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ECE-320,
Quiz #5

For all of the following problems, assume we are using a two-sided z-transform.

1) The z-transform of a sequence $x(n)$ is defined as

a) $X(z) = \sum_{k=-\infty}^{\infty} x(k) z^{k}$ b) $X(z) = \sum_{k=-\infty}^{\infty} x(k) z^{-k}$

2) The z-transform of the sequence $x(n) = 3^n u(n)$ is

a) $\frac{z}{3-z}$ b) $\frac{1}{z-3}$ c) $\frac{1}{3-z}$ d) $\frac{z}{z-3}$ e) none of these

3) The z-transform of $x(n) = u(n)$ is

a) $\frac{z}{z-1}$ b) $\frac{1}{z-1}$ c) $\frac{1}{1-z}$ d) $\frac{z}{1-z}$ e) none of these

4) The z-transform of $x(n) = u(n-1)$ is

a) $\frac{z}{z-1}$ b) $\frac{1}{z-1}$ c) $\frac{1}{1-z}$ d) $\frac{z}{1-z}$ e) none of these

5) The z-transform of the sequence $x(n) = \delta(n)$ is

a) 1 b) z c) z^{-1} d) 0 e) none of these

6) The z-transform of the sequence $x(n) = \delta(n-1)$ is

a) 1 b) z c) z^{-1} d) 0 e) none of these

7) The z-transform of the sequence $x(n) = 3^{n+1} u(n)$ is

a) $\frac{3z}{z-3}$ b) $\frac{1}{3}\frac{z}{z-3}$ c) $\frac{1}{3}\frac{z^2}{z-3}$ d) $\frac{3z^2}{z-3}$ e) none of these

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8) The z-transform of the sequence $x(n)=3^n u(n-1)$ is

a) $\frac{3}{z-3}$ b) $\frac{3z}{z-3}$ c) $\frac{9z}{z-3}$ d) $\frac{9}{z-3}$ e) none of these

9) The z-transform of the sequence $x(n)=3^n u(n+1)$ is

a) $\frac{3z^2}{z-3}$ b) $\frac{1}{3}\frac{z}{z-3}$ c) $\frac{1}{9}\frac{z^2}{z-3}$ d) $\frac{1}{3}\frac{z^2}{z-3}$ e) none of these

10) The z-transform of the sequence $x(n)=2^n u(n)$ converges provided

a) $2<|z|$ b) $|z|<2$

11) The z-transform of the sequence $x(n)=\left(\frac{1}{3}\right)^n u(n-1)$ converges provided

a) $\frac{1}{3}<|z|$ b) $|z|<\frac{1}{3}$

12) For z-transform $Y(z)=\frac{z^{-1}}{z-2}$, the inverse z-transform is

a) $y(n)=2^n u(n)$ b) $y(n)=2^{n-2}u(n-2)$ c) $y(n)=2^{n+2}u(n+2)$ d) $y(n)=2^{n-2}u(n)$ e) none of these

13) For z-transform $Y(z)=\frac{1}{z-2}$, the inverse z-transform is

a) $y(n)=\frac{1}{2}\delta(n)-\frac{1}{2}2^n u(n)$ b) $y(n)=-\frac{1}{2}\delta(n)+\frac{1}{2}2^n u(n)$

14) Which of the following transfer functions represents an (asymptotically) unstable systems? (circle all of them)

a) $G(z)=\frac{z}{z+0.8}$ b) $G(z)=\frac{z}{z-0.8}$ c) $G(z)=\frac{z}{z+1.2}$ d) $G(z)=\frac{z}{z-1.2}$

15) Which of the following systems will have a smaller settling time?

a) $G(z)=\frac{z}{z-0.9}$ b) $G(z)=\frac{z}{z-0.7}$ c) $G(z)=\frac{z}{z+0.5}$ d) $G(z)=\frac{z}{z+0.1}$

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For problems 6-18 , consider a closed loop system with transfer function

$$G_0(s) = \frac{s+a}{s^2+bs+k}$$

16) The sensitivity to variations in k, $S_k^{G_0}(s)$, is

a) $\frac{k}{s^2+bs+k}$ b) $\frac{-k}{s^2+bs+k}$ c) 1 d) $\frac{k}{s+a} - \frac{k}{s^2+bs+k}$ e) none of these

17) The sensitivity to variations in b, $S_b^{G_0}(s)$, is

a) $\frac{-b}{s^2+bs+k}$ b) $\frac{-bs}{s^2+bs+k}$ c) 1 d) $\frac{b}{s+a} - \frac{bs}{s^2+bs+k}$ e) none of thes

18) The sensitivity to variations in a, $S_a^{G_0}(s)$, is

a) $\frac{a}{s^2+bs+k}$ b) $\frac{-a}{s^2+bs+k}$ c) 1) d) $\frac{a}{s+a}$ e) none of these

19) Assume we compute the sensitivity of a system with nominal value $a = 4$ to be

$$S_a^{G_0}(s) = \frac{1}{s+a}$$

For what frequencies will the sensitivity function be less than $\frac{1}{\sqrt{32}}$?

a) $\omega < 4 \text{ rad/sec}$ b) $\omega > 4 \text{ rad/sec}$ c) $\omega > 16 \text{ rad/sec}$ d) $\omega < 16 \text{ rad/sec}$ e) none of these

20) Assume we compute the sensitivity of a system with nominal value $a = 3$

to be

$$S_a^{G_0}(s) = \frac{s+2}{s+1+a}$$

For what frequencies will the sensitivity function be greater than $\sqrt{\frac{10}{16}}$?

a) $\omega < 4 \text{ rad/sec}$ b) $\omega > 4 \text{ rad/sec}$ c) $\omega > 16 \text{ rad/sec}$ d) $\omega < 16 \text{ rad/sec}$ e) none of these

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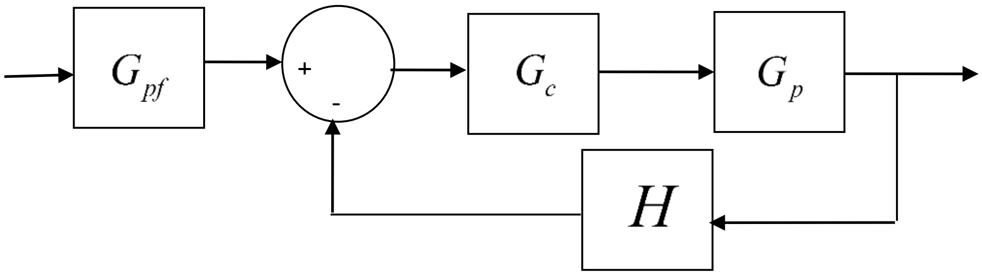
Problems 21-24 refer to the following system



21) To reduce the sensitivity of the closed loop transfer function variations in the plant G_p, we should

a) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ large b) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ small

c) make G_{pf} large d) do nothing, we cannot change the sensitivity

22) To reduce the sensitivity of the closed loop transfer function to variations in the prefilter G_{pf}, we should

a) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ large b) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ small

c) make G_{pf} small d) do nothing, we cannot change the sensitivity

23) To reduce the sensitivity of the closed loop transfer function to variations in the controller G_c we should

a) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ large b) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ small

c) make $|H(j\omega)|$ large d) do nothing, we cannot change the sensitivity

24) To reduce the sensitivity of the closed loop transfer function to variations in the sensor H, we should

a) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ large b) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ small

c) make G_{pf} large d) do nothing, we cannot change the sensitivity

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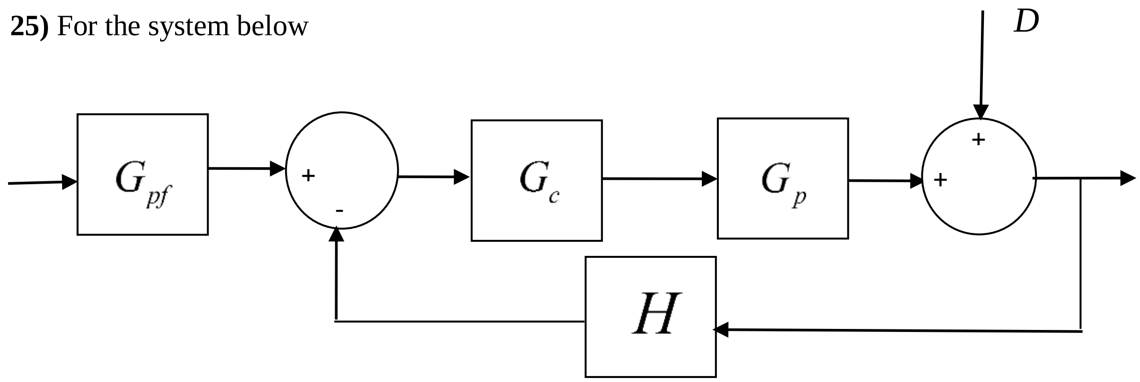
25) For the system below

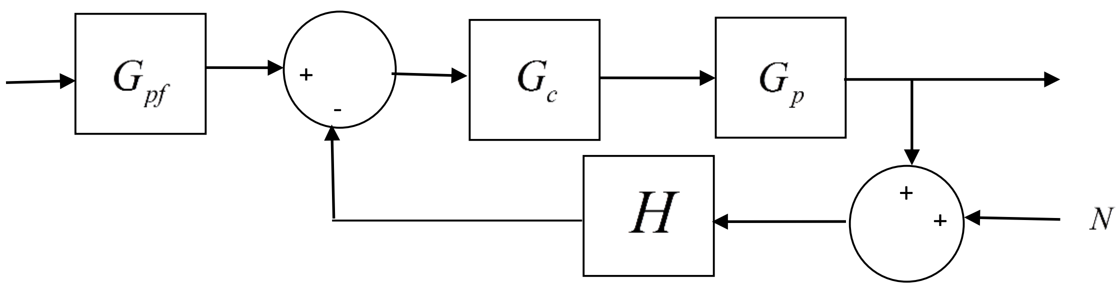


to reduce the effects of the external disturbance D on the system output, we should

a) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ large   b) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ small

c) make G_{pf} large   d) do nothing, we cannot change the sensitivity

26) For the system below



to reduce the effects of sensor noise N on the closed loop system , we should

a) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ large   b) make $|G_c(j\omega)G_p(j\omega)H(j\omega)|$ small

c) make $|H(j\omega)|$ large   d) do nothing, we cannot change the sensitivity

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For the problems 27 - 29, assume *a*, *b*, *c*, *d*, *e*, and *f* are real-valued numbers, and write and expression for the magnitude of the following:

27) $Z = \dfrac{a + j\omega b}{c - j\omega d}$

28) $Z = \dfrac{a + b - j\omega c}{d + j\omega}$

29) $Z = \dfrac{a + j + j\omega c + j\omega d}{1 - j\omega e + f}$