



B.E DEGREE EXAMINATIONS: MAY 2017

(Regulation 2014)

Sixth Semester

ELECTRONICS AND INSTRUMENTATION ENGINEERING

U14 EIT601: Digital Control System

COURSE OUTCOMES

- CO1:** Describe a discrete time system by difference equations.
- CO2:** Estimate the response of a discrete time system for any given input.
- CO3:** Analyze the stability of a given system with varying sampling time periods.
- CO4:** Apply the design procedures to obtain a digital controller meeting the desired specifications.
- CO5:** Describe about few application of the digital control systems.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Match list I (DT input function name) with list II (Z transform equation) and select the correct answer the codes given below. CO1 [K1]

List I	List II
A. Impulse function	1. $\frac{Z}{Z-1}$
B. Step function	2. $\frac{T^2 Z(Z+1)}{(Z-1)^3}$
C. Ramp function	3. 1
D. Parabolic function	4. $\frac{T Z^2}{(Z-1)^2}$

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|----|---|---|---|---|
| | A | B | C | D |
| a) | 4 | 3 | 2 | 1 |
| b) | 2 | 4 | 1 | 3 |
| c) | 3 | 1 | 4 | 2 |
| d) | 1 | 2 | 3 | 4 |

2. The pulse transfer of the system shown in Figure: 1 is CO1 [K3]

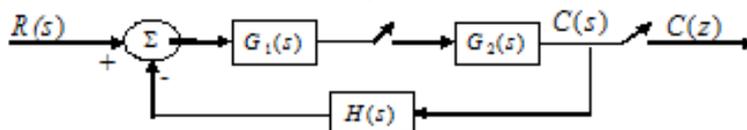


Figure: 1

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|--|--|
| <p>a) $\frac{C(Z)}{R(Z)} = \frac{G_1(Z)G_2(Z)}{1+G_1G_2(Z)H(Z)}$</p> <p>c) $\frac{C(Z)}{R(Z)} = \frac{G_1(Z)G_2(Z)}{1+G_1(Z)G_2(Z)H(Z)}$</p> | <p>b) $\frac{C(Z)}{R(Z)} = \frac{G_1G_2(Z)}{1+G_1(Z)G_2H(Z)}$</p> <p>d) $\frac{C(Z)}{R(Z)} = \frac{G_1(Z)G_2(Z)}{1+G_1(Z)G_2H(Z)}$</p> |
|--|--|

3. A linear discrete-time system has the following characteristic equation, $Z^2 - Z + 0.6321 = 0$, so the system stability is _____. CO2 [K₃]
 a) Stable b) Unstable
 c) Marginally stable d) Stable at 0.5 and 0.6181
4. The position and velocity errors of a type-2 system are _____ respectively. CO2 [K₁]
 a) Constant and Constant b) Constant and Infinity
 c) Zero and Constant d) Zero and Zero
5. Assertion (A): Steady state error can be reduced by increasing integral gain. CO3 [K₂]
 Reason (R): Overshoot can be reduced by increasing derivative gain.
 a) Both A and R are true and R is the correct explanation of A b) Both A and R are true but R is not correct explanation of A
 c) A is true but R is false d) A is false but R is true
6. The discrete PID controller equation becomes $M(Z) = \left[K_P + \frac{K_I}{1-Z^{-1}} + K_D(1-Z^{-1}) \right] E(Z)$. CO3 [K₁]
 In this equation K_P , K_I and K_D are equal to
 a) $K - KT/2T_i$, KT/T_i and KT_d/T b) KT/T_i , $K - KT/2T_i$ and KT_d/T
 c) $K + KT/2T_i$, KT/T_i and KT_d/T d) KT/T_i , $K + KT/2T_i$ and KT_d/T
7. The feedback control system with gain margin of about 30. At _____ point the Nyquist plot crosses negative real axis. CO4 [K₃]
 a) -3 b) -0.3
 c) -30 d) -0.03
8. The nature of root locus about the real axis is _____. CO4 [K₁]
 a) Asymmetric b) Symmetric
 c) Exponential d) Decaying
9. Consider the following statements for a PI compensator for a control system. CO5 [K₄]
 1. It is equivalent to adding a zero at origin
 2. It reduces a overshoot
 3. It improves order of the system by 1.
 4. It improves steady state error of the system
 Which of the statements given above are correct?
 a) 1, 2, 3 and 4 b) 1, 2 and 3 only
 c) 2, 3 and 4 only d) 1 and 4 only
10. Consider the following to build the control loop in the temperature control of air flow system. CO5 [K₄]
 1. Operation on the signal by an appropriate algorithm
 2. Sampling the temperature measurement signal
 3. Compare the measured temperature with a stored desired temperature
 4. Transfer the output signal through the interface to the power control unit
 a) 1-2-4-3 b) 2-3-1-4
 c) 4-1-2-3 d) 3-4-2-1

PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

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|--|-----|-------------------|
| 11. Name the methods to find the inverse Z transform for the given system. | CO1 | [K ₁] |
| 12. For a unit acceleration input $r(t) = \frac{1}{2}t^2 1(t)$, estimate the steady state error (e_{ss}) equation in discrete domain. | CO1 | [K ₄] |
| 13. Recall the transient response specifications. | CO2 | [K ₁] |
| 14. Identify the stability criterion by the Jury's stability test. | CO2 | [K ₁] |
| 15. List the realization methods of digital controllers to avoid the coefficient sensitivity problem. | CO3 | [K ₁] |
| 16. Discuss the advantages of velocity form PID control scheme over position form PID control scheme. | CO3 | [K ₂] |
| 17. Draw the structure of the internal model controller (IMC). | CO4 | [K ₄] |
| 18. Discuss the principle of optimality. | CO4 | [K ₂] |
| 19. List the disadvantages of absolute encoder for the position control system. | CO5 | [K ₁] |
| 20. Choose the two critical control problems in the servo track writing (STW) for the desired accuracy. | CO5 | [K ₂] |

Answer any FIVE Questions:-

PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

Q.No. 21 is Compulsory

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|---|-----|-------------------|
| 21. A discrete time unity feedback control system shown in Figure: 2. Determine the range of gain K for which the system is stable by using Jury stability criterion. | CO2 | [K ₅] |
|---|-----|-------------------|

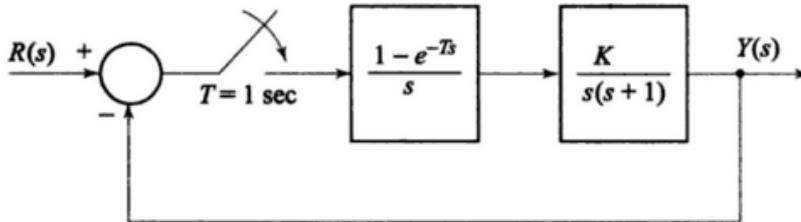


Figure:2

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|---|-----|-------------------|
| 22. A discrete-time system $y(k+2) + \frac{1}{4}y(k+1) - \frac{1}{8}y(k) = 3r(k+1) - r(k)$ with input, $r(k) = (-1)^k u(k)$ and initial conditions $y(-1) = 5, y(-2) = -6$. Determine the output $y(k)$ for $k \geq 0$.
[Where, $y(k)$ is the output, $r(k)$ is the input and $u(k)$ is the unit step sequence] | CO1 | [K ₅] |
| 23. A feedback control system shown in Figure: 3. The plant is described by the following equation $G(S) = \frac{1}{S(S+2)}$. Design a digital controller by using the Bode diagram approach in the W plane, for the system to meet the following specifications:
a) The phase margin be 55°
b) The gain margin be at least 10 dB
c) The static velocity error constant be 5 sec^{-1}
d) Sampling period is specified as 0.1 sec. | CO3 | [K ₆] |

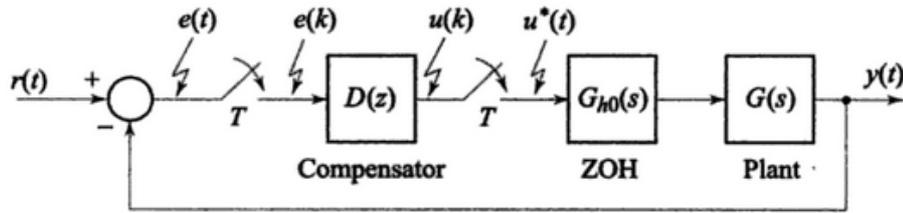


Figure: 3

24. Explain the following adaptive control schemes: CO4 [K₂]
 (i) Gain Scheduling
 (ii) Model Reference Adaptive Systems (MRAC)
25. Explain the implementation of control algorithm for microprocessor based controller for temperature control in an air flow system. CO5 [K₂]
26. Determine the pulse transfer function, $Y(Z) / R(Z)$ of the closed loop sample-data system shown in Figure: 4. CO1 [K₅]

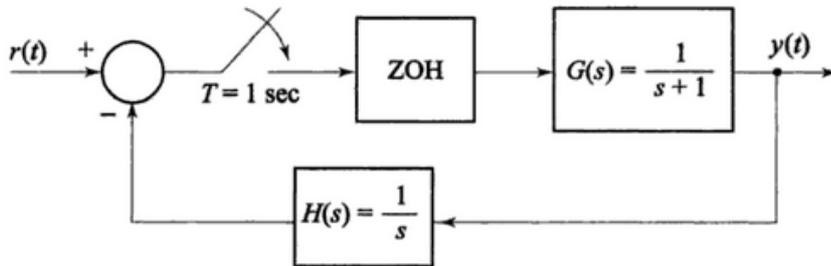


Figure: 4

27. A digital control system shown is in Figure: 5, Where $ZOH = \frac{1 - e^{-Ts}}{s}$; $G_P(s) = \frac{e^{-2S}}{S + 1}$ and Sampling Period is 1 sec. CO3 [K₆]

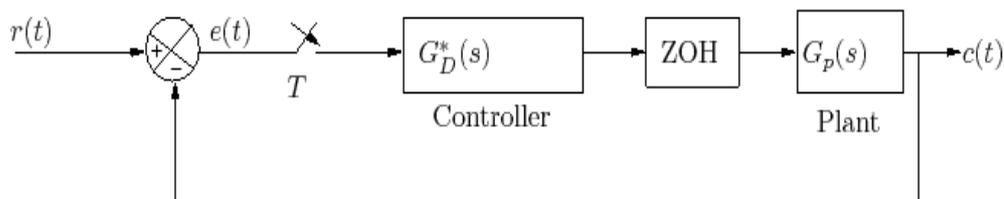


Figure: 5

Design a digital PI Controller such that the dominant closed loop poles have a damping ratio ζ of 0.5 and the number of samples per cycle of damped sinusoidal oscillations is 10.
