ECE 486 First Midterm Exam: Sample

This is a *closed-book closed-notes* test, with only one sheet of notes (double-sided) allowed, and no calculators. For scratch work you may use backs of pages and the additional sheets provided. You have three problems to solve in 80 minutes.

Good luck!

Full Name: ....

Problem 1: ..... / 10 points

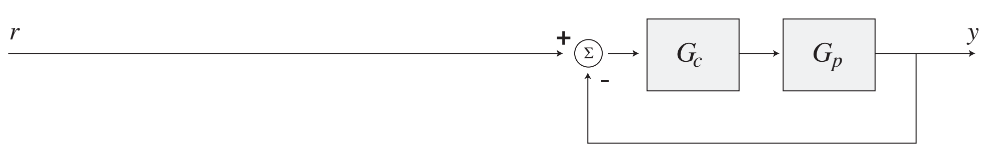
Problem 2: ..... / 20 points

Problem 3: ..... / 20 points

TOTAL: ..... / 50 points

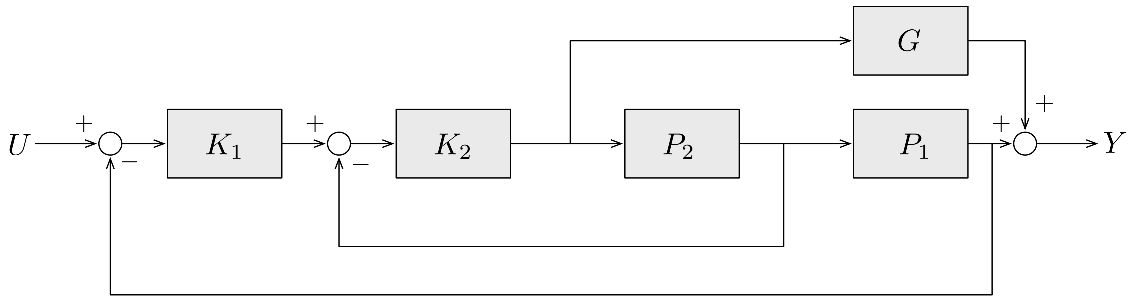
Useful approximations for 2nd-order system, $H(s) = \dfrac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$

Rise time, peak time, settling time, $t_r \approx \dfrac{1.8}{\omega_n}$ $t_p = \dfrac{\pi}{\omega_n\sqrt{1-\zeta^2}}$ $t_s^{5\%} \approx \dfrac{3}{\zeta\omega_n}$



Problem 1 (10 points)

Consider the system given by the block diagram below:



Compute the transfer function from the input U to the output Y.

(Your answer should be an expression involving the transfer functions K_1, K_2, P_1, P_2, G.)

Problem 2 (20 points) *5+15*

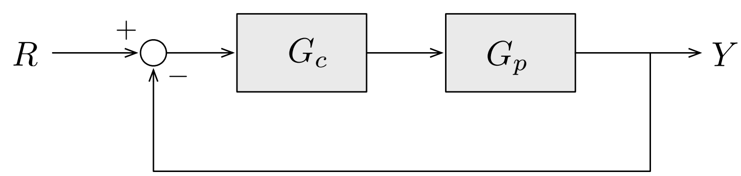
An unknown second-order system of the type shown on the front page of this exam has peak time $t_p = 0.5$ sec. and 5% settling time $t_s = 1.5$ sec.

(a) Determine the poles of this system.

(b) Does this system satisfy the spec $t_r \leq 0.18$ sec.? *Justify your answer!*

Problem 3 (20 points)

A linear time invariant system with transfer function G_p is to be controlled using unity feedback as in the diagram shown on the front of this exam:



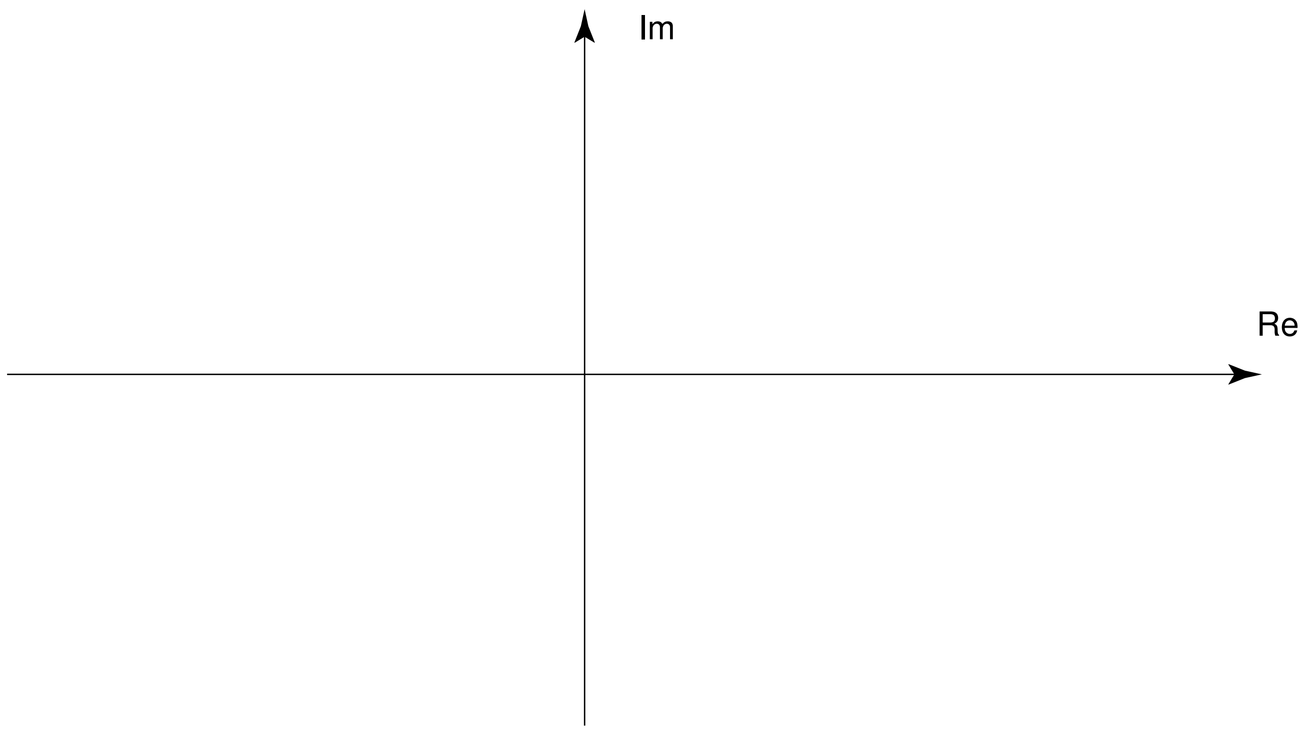
The transfer function of the plant is $G_p(s) = \dfrac{1}{s^2 - 1}$.

A controller with transfer function $G_c(s) = K\dfrac{s}{s+1}$ is applied to this system. On the next page,

1. Give a sketch of the root locus of the closed-loop system for $K > 0$.

2. Indicate the range of $K > 0$ for which the resulting closed-loop system is stable.

You *must* base your answer on the resulting root locus.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