A System Theory – Midterm-type exam June 20, 2017

Name and group: ______________________________

This exam is closed-books. Write your name on every page. Write clearly and legibly. Explain your work in words

P1 (1p). Circle the right answer: (**T**rue OR **F**alse OR **I D**on't **K**now) *(0.2p correct answer, -0.1p wrong answer, 0p IDK)*

[T F IDK] The equivalent transfer function for two linear systems with the transfer functions $G_1(s)$ and $G_2(s)$ connected in parallel is $G_1(s)G_2(s)$.

[T F IDK] A system having the poles -2 and -3 is overdamped.

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[T F IDK] The eigenvalues of the system matrix are the zeros of the system.

[T F IDK] The order of a system is equal to the number of zeros.

P2 (1.5p). For a closed-loop system with the characteristic equation:

$$1 + k\frac{s^2 + 2s + 2}{(s-1)(s+3)} = 0$$

A) (1p) Sketch the root locus.
B) (0.5p) Determine the range of *k* for which the closed-loop poles are real and negative.

P3 (1.5p). A system having the input *u(t)* and the output *y(t)* is described by the differential equation:

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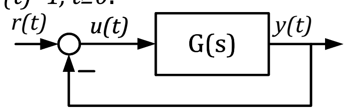

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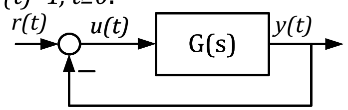

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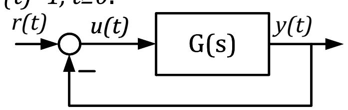

A System Theory – Final exam June 20, 2017

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$$G(s) = \frac{10^{-1}(10^2 s + 1)(10^{-1} s + 1)}{s^2 + s + 1}$$

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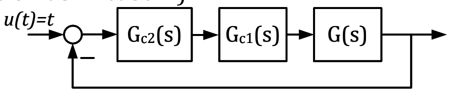
B) (0.5p) Determine the frequencies for which the magnitude of the output signal is the same as the magnitude of the input signal.

P2 (2.5p). Consider a unity negative feedback control system with the open loop-transfer function: $G(s) = \frac{1}{s+2}$

A) (1.5p) Design an ideal PI compensator with the transfer function $G_{c1}(s) = K_P + \frac{K_I}{s}$, so that the closed-loop system has the natural frequency $\omega_n = 2\sqrt{2}$ and the settling time t_s=2 sec.

B) (1p) Add another compensator (see the figure below), with the transfer function $G_{c2}(s) = \frac{s+z}{s+p}$, (with |z| >|p|), so that the velocity error constant is K_{vcomp} = 32 and the dominant closed-loop poles are located in approximately the same position as in case A).



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$$G(z) = \frac{Y(z)}{U(z)} = \frac{z-1}{z^2 - 2az + a^2}$$

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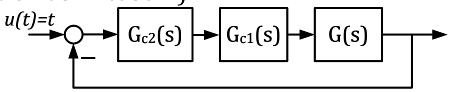

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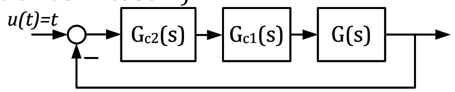

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B System Theory – Midterm-type exam June 20, 2017

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[T F IDK] A system is stable if all poles lie in the left half-plane.

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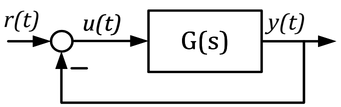

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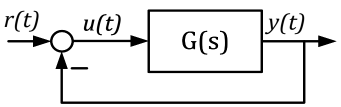

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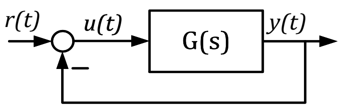

B System Theory – Final exam June 20, 2017

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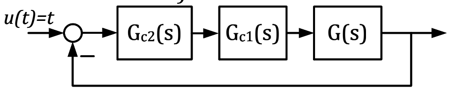

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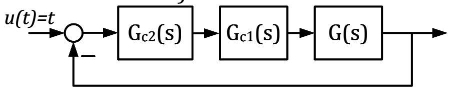

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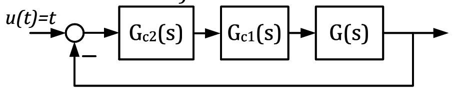

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