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.

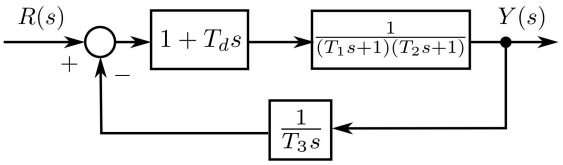

Figure 1: *Feedback control system in Problem 1*

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.

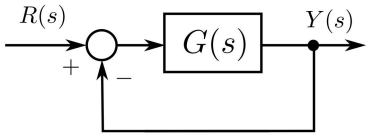

Figure 2: *Feedback control system in Problem 2*

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*.

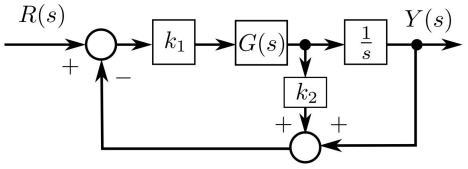

Figure 3: *Feedback control system in Problem 3*

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 $k = 7.18421\frac{N}{m}$.

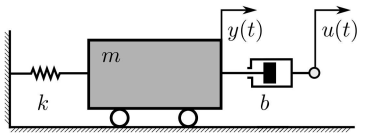

Figure 4: *Mechanical system in Problem 4*

Answer: $L(\omega) =$ _____dB $\varphi(\omega) =$ _____$^\circ$

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

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