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ECE-320 Quiz #4

For problems 1-3 , consider a closed loop system with transfer function

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

1) 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

2) 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

3) 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

4) 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

5) 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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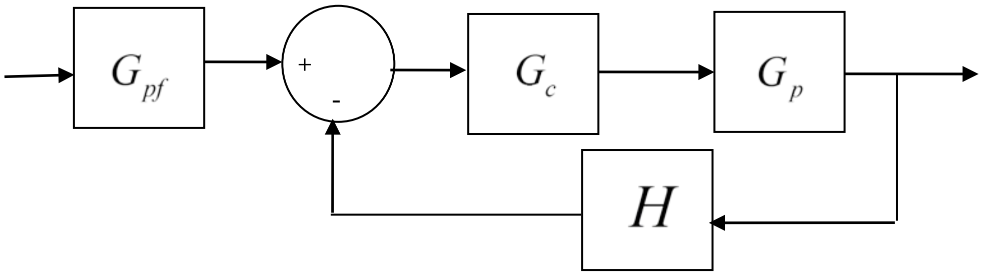
Problems 6-9 refer to the following system



6) 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

7) 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

8) 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

9) 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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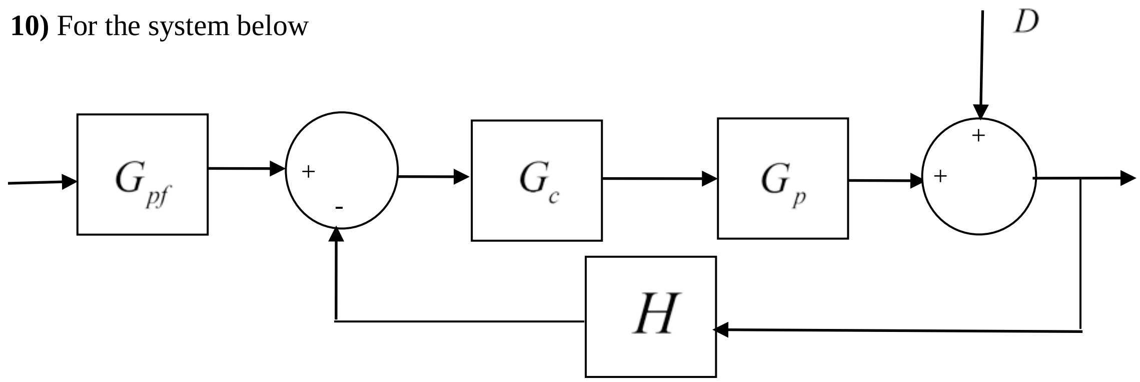
10) For the system below

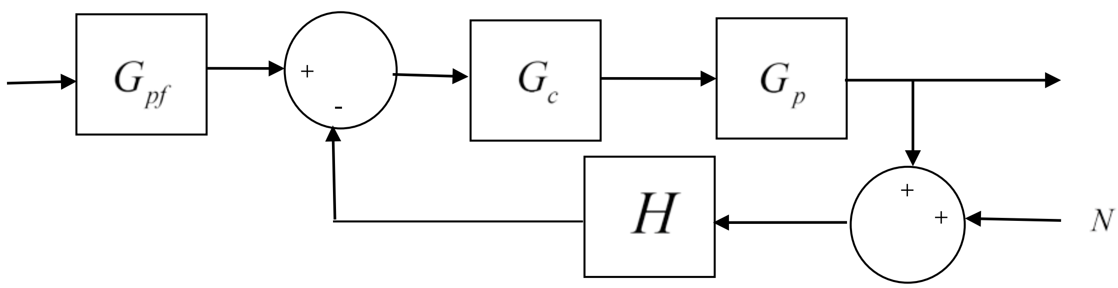


to reduce the effects of the external disturbance D on the system output, we should

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

11) 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

12) For the 2x2 matrix $P = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, the inverse of this matrix, P^{-1}, is which of the following:

a) $P^{-1} = \frac{1}{ad-bc}\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ b) $P^{-1} = \frac{1}{ad-bc}\begin{bmatrix} d & b \\ c & a \end{bmatrix}$ c) $P^{-1} = \frac{1}{ad+bc}\begin{bmatrix} d & b \\ c & a \end{bmatrix}$

d) $P^{-1} = \frac{1}{ad+bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$ e) $P^{-1} = \frac{1}{ad-bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$ f) none of these

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13) For the following state variable model

$$\dot{q}(t) = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix} q(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$
$$y(t) = [1 \quad 2] q(t)$$

The poles of the system are at

a) -1 and -3 b) -2 and -2 c) 1 and 3 d) 0 and 1 e) 2 and 2

14) For the following state variable model

$$\dot{q}(t) = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} q(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$
$$y(t) = [1 \quad 2] q(t)$$

The poles of the system are at

a) -1 and -2 b) -1 and -1 c) 1 and 3 d) 0 and 1 e) 1 and 2

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15) Is the following system ***controllable***?

$$G(s) = \frac{8G_{pf}}{s^2 + 12s + (k_1 + k_2 + 20)}$$

a) Yes b) No c) impossible to determine

16) Is the following system **controllable**?

$$G(s) = \frac{G_{pf}}{s^2 + (k_2 + k_1 - 1)s + (k_2 + 2)}$$

a) Yes b) No c) impossible to determine

17) A system with state variable feedback has the following transfer function

$$G(s) = \frac{G_{pf}}{(s - k_1 k_2)^2}$$

Is the system controllable?

a) Yes b) No c) impossible to determine

18) Consider a plant that is unstable but is a controllable system. Is it possible to use state variable feedback to make this system stable?

a) Yes b) No

19) Is it possible for a system with state variable feedback to change the zeros of the plant (other than by pole-zero cancellation) ?

a) Yes b) No

20) Is it possible for a system with state variable feedback to introduce zeros into the closed loop system?

a) Yes b) No

21) If a plant has *n* poles, then a system with state variable feedback with no pole-zero cancellations will have

a) more than *n* poles b) less than *n* poles c) n poles d) it is not possible to tell

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22) Consider the following state variable model

$$\dot{q}(t) = \begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix} q(t) + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 3 & 0 \end{bmatrix} q(t)$$

Assume state variable feedback of the form $u(t) = G_{pf} r(t) - Kq(t)$ The closed loop transfer function for this system is which of the following?

a) $G(s) = \dfrac{-6G_{pf}}{s(s-1+2k_2)-2k_1+1}$ b) $G(s) = \dfrac{6G_{pf}}{s(s-1+2k_2)-2k_1+1}$

c) $G(s) = \dfrac{6G_{pf}}{s(s-1+2k_2)+2k_1-1}$ d) $G(s) = \dfrac{-6G_{pf}}{s(s-1+2k_2)+2k_1-1}$

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23) Consider the following state variable model

$$\dot{q}(t) = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} q(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t)$$
$$y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} q(t)$$

Assume state variable feedback of the form $u(t) = G_{pf} r(t) - Kq(t)$ Is the closed loop transfer function for this system equal to

$$G(s) = \frac{G_{pf}}{s + 1 + k_1}$$

a) yes b) no