



**M.E DEGREE EXAMINATIONS: JUNE 2018**

(Regulation 2015)

Second Semester

**APPLIED ELECTRONICS**

P15AET202 : Advanced Control Engineering

**COURSE OUTCOMES**

- CO1: Solve difference equations using z-transform.
- CO2: Review D/A and A/D conversion techniques.
- CO3: Apply state space techniques for analysis of systems.
- CO4: Design discrete time control systems using transform methods.
- CO5: Analyze the time and frequency response of discrete time systems

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Assertion (A): It is observed that step function is first derivative of a ramp function and impulse function is first derivative of a step function. CO4 [K<sub>4</sub>]  
Reason (R): From the derived time response expression it is concluded that the output time response also follows the same sequence as that of input functions.  
a) Both A and R are Individually true and R is the correct explanation of A      b) Both A and R are Individually true but R is not the correct explanation of A  
c) A is true but R is false      d) A is false but R is true
2. In bilinear transformation, the left-half s-plane is mapped to which of the following in the z-domain? CO3 [K<sub>2</sub>]  
a) Entirely outside the unit circle  $|z|=1$       b) Partially outside the unit circle  $|z|=1$   
c) Partially inside the unit circle  $|z|=1$       d) Entirely inside the unit circle  $|z|=1$
3. In which of the following transformations, poles and zeros of H(s) are mapped directly into poles and zeros in the z-plane? CO3 [K<sub>1</sub>]  
a) Impulse invariance      b) Bilinear transformation  
c) Approximation of derivatives      d) Matched Z-transform

4. Matching type item with multiple choice code

CO5 [K<sub>2</sub>]

| Transfer Function   | Types of Damping                  |
|---------------------|-----------------------------------|
| A. PI Controller    | i. Improves Damping of the System |
| B. PD Controller    | ii. Increase Bandwidth            |
| C. Lead Compensator | iii. Decrease Bandwidth           |
| D. Lag Compensator  | iv. Decrease Steady State Error   |

|    | A   | B  | C   | D  |
|----|-----|----|-----|----|
| a) | ii  | i  | iii | iv |
| b) | iii | iv | ii  | i  |
| c) | iv  | i  | iii | ii |
| d) | iii | i  | ii  | Iv |

5. Assertion (A): Relative stability of the system reduces due to the presence of transportation lag.

CO5 [K<sub>4</sub>]

Reason (R): Transportation lag can be conveniently handled by Bode plot.

- a) Both A and R are true but R is correct explanation of A
- b) Both A and R are true but R is correct explanation of A
- c) A is true but R is false
- d) A is false but R is true

6. A system is said to be \_\_\_\_\_ if it is possible to transfer the system state from any initial state to any desired state in finite interval of time.

CO2 [K<sub>1</sub>]

- a) Controllable
- b) Observable
- c) Cannot be determined
- d) Controllable and observable

7. Consider the following statements:

CO4 [K<sub>2</sub>]

The gain margin and phase margin of an unstable system may respectively be

1. Positive, positive
2. Positive, negative
3. Negative, positive
4. Negative, negative

- a) 1 and 4 are correct
- b) 1 and 2 are correct
- c) 1, 2 and 3 are correct
- d) 2,3 and 4 are correct

8. Sampling is necessary :

CO1 [K<sub>1</sub>]

- a) In complex control systems
- b) Where high accuracy is required
- c) Non automated control systems
- d) Automated control system

9. The several ways to perform an inverse Z transform are COL [K<sub>1</sub>]
- 1) Direct computation
  - 2) Long division
  - 3) Partial fraction expansion with table lookup
  - 4) Direct inversion
- a) 1, 2 and 3 are correct b) 1 and 2 are correct  
c) 2 and 3 are correct d) All the four are correct
10. State whether the following signals are discrete or continuous. CO2 [K<sub>2</sub>]
- i. Temperature in a room
  - ii. Digital clock display
  - iii. The output of a loudspeaker
1. Discrete
  2. Continuous
- a) i-1,ii-2,iii-1 b) i-2,ii-2,iii-2  
c) i-2,ii-1,iii-2 d) i-1,ii-1,iii-2

**PART B (10 x 2 = 20 Marks)**

11. Define Initial Value Theorem. CO1 [K<sub>1</sub>]
12. Obtain Z-Transform of  $k^2$  CO1 [K<sub>3</sub>]
13. What is state space? CO2 [K<sub>1</sub>]
14. In what process do we use samplers and Holding circuits and Why? CO2 [K<sub>4</sub>]
15. Differentiate between Sampled Data Systems & Continuous-Time Systems. CO3 [K<sub>1</sub>]
16. Write down the expression for Impulse Invariance method of Discrete Time Control Systems. CO3 [K<sub>1</sub>]
17. The Damping ratio of a system is 0.6 and the natural frequency of oscillation is 8rad/sec. Determine the rise time. CO4 [K<sub>3</sub>]
18. How will you find the gain K at a point on root locus? CO4 [K<sub>2</sub>]
19. What is the transfer function of lag/lead compensator? CO5 [K<sub>1</sub>]
20. What is the effect of PD controller on the system performance? CO5 [K<sub>1</sub>]

**PART C (6 x 5 = 30 Marks)**

21. Using long division, determine the inverse z-transform of CO1 [K<sub>3</sub>]  
 $X(z) = (1+2z^{-1}) / (1-2z^{-1}+z^{-2})$ .
22. Derive expression for Discrete-Time State Equations using Z-transform approach. CO2 [K<sub>1</sub>]

- |     |  |     |                   |
|-----|--|-----|-------------------|
| 23. | Using Routh-Hurwitz criterion, determine the stability of the closed loop system with characteristic equation $s^4+2s^3+10s^2+20s+5 = 0$ . | CO4 | [K <sub>3</sub> ] |
| 24. | Determine the stability by using bilinear transformation of the system whose characteristics equation is given by $5z^2-2z+2=0$ .          | CO3 | [K <sub>2</sub> ] |
| 25. | Derive the expression for PD controller.   | CO5 | [K <sub>1</sub> ] |
| 26. | Derive the expression for Pole Zero Mapping.   | CO3 | [K <sub>1</sub> ] |

**Answer any FOUR Questions**

**PART D (4 x 10 = 40 Marks)**

- |     |   |            |                          |
|-----|---|------------|--------------------------|
| 27. | For the following transfer function draw bode plot and obtain gain margin, phase margin, gain cross-over frequency and phase cross-over frequency.<br>$G(s) = 20 / s (1+3s) (1+4s)$ . | CO4        | [K <sub>3</sub> ]        |
| 28. | Determine the stability by using Jury's stability analysis of the system whose characteristics equation is given by $F(z) = z^3-0.2z^2-0.25z+0.05 = 0$ .                              | CO4        | [K <sub>4</sub> ]        |
| 29. | Check the controllability of the following state space system.<br>$x_1 = x_2+u_2$<br>$x_2 = x_3$<br>$x_3 = -2x_2-3x_3+u_1+u_2$  | CO2        | [K <sub>4</sub> ]        |
| 30. | i) Write down the steps involved in constructing a Lag compensator.<br>ii) Compare the performance of lead and lag compensator.   | (6)<br>(4) | CO5<br>[K <sub>1</sub> ] |
| 31. | Find the overall gain $C(s) / R(s)$ for the signal flow graph shown below.  | CO1        | [K <sub>3</sub> ]        |

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