

## EL412 CONTROL SYSTEMS

Final Examination

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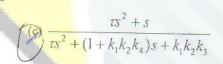
- \* Consider the feedback control system shown in Fig.1 to answer Q1,Q2, Q3 and Q4
- Q1. The effect of increasing the gain  $k_3$  on the step response is
  - (a) decrease the stability of the system
  - (b) increase the steady state error
  - decrease the effect of the load disturbance

b and c

- Q2. The effect of increasing the gain  $k_4$  on the step response is
  - (a) increase the stability of the system
  - (b) decrease the steady state error
  - (c) not affect the steady state error due to R(s) and disturbance
  - (d) a and c
- Q3. The sensitivity of the closed loop transfer function  $\frac{Y(s)}{R(s)}$  to  $k_2$  is

(a) 
$$\frac{-k_1 k_2 k_4 s}{\tau s^2 + (1 + k_1 k_2 k_4) s + k_1 k_2 k_3}$$

(b) 
$$\frac{\tau s^2 + s}{(\tau s^2 + (1 + k_1 k_2 k_4) s + k_1 k_2 k_3)^2}$$



(d) 
$$\frac{-\tau s^2}{\tau s^2 + (1 + k_1 k_2 k_4) s + k_1 k_2 k_3}$$

- 24. The type of the system with respect to R(s) is
  - (a) Zero if  $k_3 = 1$
  - Gero if  $k_3 \neq 1$
  - (c) One for any value of  $k_3$
  - (d) One if  $k_4 = 1$



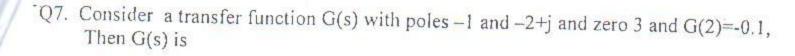


reasons to design control systems are

Automatic control (b) Remote control (c) Power amplification (d) all of the above

The actuating signal (u(t)) of a closed loop control system can be expressed as (f is some function) (a) u(t)=f(r(t))

- (b) u(t) = f(r(t), y(t))
- (c) u(t)=f(y(t))
- (d) c and b

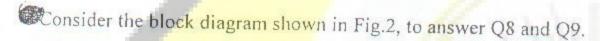


(a) 
$$G(s) = \frac{5 \cdot 1(s-3)}{(s+1)(s+2+j)(s+2-j)}$$

(b) 
$$G(s) = \frac{1.7(s-3)}{(s+1)(s+2-j)}$$

(c) 
$$G(s) = \frac{1.7(s-3)}{(s+1)(s+2+j)(s+2-j)}$$

(d) 
$$G(s) = \frac{51(s-3)}{(s+1)(s+2+j)(s+2-j)}$$



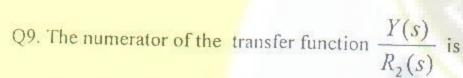
Q8. The determinant of SFG corresponding to the block diagram shown in Fig2 is

(a) 
$$\Delta = 1 + G_1 G_2 G_3 + G_1 G_4 + G_1 G_2 G_6 + G_2 G_3 G_5 - G_4 G_5$$

(b) 
$$\Delta = 1 + G_1G_2G_3 + G_1G_4 + G_1G_2G_6 - G_2G_3G_5 + G_4G_5$$

(c) 
$$\Delta = 1 + G_1 G_2 G_3 + G_1 G_4 + G_1 G_2 G_6 + G_2 G_3 G_5 + G_4 G_5$$

(d) 
$$\Delta = 1 + G_1G_2G_3 + G_1G_4 + G_1G_2G_6 - G_2G_3G_5 - G_4G_5$$



(a) 
$$-G_2G_3G_5 + G_4G_5$$

(b) 
$$-G_2G_3G_5 - G_4G_5$$

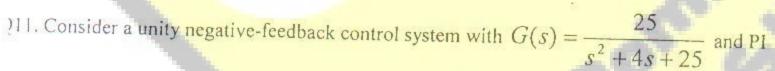
(c) 
$$G_2G_3G_5 + G_4G_5$$

(d) none of the above

310. If 
$$\frac{Y(s)}{R(s)} = \frac{2+3s}{2+3s+s^2}$$
 and  $R(s) = \frac{2}{s} + \frac{1}{s^2}$ , then the steady state response is

(a) 
$$(3+t)u(t)$$
 (b)  $tu(t)$  (c)  $(2+t)u(t)$ 

(c) 
$$(2+t)$$
  $v(t)$ 



controller with transfer function  $G_c(s) = k_p + \frac{k_i}{s}$ , then the value of  $k_i$  so that the steady state error due to unit ramp input equal to 0.04 is

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(d) none of the above

12. To obtain zero steady state error for a step input, the system type should be at least

(b) zero

(c) Two

(d) Three

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13. A closed loop control system is described by the state equations

$$\dot{x} = \begin{bmatrix} 0 & -1 \\ 1 & -1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u, \quad y = \begin{bmatrix} 0 & 1 \end{bmatrix} x, \text{ then the transfer function } T(s) = \frac{Y(s)}{U(s)}$$
is:

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

(b) 
$$\frac{3}{s^2 + 3s + 1}$$

(a) 
$$\frac{2}{s^2 + 2s + 1}$$
 (b)  $\frac{3}{s^2 + 3s + 1}$  (c)  $\frac{1}{s^2 + s + 1}$  (d) none of the above

14. Consider a unity negative-feedback control system with an open loop transfer function

$$kG_c(s)G(s) = \frac{k(k_p + k_d s)}{s(s+2)}, \text{ then system will have the fastest settling time if and}$$

(a) 
$$\sqrt{kk_p} = 1 + \frac{kk_d}{2}$$

(b) 
$$\sqrt{kk_p} = 1 + kk_d$$

(a) 
$$\sqrt{kk_p} = 1 + \frac{kk_d}{2}$$
 (b)  $\sqrt{kk_p} = 1 + kk_d$  (c)  $\sqrt{kk_p} = \frac{1}{3} + \frac{3kk_d}{2}$ 

(d) none of

the above

onsider a unity negative-feedback control system with an open loop transfer function  $G(s) = \frac{s+k}{s^3 + (1+k)s^2 + (k-1)s + 1-k}$ root locus of this system is (as a function of the parameter k) is as shown in Fig.3 to answer Q15, Q16,Q17 and Q18

5. It is desired that the absolute value of the steady state error for a unit step input be less than 10%

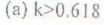
of the magnitude of the unit step input, then the range of k required is

(c)3.6<k<4.4 (d) none of the above

The open loop zeros of the root locus are

(d) none of the above

. The closed loop system is stable for



(d) none of the above

. The open loop poles of the root locus are the roots of

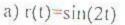
(a) 
$$s^2 + s$$

(a) 
$$s^2 + s$$
 (b)  $s^3 + (1+k)s^2 + (k-1)s + 1 - k$  (c) 0 and -1 (d)  $s^3 + s^2 + 1$ 

(c) 
$$0$$
 and  $-1$  (d)  $s^3 + s^2 + 1$ 

Consider a control system with transfer function  $\frac{Y(s)}{R(s)} = \frac{s^2 - 1}{4s^2 + 1}$ , the bounded input

applied to this system that will excites an unbounded output is



(b) 
$$r(t)=4\sin(0.5t)$$

$$(c)r(t)=6sin(0.25t)$$

$$(d)r(t)=7\sin(0.2t)$$

Consider a negative feedback control system with  $G(s) = \frac{4k}{s^2}$  and  $H(s) = 1 + k_1 s$ , then the value of k and  $k_1$  such that

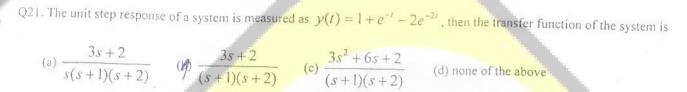
 $-1 \pm j\sqrt{3}$  are a closed loop poles are

) 
$$k=4$$
,  $k_1=0.5$  (d)  $k=4$ ,  $k_1=0.125$  الأسلامية  $k=1$ ,  $k_1=0.5$ 

d) 
$$k=4$$
,  $k_1=0.12$ 

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S(s+1)(s+2) 
$$(s+1)(s+2)$$
 (s) Hone of the above which regatives feedback controller has the the plant  $C(s)$ 

Q22. Aunity negative- feedback controller has the the plant 
$$G(s) = \frac{k}{s(s+\sqrt{2k})}$$
, the range of k so that the settling time (2% criterion) is less than 2 seconds is

(a) 
$$k>32$$
 (b)  $k>2$  (c)  $k>8$  (d) none of the above

223. In terms of 
$$k_1$$
 and  $k_2$  (assume of  $k_1 > 0$  and  $k_2 > 0$ ), the region of stability for the system shown in Fig. 4. Is

(a) 
$$0 < k_2 < k_1$$
 (b)  $0 < 2k_2 < k_1$  (c)  $0 < k_2 < 2k_1$  (d) none of the above

(a) s+0.2 (b) s(s+4) (c) 
$$s(s+4)^2$$
 (d) s+4

(a) 
$$\frac{1}{s}$$
 (b)  $\frac{0.8}{s}$  (c)  $\frac{3.17}{s}$  (d)  $\frac{12.62}{s}$ 

26. The damping ratio of the transfer function 
$$\xi$$
 is

7. The natural undamped frequency 
$$w_n$$
 is

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