كلية التقنية الالكترونية طرابلس
College of Electronic Technology - Tripoli

القســـم: التحكم الالي   أسئلة الامتحان النهائي لمادة: تصميم أنظمة تحكم خطية
لطلبة الفصل:السادس   رمز المادة: CT312   التاريخ:2022/03/16
للفصل الدراسي :خريف2021   اسم الأستاذ: هشام الشروي   الزمن: ساعتان

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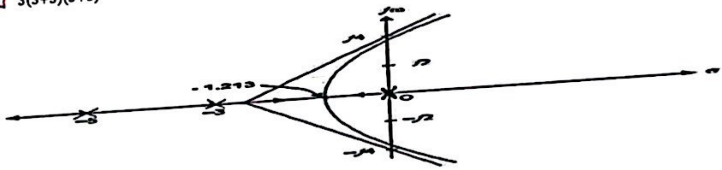
Q1: Choose the correct answer:

1. The root locus of a unity feedback system is shown in the following Figure. The open loop transfer function of the system is:

a) $\frac{K}{S(S+3)(S+5)}$ b) $\frac{K}{S(S-3)(S-5)}$ c) $\frac{Ks}{(S+3)(S+5)}$ d) None of these   [1 marks]



2. From a, the value of K at the break-away point is: [2 marks]

a) 2.343   b)4.632   c) 6.125   d) 8.21   e) None of these

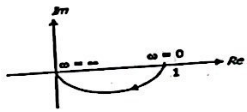
3. The angle of departure of the root locus from the pole(s= -2+j) for: $G(s)H(s) = \frac{K}{(s+1)(S^2+4S+5)}$, is: [2 marks]

a) -255   b) - 45   c) 45   d) None of these

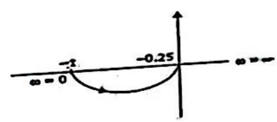
[2 marks]

4. The polar plot of G(s) = $\frac{1+s}{1+4s}$ for $0 \leq w \geq \infty$, is figure:

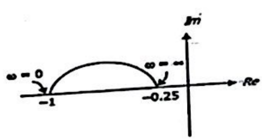
(a)



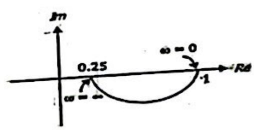
(b)



(c)



(d)



[1 mark]

5. The term reset control refers to:

a) Proportional controller   b) derivative controller
c) Integral controller   d) none of these

[1 mark]

6. Effect of adding a pole to transfer function is:

a) Pulling the root locus to the left   b) Pulling the root locus to the right   c) None of these

Q3 a

$$\frac{X_1}{X_2} = \frac{20}{s+10} \quad \boxed{1/2} \qquad \frac{X_2}{U - X_3} = \frac{1}{s} \quad \boxed{1/2} \qquad \frac{X_3}{X_1} = \frac{1}{s+1} \quad \boxed{1/2}$$

$$\dot{x}_1 = -10x_1 + 20x_2 \quad \boxed{1/2} \qquad \dot{x}_2 = -x_3 - u \quad \boxed{1/2} \qquad \dot{x}_3 = x_1 - x_3 \quad \boxed{1/2}$$

$$y = x_1 \quad \boxed{1/2}$$

$$\boxed{1} \quad \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -10 & 20 & 0 \\ 0 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ -1 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \quad \boxed{1/2}$$

5 marks

Q3 b

$$sI - A = \begin{bmatrix} s & -1 \\ 2 & s+3 \end{bmatrix} \quad \boxed{1}$$

3 marks

$$|sI - A| = s^2 + 3s + 2 \quad \boxed{1}$$

$$(sI - A)^{-1} = \phi(s) = \begin{bmatrix} \frac{s+3}{(s+1)(s+2)} & \frac{1}{(s+1)(s+2)} \\ \frac{-2}{(s+1)(s+2)} & \frac{s}{(s+1)(s+2)} \end{bmatrix} \quad \boxed{1}$$

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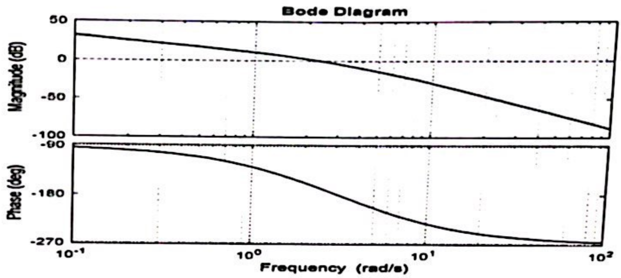
7. The phase crossover frequency and gain crossover frequency from the following figure are:

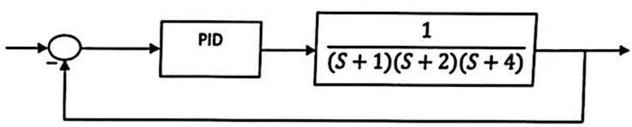


a)3.16&2.35 b) 10&1 c) 0.3&0.2 d) none of these [1 marks]

8. From7, the system is: [1 mark]

a) Stable b) unstable c) None of these

9. For the following system, the value of Kp that makes sustained oscillation will occure, is:



a) 190 b) 90 c) 30 d)none of these [2 marks]

10. The gain margin of the following open loop transfer function G(s)H(s) = 10 / S (S+1) (S+5), is:
a) 11.3 b) 9.5db c) 7.5db d) None of these [3 marks]

11. The magnitude of the basic factor which, is a straight line with slope of 20 dB/decade and crsossing the zero dB at w=1is: [1 mark]

a) 1/S b) S c) (s+1) d) 1/(s+1) e) None of these

12. The eigen value of: A=$\begin{pmatrix} 0 & 1 \\ -12 & -7 \end{pmatrix}$, then determine if the system stable or unstable? [2 marks]

a) -3&-4 & unstable b) -3&-4 & stable c) 3&4 & stable d) 3&4 & unstable e) None of these

13. Test the controllability of the system when: [2 marks]

A= $\begin{pmatrix} 0 & 1 \\ 5 & -1 \end{pmatrix}$, B= $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$, and C=(1 1)

a) Controllable b) Not controllable c) None of these

....

Q_2 [a] $\angle G(s)H(s)\big|_{s=-2+j\sqrt{12}} = \angle -30°$ [1]

[6 marks]

let $a = 3$ $\therefore b = 5.6$ [3]

$k = 19.2$ [1] $K_{cr} = 1.92$ [1]

$$G_c(s) = 1.92 \cdot \frac{s+3}{s+5.6}$$

Q_2 [b] $PM = 180 + \angle G(s)H(s)$

$40 = 180 + \angle G(s)H(s)$

$\angle G(s)H(s) = -140$ [1]

[5 marks]

$\omega_{gc} = 1.678$ [2]

$\therefore k = 0.541$ [2]

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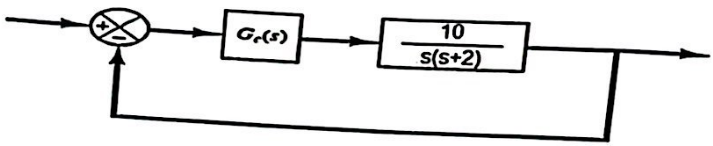
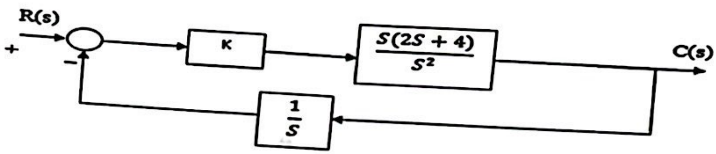
Q2: a) For the following system, Design a **lead compensator** such that the dominant closed loop poles a located at s= $-2 \pm j\sqrt{12}$.

[6 ma

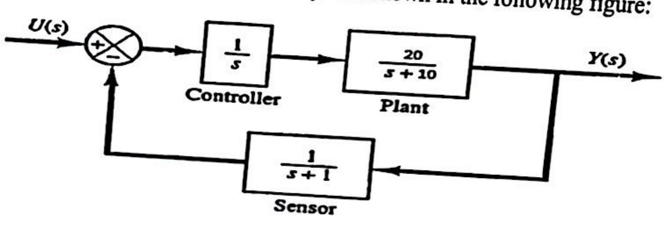


b) For the following control system, determine the value of the gain **K** such that the phase margin is **40°**.

[5 marks]



Q3: a) Obtain the state space model of the system shown in the following figure: [5 marks]



b) Find the resolvent matrix $\phi(s)$, of the given system: [3 marks]

$$\begin{pmatrix}\dot{x}_1\\ \dot{x}_2\end{pmatrix}=\begin{pmatrix}0 & 1\\ -2 & -3\end{pmatrix}\begin{pmatrix}x_1\\ x_2\end{pmatrix}+\begin{pmatrix}0\\ 1\end{pmatrix}u$$

Good Luck