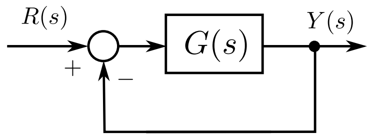

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+2}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 3\frac{rad}{sec}$. *Plot the step response*.

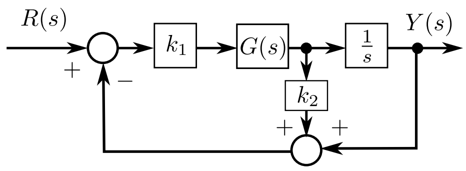

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ________________ $k_2 =$ ________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.50756\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.283554\frac{Ns}{m}$, and $k = 2.01008\frac{N}{m}$.

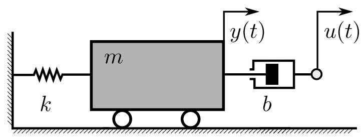

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ________________dB $\varphi(\omega) =$ ________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 87

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/70sec$, and $T_3 = 1/280sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

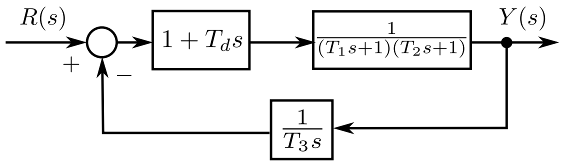

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 2/5)(s + 8)(s + 50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

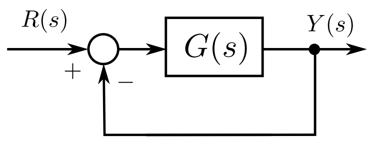

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+49}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 73.5 \frac{rad}{sec}$. *Plot the step response*.

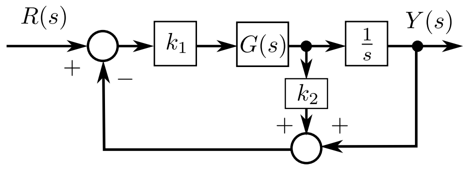

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.42218 \frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.34439 \frac{Ns}{m}$, and $k = 7.22957 \frac{N}{m}$.

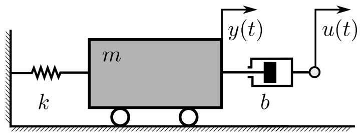

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 88

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/40sec$, $T_2 = 1/20sec$, and $T_3 = 1/120sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

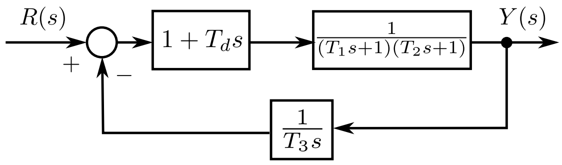

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\qquad \omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 7/10)(s + 5)(s + 100)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

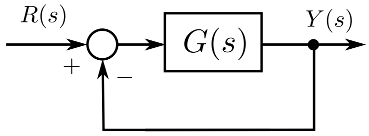

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+8}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 12\frac{rad}{sec}$. *Plot the step response*.

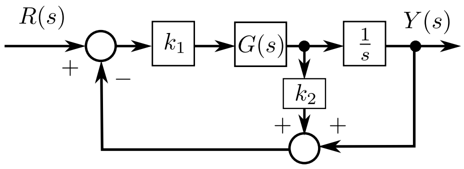

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $\qquad k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 1.52351\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.498839\frac{Ns}{m}$, and $k = 2.03135\frac{N}{m}$.

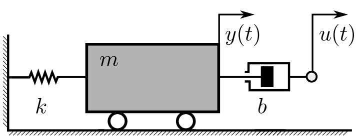

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\qquad \varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________

Student's registration book number: ______________________

Field of study: ______________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 89

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/70sec$, $T_2 = 1/100sec$, and $T_3 = 1/340sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

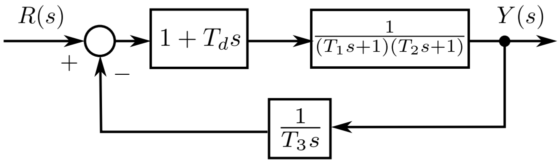

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 2/5)(s + 8)(s + 20)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

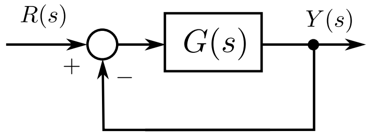

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+70}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 105\frac{rad}{sec}$. *Plot the step response*.

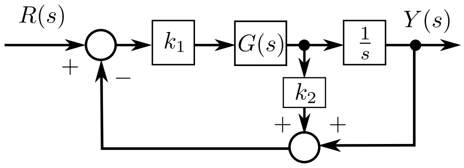

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 7.74597\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.60686\frac{Ns}{m}$, and $k = 10.328\frac{N}{m}$.

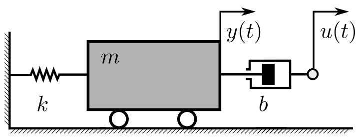

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 90

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/80sec$, and $T_3 = 1/340sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

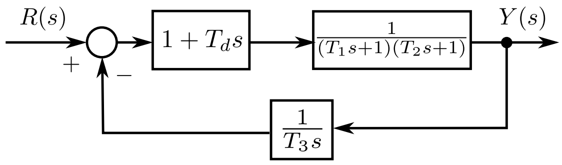

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

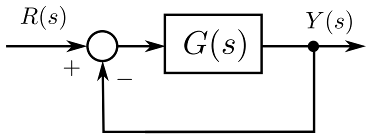

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+72}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 108\frac{rad}{sec}$. *Plot the step response*.

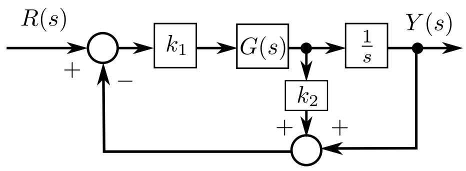

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.28971\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.73754\frac{Ns}{m}$, and $k = 8.38628\frac{N}{m}$.

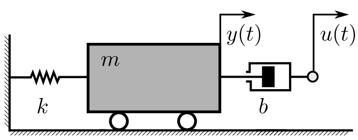

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________°

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 91

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/50sec$, $T_2 = 1/40sec$, and $T_3 = 1/180sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

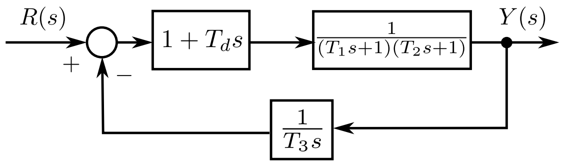

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________$\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 3/5)(s + 6)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

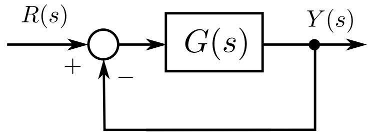

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+20}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 30\frac{rad}{sec}$. *Plot the step response*.

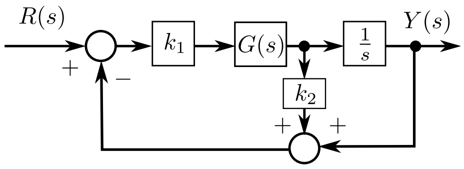

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.06186\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.808206\frac{Ns}{m}$, and $k = 4.08248\frac{N}{m}$.

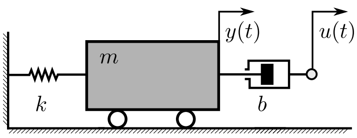

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 92

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/50sec$, and $T_3 = 1/300sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

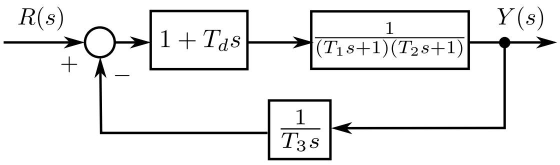

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/10)(s + 11)(s + 70)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

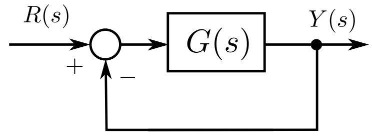

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+50}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 75\frac{rad}{sec}$. *Plot the step response*.

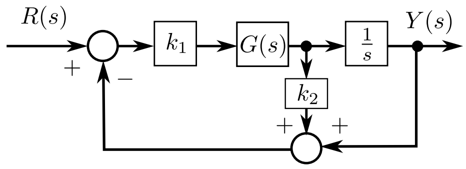

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.96526\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.49458\frac{Ns}{m}$, and $k = 5.28701\frac{N}{m}$.

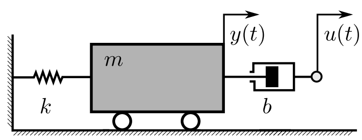

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0] The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 93

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/70sec$, and $T_3 = 1/340sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

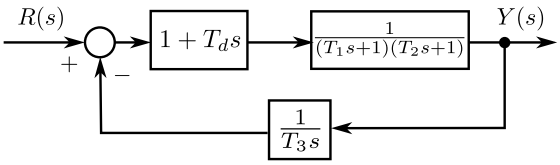

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________ sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/10)(s + 11)(s + 50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

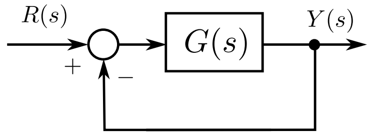

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+70}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 105\frac{rad}{sec}$. *Plot the step response*.

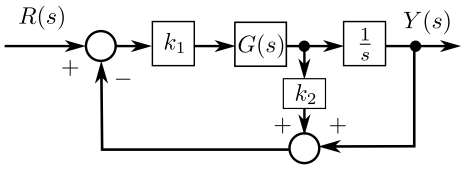

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.55136\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.76841\frac{Ns}{m}$, and $k = 7.40181\frac{N}{m}$.

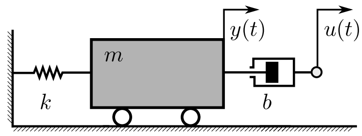

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________ dB $\varphi(\omega) =$ ______________________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 94

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/60sec$, $T_2 = 1/80sec$, and $T_3 = 1/280sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

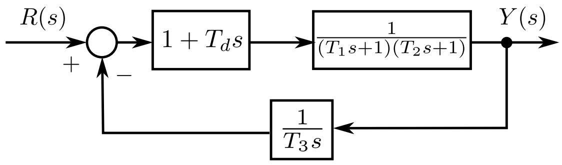

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1/2)(s+7)(s+40)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

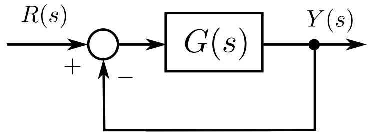

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+48}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 72\frac{rad}{sec}$. *Plot the step response*.

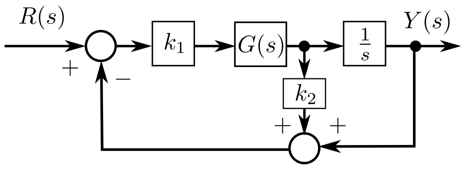

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 6.1579\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.28943\frac{Ns}{m}$, and $k = 8.21053\frac{N}{m}$.

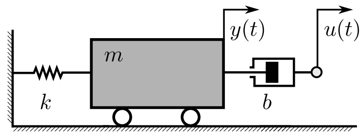

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 95

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/80sec$, $T_2 = 1/70sec$, and $T_3 = 1/300sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

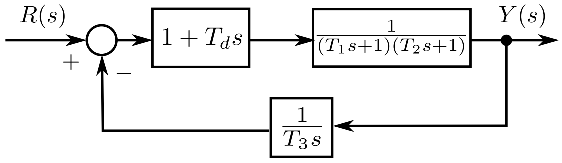

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________________sec $\omega_{osc} =$ ______________________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+3/10)(s+9)(s+50)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

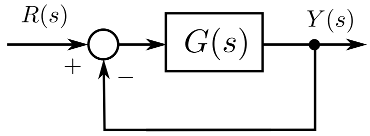

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+56}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 84\frac{rad}{sec}$. *Plot the step response*.

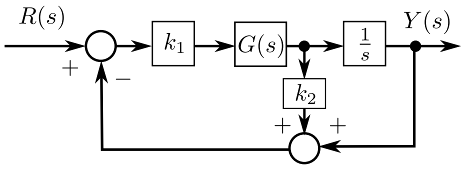

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________________ $k_2 =$ ______________________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 5.46054\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.48405\frac{Ns}{m}$, and $k = 7.28071\frac{N}{m}$.

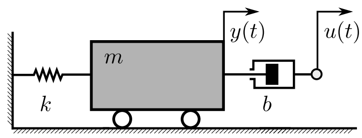

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________________dB $\varphi(\omega) =$ ______________________________$^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 96

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/10sec$, and $T_3 = 1/80sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

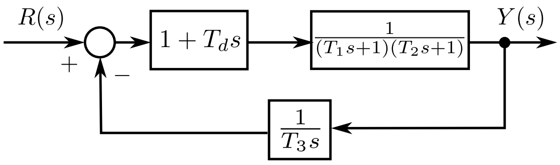

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ __________________ sec $\omega_{osc} =$ __________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 4/5)(s + 4)(s + 110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

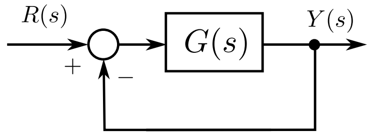

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ __________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+3}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 4.5\frac{rad}{sec}$. *Plot the step response*.

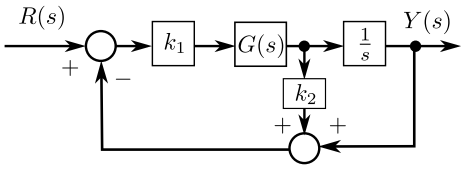

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ __________________ $k_2 =$ __________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.758583\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.301712\frac{Ns}{m}$, and $k = 1.01144\frac{N}{m}$.

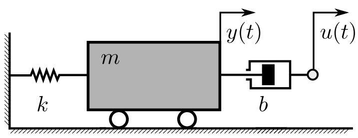

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ __________________ dB $\varphi(\omega) =$ __________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ______________________________

Student's registration book number: ______________________________

Field of study: ______________________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 97

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/30sec$, $T_2 = 1/40sec$, and $T_3 = 1/140sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

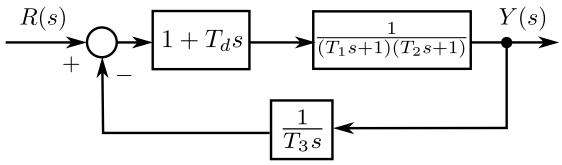

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ______________________ sec $\omega_{osc} =$ ______________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 4/5)(s + 4)(s + 80)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

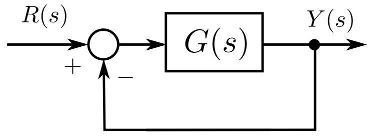

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ______________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+12}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 18\frac{rad}{sec}$. *Plot the step response*.

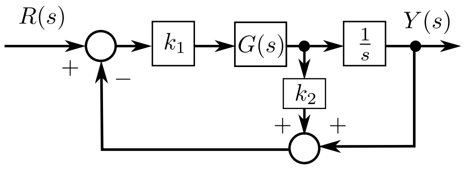

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ______________________ $k_2 =$ ______________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 3.03433\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.603423\frac{Ns}{m}$, and $k = 4.04577\frac{N}{m}$.

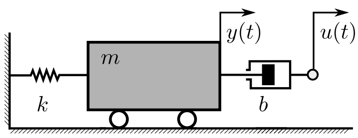

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ______________________ dB $\varphi(\omega) =$ ______________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 98

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/100sec$, $T_2 = 1/10sec$, and $T_3 = 1/220sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

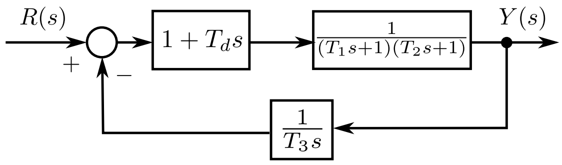

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/10)(s + 11)(s + 110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

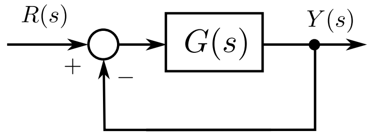

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+10}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 15\frac{rad}{sec}$. *Plot the step response*.

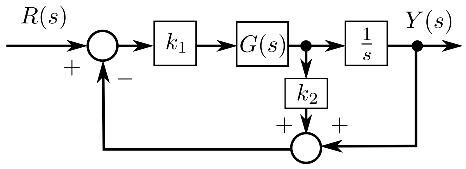

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.793052\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.668395\frac{Ns}{m}$, and $k = 1.0574\frac{N}{m}$.

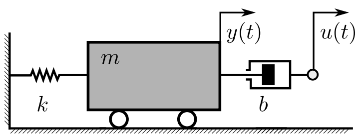

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 99

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/10sec$, $T_2 = 1/10sec$, and $T_3 = 1/40sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

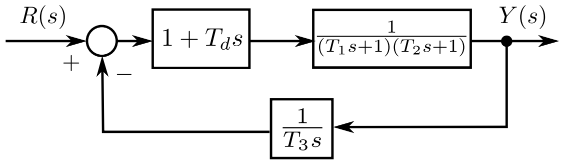

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s+1)(s+2)(s+110)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain* K.

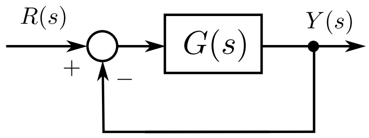

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+1}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 1.5\frac{rad}{sec}$. *Plot the step response*.

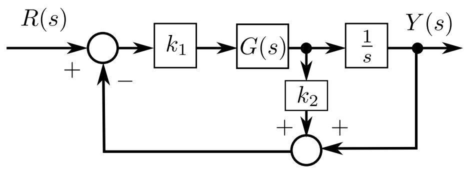

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response* $y(t)$ and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 0.753778\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 0.200503\frac{Ns}{m}$, and $k = 1.00504\frac{N}{m}$.

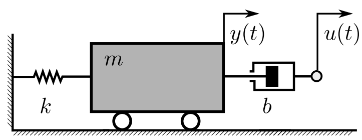

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00

Name and surname (legibly): ____________________

Student's registration book number: ____________________

Field of study: ____________________

Please write your answers to three decimal places and enclose the solutions to each problem.

PROBLEM SET 100

Problem 1

Consider the feedback control system given in Fig. 1, where $T_1 = 1/90sec$, $T_2 = 1/30sec$, and $T_3 = 1/240sec$. Determine the value of the constant T_d of the PD controller when the system oscillates and calculate the angular frequency of these oscillations.

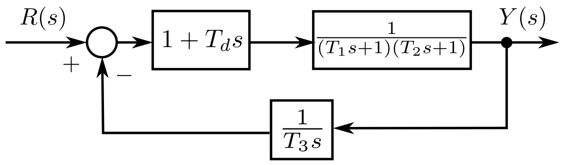

Figure 1: *Feedback control system in Problem 1*

Answer: $T_d =$ ____________________ sec $\omega_{osc} =$ ____________________ $\frac{rad}{sec}$

Problem 2

Consider a unity feedback control system shown in Fig. 2 with the open-loop transfer function

$$G(s) = \frac{K}{(s + 1/5)(s + 10)(s + 90)}.$$

Analitically find the gain K such that the gain margin is less than $10dB$. *Plot the Nyquist plot for the calculated gain K.*

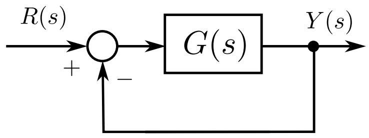

Figure 2: *Feedback control system in Problem 2*

Answer: $K =$ ____________________

Problem 3

A feedback control system has the structure shown in Fig. 3, where $G(s) = \frac{1}{s+27}$ Assume that $k_1 > 0$, $k_2 > 0$ and select the gains k_1 and k_2 such that the closed-loop response to a step input is critically damped, and the natural frequency is equal to $\omega_n = 40.5\frac{rad}{sec}$. *Plot the step response*.

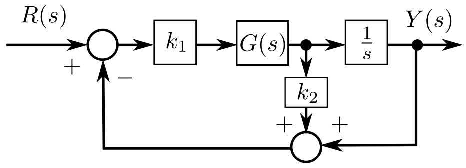

Figure 3: *Feedback control system in Problem 3*

Answer: $k_1 =$ ____________________ $k_2 =$ ____________________

Problem 4

A mechanical system is shown in Fig. 4. Assume that the input and output are the displacements $u(t)$ and $y(t)$, respectively. The displacement $y(t)$ is measured from the equilibrium position. Suppose that $u(t) = \sin \omega t$. What is the output $y(t)$ at steady-state? *Plot the response $y(t)$* and find the magnitude (in dB) and phase angle (in degrees) for $\omega = 2.35864\frac{rad}{sec}$. *Graph the Bode plots for the system.* Assume that the system is linear throughout the operating period and $m = 1kg$, $b = 1.06402\frac{Ns}{m}$, and $k = 3.14485\frac{N}{m}$.

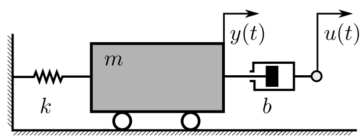

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ ____________________ dB $\varphi(\omega) =$ ____________________ $^\circ$

Problem	No. 1	No. 2	No. 3	No. 4	Total
Points					

[0]The problem set has been generated December 15, 2020 , 10:42:00