ITMO

TEST 1

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Preliminary

The test consists of 10 questions with answers (5 points max)

You have 1 attempt.

Any new attempt gives you 0,5-point penalty.

In the case of anonymous answer (like «Name – 1, HDU ID – 1 ……»)
ALL students will receive 0,5-point penalty for each case.

All questions are in this presentation.
Form with answers can be filled here:

https://forms.yandex.ru/u/67c99d4c068ff011cc426dcb/

Question 1

Consider the differential equation of RL-circuit:

$$L\frac{di}{dt} = U - Ri$$

$$R = 1.5$$

$$L = 0.006$$

Calculate the settling time within 5% tolerance for the step response of the voltage U

a) 0.004 c

b) 0.008 c

c) 0.012 c

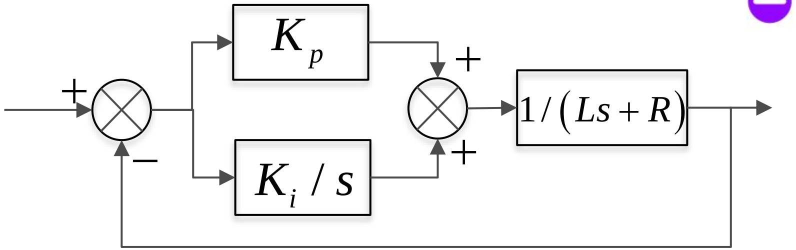
d) 0.009 c

e) 0.006 c

f) 0.018 c

Question 2

Consider the closed-loop system with the first order transfer function and proportional-integral controller.



Calculate symbolical equations for K_p and K_i that gives us the closed loop transfer function of the form: $W_{CL} = \dfrac{\omega_c}{s+\omega_c}$

a) $K_p = R \cdot \omega_c, K_i = L \cdot \omega_c$ b) $K_p = \dfrac{L}{R} \cdot \omega_c, K_i = 1$ c) $K_p = R \cdot \omega_c^2, K_i = L \cdot \omega_c^2$

d) $K_p = 1, K_i = \dfrac{L}{R} \cdot \omega_c$ e) $K_p = L \cdot \omega_c, K_i = R \cdot \omega_c$ f) $K_p = L \cdot \omega_c^2, K_i = R \cdot \omega_c^2$

Question 3

Consider the second order transfer function with the follows form:

$$W(s) = \frac{50000}{s^2 + 5s + 2500}$$

Determine *percent overshoot* of the output signal for unit step response.

a) $\approx 85.5\%$ b) $\approx 62.5\%$ c) $\approx 43\%$

d) $\approx 46.1\%$ e) $\approx 38.5\%$ f) 0

Question 4

Consider the second order transfer function with the follows form:

$$W(s) = \frac{100000}{s^2 + 50s + 10000}$$

Determine *damped natural frequency* of the output signal for unit step response.

a) $\approx 100\,rad/s$

b) $\approx 10\,rad/s$

c) $\approx 96.8\,rad/s$

d) $\approx 48.4\,rad/s$

e) $\approx 103.1\,rad/s$

f) $\approx 51.6\,rad/s$

Question 5

Consider the second order transfer function with the follows form:

$$W(s) = \frac{100000}{s^2 + 100s + 10000}$$

Determine *peak time* of the output signal for unit step response.

a) $\approx 0.009\ s$

b) $\approx 0.018\ s$

c) $\approx 0.288\ s$

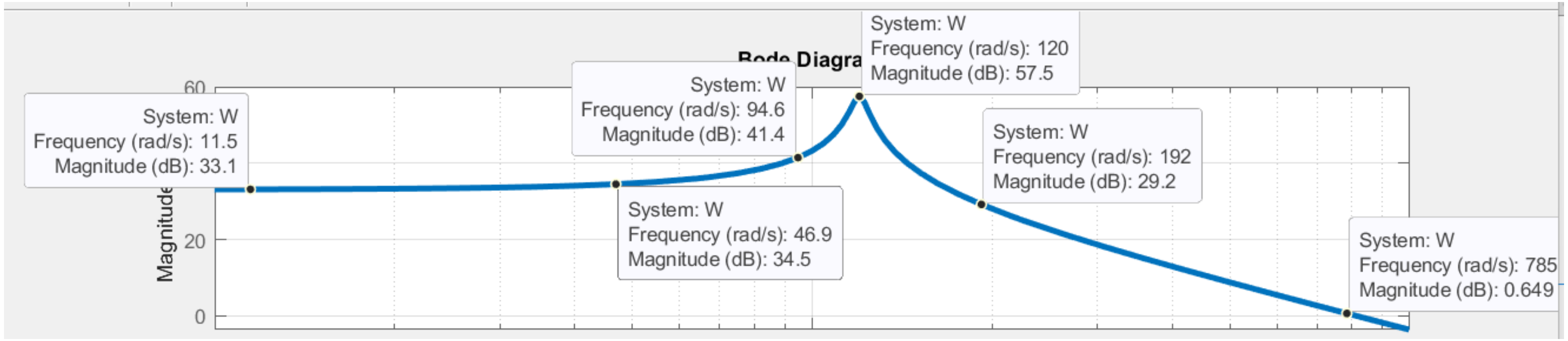
d) $\approx 0.036\ s$

e) $\approx 0.144\ s$

f) $\approx 0.072\ s$

Question 6

Consider the system with the follows bode plot. Find the static gain of the such system.



a) ≈ 45

b) ≈ 53

c) ≈ 117.5

d) ≈ 750

e) ≈ 28.8

f) ≈ 1.1

Question 7

Consider the DC motor described by the follows equations:

$$\begin{cases} 0.0005 \cdot \dfrac{di_a}{dt} = U - 0.1 \cdot i_a - 0.2 \cdot \omega \\ 0.02 \cdot \dfrac{d\omega}{dt} = 0.2 \cdot i_a - T_L \end{cases}$$

Calculate poles of the transfer function from the voltage to speed.

a) $s_{12} \approx -0.0500 \pm 1.4i$

b) $s_1 \approx -57.3,\ s_2 \approx -12.1$

c) $s_1 \approx -388.4,\ s_2 \approx -135.7$

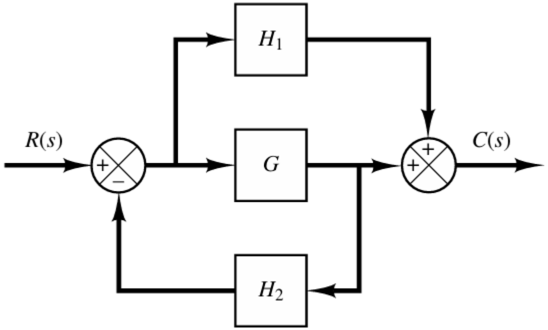
d) $s_1 \approx -199.6,\ s_2 \approx -0.4$

e) $s_{12} \approx -0.0500 \pm 0.2i$

f) $s_1 \approx -177.5,\ s_2 \approx -22.5$

Question 8

Consider the follows block diagram:



Simplify this to 1 transfer function from R(s) to C(s).

a) $W(s) = \dfrac{G - H_1}{1 + GH_2}$

b) $W(s) = \dfrac{G + H_2}{1 + GH_1}$

c) $W(s) = \dfrac{G + H_1}{1 + GH_2}$

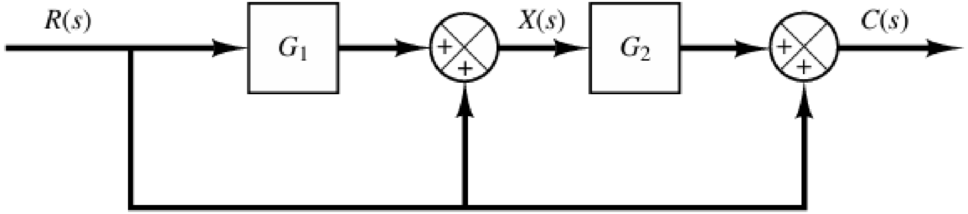
d) $W(s) = \dfrac{G + H_1}{1 + H_1 H_2}$

e) $W(s) = \dfrac{G + H_1}{1 - GH_2}$

f) $W(s) = \dfrac{G - H_2}{1 + GH_1}$

Question 9

Consider the follows block diagram:



Simplify this to 1 transfer function from R(s) to C(s).

a) $W(s) = G_1 G_2 + G_1 + 1$

b) $W(s) = G_1 G_2 + G_2 + 1$

c) $W(s) = G_1 G_2 - G_2 - 1$

d) $W(s) = \dfrac{G_1 G_2}{G_2 + 1}$

e) $W(s) = \dfrac{G_1 G_2}{G_1 + 1}$

f) $W(s) = \dfrac{G_1 + G_2}{G_1}$

Question 10

Consider the dynamic system that is described by the follows differential equation: $2\ddot{y} + 4\dot{y} + 12y = u$

Also, that can be described in state space form with some coefficients a_{21}, a_{22}, b_{21}:

$$\dot{x}_1 = x_2$$
$$\dot{x}_2 = a_{21}x_1 + a_{22}x_2 + b_{21}u$$
$$y = x_1$$

Find the value of the coefficient a_{21}

a) $a_{21} = -3$

b) $a_{21} = -2$

c) $a_{21} = 3$

d) $a_{21} = -6$

e) $a_{21} = 6$

f) $a_{21} = -4$

THANK YOU
FOR YOUR TIME!