Zagazig University,Faculty of Engineering **Midterm Exam**
Academic Year: 2017/2018
Specialization: Computer & Systems Eng.
Course Name: Digital Control
Course Code: CSE421
Examiner: Dr. **Mohammed Nour**

Date: 11/11/2016
Exam Time: 60 min.
No. of Pages: 5
No. of Questions: 4 (20 items)
Full Mark: [60]

▷ Please **answer all questions**. Use **3** decimal digits approximation.

▷ Mark your **answers** for all questions **in the Answer Sheet** provided.

▷ In last page, some supplementary identities you *may* need.

Question 1

[2 p] **1.Ballast Coding** is used to synchronize the sampling and control process. Which of the following **does not** apply for this method:

a) completely implemented in software.
b) software interrupt mechanism is used.
c) adds dummy code to compensate for required sampling interval.
d) very sensitive to changes in code and/or CPU clock rate.

[2 p] **2.**For the two systems **A** and **B** represented by the following difference equations:

$$\mathbf{A}: y(k+2) = y(k+1)y(k) + u(k), \quad \mathbf{B}: y(k+5) = y(k+4) + u(k+1) - u(k),$$

a) **A** is homogeneous and **B** is linear.
b) **A** is time-variant and **B** is homogeneous.
c) both systems are linear and time-invariant.
d) both systems are time-invariant and homogeneous.

[4 p] **3.**The z-transform of the sequence: $\{0, 2^{-0.5}, 1, 2^{-0.5}, 0, 0, \cdots\}$ is: (note: $\sin(45°) = \frac{1}{\sqrt{2}}$)

a) $\dfrac{z^2+z+1}{\sqrt{2}z}$
b) $\dfrac{z^4-1}{z^3\,[z^2-2\,z+1]}$
c) $\dfrac{z}{[\sqrt{2}\,z^2-2\,z+\sqrt{2}]}$
d) $\dfrac{z^4-1}{\sqrt{2}\,z^3\,[z^2-\sqrt{2}\,z+1]}$

[4 p] **4.**The inverse transform of the function: $F(z) = \dfrac{z}{z^2+0.3\,z+0.02}$ is:

a) $\{0, 1, -0.3, 0.07, \cdots\}$
b) $\{1, -0.3, 0.07, \cdots\}$
c) $\{0, 1, 0.3, 0.02, \cdots\}$
d) $\{1, 0.3, 0.02, \cdots\}$

[3 p] **5.**The inverse transforms of the function: $F(z) = \dfrac{z-0.1}{z^2+0.04z+0.25}$ is:

a) $\sin(1.611k + 0.196)$
b) $\cos(1.611k + 0.196)$
c) $-0.4\delta(k) + 2.057(0.5)^k \sin(1.611k + 0.196)$
d) $-0.4\delta(k) + \cos(1.611k + 0.196)$

[3 p] **6.**If the discrete output y_k of a system is related to its input u_k by $y_n = \sum_{k=0}^{n} u_k$, the transfer function $Y(z)/U(z)$ of this system is:

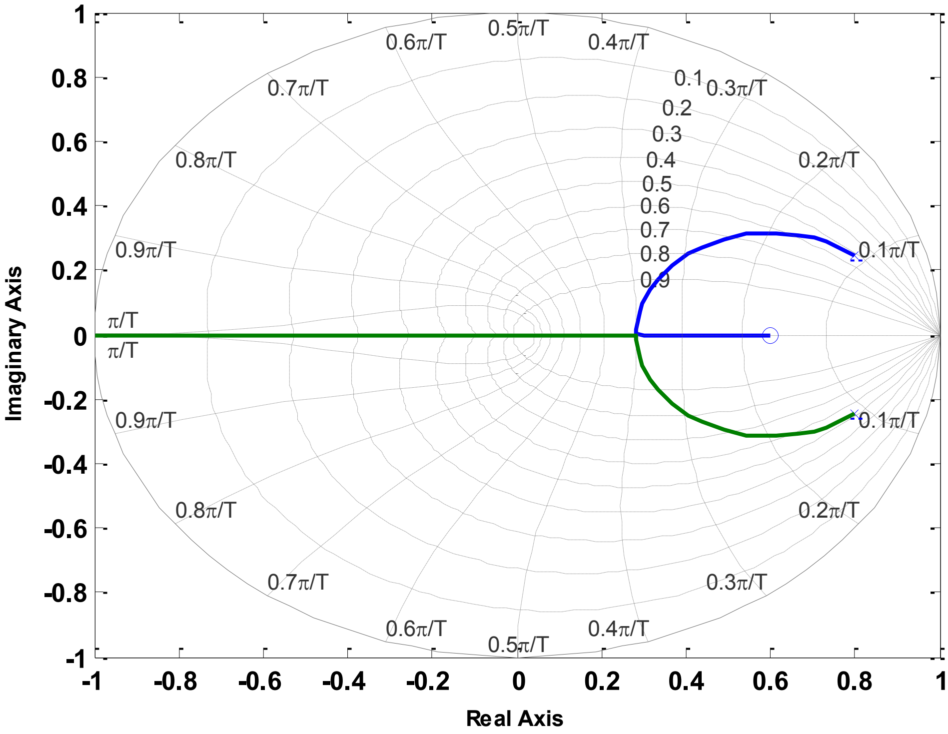
a) $\dfrac{1}{1-z^{-1}}$
b) $\dfrac{z}{z^2-1}$
c) 1
d) z^{-1}

[3 p] **7.**Consider a causal, LTI system with x_n and y_n as input and output, resp., described by the difference equation $y_n = a\,y_{n-1} + b\,x_n$. For which values of a and b is the system bounded-input bounded-output stable?

a) $a > 1$ & $b < 1$
b) $a < 1$ & $b > 1$.
c) $|b| < 1$ any a.
d) $|a| < 1$, any b

Question 2

For the next questions, consider the next root Locus chart:



[3 p] **8.** The system represented by this root locus has a transfer function $G(z)$ given by:

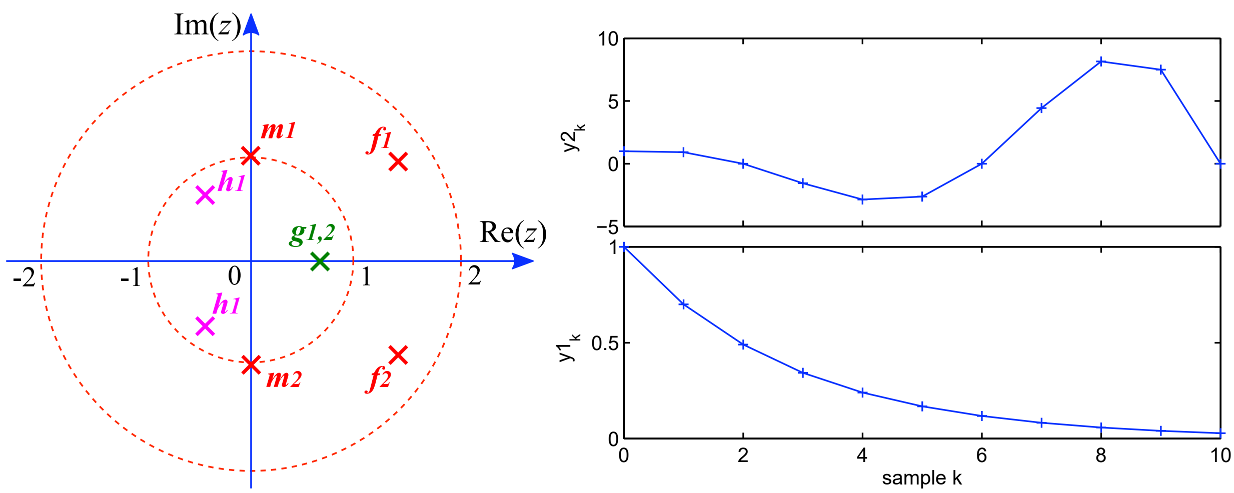
a) $\dfrac{K(z^2 - 1.6\,z + 0.7)}{z - 0.6}$ b) $\dfrac{K(z - 0.6)}{z^2 - 1.6\,z + 0.7}$ c) $\dfrac{z - 0.4\pi/T}{(z^2 - 0.1\pi/T\,z + 0.6)}$ d) $\dfrac{(z^2 - 0.1\pi/T\,z + 0.6)}{z - 0.4\pi/T}$

[3 p] **9.** Using the given chart, the appropriate poles location that results in $\omega_n > 0.63$ rad/s , $\zeta > 0.8$ (assuming $T = 1$ s) are:

a) $0.33 \pm j\,0.17$ b) $0.17 \pm j\,0.33$ c) $0.6 \pm j\,0.2$ d) $0.2 \pm j\,0.6$

Question 2

The following diagrams represent systems with poles (indicated by x's) but no zeros. The unit step response of two systems $y1_k$ and $y2_k$ is shown on the right plots.



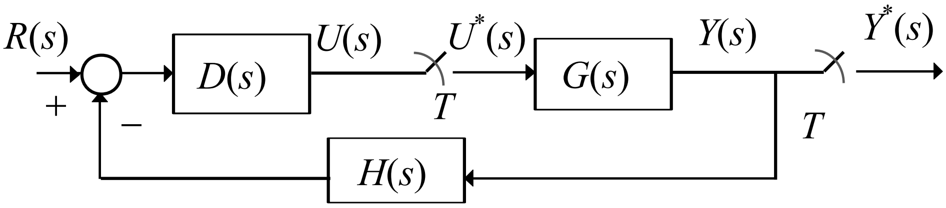
[3 p] **10.** The system with the response given by $y1_k$ has the poles:

a) f_1, f_2 b) g_1, g_2 c) h_1, h_2 d) m_1, m_2

[3 p] **11.** The system with the response given by $y2_k$ has the poles:

a) f_1, f_2 b) g_1, g_2 c) h_1, h_2 d) m_1, m_2

[3 p] **12.** In the following sampled system, $D(s), G(s)$, and $H(s)$ represent the system continuous subsystems. $R(s)$ and $Y(s)$ are input and output respectively:



The discrete response $Y(z)$ of this sampled system is:

a) $Y(z) = \dfrac{G(z)\,DR(z)}{1 + D(z)HG(z)}$

b) $Y(z) = \dfrac{G(z)\,D(z)\,R(z)}{1 + D(z)\,H(z)\,G(z)}$

c) $Y(z) = \dfrac{G(z)\,D(z)\,R(z)}{1 + DHG(z)}$

d) $Y(z) = \dfrac{G(z)\,DR(z)}{1 + DHG(z)}$

[3 p] **13.** The final value for the function $F(z) = \dfrac{z}{z^2 + 0.3\,z + 2}$ is:

a) 0 b) 3.3 c) 1/3.3 d) undefined

[3 p] **14.** The steady state DC gain of the system with transfer Function $H(z) = \dfrac{z}{z^2 - 0.7\,z + 0.1}$ is:

a) 0 b) 0.4 c) 2.5 d) undefined

[3 p] **15.** For a system with the following characteristic equation:

$$F(z) = z^5 - 0.25\,z^4 + 0.1\,z^3 + 0.4\,z^2 + 0.3\,z - 0.1$$

The Jury Table constructed to determine this system stability will have:

a) 5 rows b) 6 rows c) 7 rows d) 8 rows

[3 p] **16.** The **filth** row of that Jury Table will be:

a) $-0.986 \quad 0.528 \quad 0.713 \quad -0.528$

b) $0.905 \quad 0.331 \quad 0.100 \quad 0.466$

c) $0.812 \quad -0.2752 \quad 0.2288$

d) $0.466 \quad 0.100 \quad 0.331 \quad 0.905$

Question 3

In a unity feedback discrete system, its open loop transfer function is given as:

$$G(z) = \frac{k\left(0.084z^2 + 0.17z + 0.019\right)}{z^3 - 1.5z^2 + 0.553z - 0.05}$$

[3 p] **17.** The system characteristic equation is:

a) $G(z) = 0$

b) $G(z)\,H(z) = 0$

c) $1 + G(z) = 0$

d) $z^3 - 1.5z^2 + 0.553z - 0.05 = 0$

[3 p] **18.** The bilinear transformation used to transform the interior of the z-plane unit circle into the left-hand s-plane is:

a) $\dfrac{1-w}{1+w}$

b) $\dfrac{1+w}{1-w}$

c) $z = e^{sT}$

d) $z = e^{-sT}$

[3 p] **19.** The **third** row of the Routh–Hurwitz array will be:

a) $\dfrac{0.01\,k^2 - 1.55\,k + 4.17}{1.1 - 0.11\,k}$

b) $1.1 - 0.11\,k \qquad 3.1 + 0.07\,k$

c) $3.1 + 0.07\,k$

d) $0.003 + 0.27\,k \qquad 3.8 - 0.27\,k$

[3 p] **20.** Based on Routh–Hurwitz Criterion, this system is stable for k selected as:

a) $k > -44.3$

b) $k > -0.011$

c) $-0.011 < k < 2.74$

d) $-44.3 < k < 10$

Supplementary Material

Note: you *may* need some or none of these identities:

No.	Property	Formula
1	Linearity	$\mathcal{Z}\{\alpha f_1(k) + \beta f_2(k)\} = \alpha F_1(z) + \beta F_2(z)$
2	Time Delay	$\mathcal{Z}\{f(k-n)\} = z^{-n}F(z)$
3	Time Advance	$\mathcal{Z}\{f(k+1)\} = zF(z) - zf(0)$ $\mathcal{Z}\{f(k+n)\} = z^nF(z) - z^nf(0) - z^{n-1}f(1)\cdots - zf(n-1)$
4	Discrete-Time Convolution	$\mathcal{Z}\{f_1(k)^*f_2(k)\} = \mathcal{Z}\left\{\sum_{i=0}^{k} f_1(i)f_2(k-i)\right\} = F_1(z)F_2(z)$
5	Multiplication by Exponential	$\mathcal{Z}\{a^{-k}f(k)\} = F(az)$
6	Complex Differentiation	$\mathcal{Z}\{k^mf(k)\} = \left(-z\frac{d}{dz}\right)^m F(z)$
7	Final Value Theorem	$f(\infty) = \mathscr{L}im_{k\to\infty} f(k) = \mathscr{L}im_{z\to 1}(1-z^{-1})F(z) = \mathscr{L}im_{z\to 1}(z-1)F(z)$
8	Initial Value Theorem	$f(0) = \mathscr{L}im_{k\to 0} f(k) = \mathscr{L}im_{z\to\infty} F(z)$

$$e^{jx} = \cos x + j\sin x,$$

$$\cos x = \frac{e^{jx}+e^{-jx}}{2}, \quad \sin x = \frac{e^{jx}-e^{-jx}}{2j}$$

$$x + j\,y = \sqrt{x^2+y^2}\;\; e^{j\,\tan^{-1}(y/x)}$$

$$G(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n\,s + \omega_n^2}, \quad \omega_d = \omega_n\sqrt{1-\xi^2}$$

$$T_r = \frac{\pi-\beta}{\omega_d}, \quad \beta = \tan^{-1}\frac{\omega_d}{\xi\omega_n}, \quad T_p = \frac{\pi}{\omega_d},$$

$$T_s = \left.\frac{3}{\xi\omega_n}\right|_{5\%} = \left.\frac{4}{\xi\omega_n}\right|_{2\%}, \qquad M_p = e^{-\xi\pi/\sqrt{1-\xi^2}}$$

$$k_0 = K_p\left(1 + \frac{T}{T_i} + \frac{T_d}{T}\right), k_1 = -K_p\left(1 + 2\frac{T_d}{T}\right),$$

$$k_2 = K_p\left(\frac{T_d}{T}\right)$$

$$\Phi = e^{Ah} = \mathscr{L}^{-1}\left\{(sI-A)^{-1}\right\}, \Gamma = \int_{t=0}^{h} e^{At}Bdt$$

اسم الطالب :

التاريخ : / /

رقم الجلوس

	0	1	2	3	4	5	6	7	8	9
احاد										
عشرات										
مئات										
الاف										

نموذج الاختبار

	0	1	2	3	4	5	6	7	8	9
احاد										
عشرات										
مئات										
الاف										

ختم الكنترول

	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

No.	Continuous Time	Laplace Transform	Discrete Time	z-Transform
1	$\delta(t)$	1	$\delta(k)$	1
2	$1(t)$	$\frac{1}{s}$	$1(k)$	$\frac{z}{z-1}$
3	t	$\frac{1}{s^2}$	kT	$\frac{zT}{(z-1)^2}$ sampling t gives kT, $z\{kT\} = T\,z\{k\}$
4	t^2	$\frac{2!}{s^3}$	$(kT)^2$	$\frac{z(z+1)T^2}{(z-1)^3}$
5	t^3	$\frac{3!}{s^4}$	$(kT)^3$	$\frac{z(z^2+4z+1)T^3}{(z-1)^4}$
6	$e^{-\alpha t}$	$\frac{1}{s+\alpha}$	a^k	$\frac{z}{z-a}$ by setting $a = e^{-\alpha T}$.
7	$1-e^{-\alpha t}$	$\frac{\alpha}{s(s+\alpha)}$	$1-a^k$	$\frac{(1-a)z}{(z-1)(z-a)}$
8	$e^{-\alpha t}-e^{-\beta t}$	$\frac{\beta-\alpha}{(s+\alpha)(s+\beta)}$	a^k-b^k	$\frac{(a-b)z}{(z-a)(z-b)}$
9	$te^{-\alpha t}$	$\frac{1}{(s+\alpha)^2}$	kTa^k	$\frac{az\,T}{(z-a)^2}$
10	$\sin(\omega_n t)$	$\frac{\omega_n}{s^2+\omega_n^2}$	$\sin(\omega_n kT)$	$\frac{\sin(\omega_n T)z}{z^2-2\cos(\omega_n T)z+1}$
11	$\cos(\omega_n t)$	$\frac{s}{s^2+\omega_n^2}$	$\cos(\omega_n kT)$	$\frac{z[z-\cos(\omega_n T)]}{z^2-2\cos(\omega_n T)z+1}$
12	$e^{-\zeta\omega_n t}\sin(\omega_d t)$	$\frac{\omega_d}{(s+\zeta\omega_n)^2+\omega_d^2}$	$e^{-\zeta\omega_n kT}\sin(\omega_d kT)$	$\frac{e^{-\zeta\omega_n T}\sin(\omega_d T)z}{z^2-2e^{-\zeta\omega_n T}\cos(\omega_d T)z+e^{-2\zeta\omega_n T}}$
13	$e^{-\zeta\omega_n t}\cos(\omega_d t)$	$\frac{s+\zeta\omega_n}{(s+\zeta\omega_n)^2+\omega_d^2}$	$e^{-\zeta\omega_n kT}\cos(\omega_d kT)$	$\frac{z[z-e^{-\zeta\omega_n T}\cos(\omega_d T)]}{z^2-2e^{-\zeta\omega_n T}\cos(\omega_d T)z+e^{-2\zeta\omega_n T}}$
14	$\sinh(\beta t)$	$\frac{\beta}{s^2-\beta^2}$	$\sinh(\beta kT)$	$\frac{\sinh(\beta T)z}{z^2-2\cosh(\beta T)z+1}$
15	$\cosh(\beta t)$	$\frac{s}{s^2-\beta^2}$	$\cosh(\beta kT)$	$\frac{z[z-\cosh(\beta T)]}{z^2-2\cosh(\beta T)z+1}$

Exam Model: 4629