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M.E DEGREE EXAMINATIONS: JUNE 2015

(Regulation 2014)

Second Semester

APPLIED ELECTRONICS

P14AET202: Advanced Control Engineering

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Match the functions in List I with its Z Transforms in List II [K_1]

List I	**List II**
A. e^{-akT}	i. $\frac{1}{1-az^{-1}}$
B. a^k	ii. $\frac{Tz^{-1}}{(1-z^{-1})^2}$
C. $\delta(k-k0)$	iii. $\frac{1}{1-e^{-aT}z^{-1}}$
D. kT	iv. z^{-k0}

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

2. Determine $x(k)$ k = 0,1,2,3,4 if its Z-Transform $X(z)$ is [K_2]
$10z^{-1}+17z^{-2}+18.4z^{-3}+18.68z^{-4}$
a) 0,10, 17, 18.4,18.68 b) 10, 17, 18.4, 18.68, 0
c) 18.68, 18.4, 17, 10, 0 d) 10, 0, 17, 18.4, 18.64

3. A system is represented by the state space equation [K_2]

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0.4 & 1.3 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}.$$

Identify the state space representation in which the system is realized
a) Observable Canonical Form b) Jordan Canonical Form
c) Diagonal Canonical Form d) Controllable Canonical Form

4. Using the backward difference method to find the digital equivalent of the following analog system [K_2]

$H(s) = \frac{4}{(s^2+9)}$ Assume sampling time T = 1 second.

a) $H(z) = \frac{4}{\left(4\left(\frac{1}{1+z^{-1}}\frac{z^{-1}}{}\right)^2 + 9\right)}$

b) $H(z) = \frac{4}{\left(\left(\frac{1-z^{-1}}{z^{-1}}\right)^2 + 9\right)}$

c) $H(z) = \frac{4}{((1-z^{-1})^2+9)}$

d) $H(z) = \frac{4}{\left(\left(\frac{1}{1-z^{-1}}\right)^2 + 9\right)}$

5. Identify the correct statements regarding state space analysis [K2]

a) Can be applied to non-linear and time varying systems

b) Can be applied only to specific inputs

c) Cannot incorporate initial conditions easily.

d) Can be applied to multiple input multiple output systems

6. Identify the transient response specifications for a second order system [K2]

a) $Rise\ time\ t_r - \frac{4\pi}{\omega_d}$

b) $Settling\ time\ t_s = \frac{4}{\xi\omega_n}$

c) $Peak\ time\ t_p = \frac{\pi}{\omega_d}$

d) $Peak\ Overshoot\ M_p = \frac{\xi}{(1-\xi)}$

7. Identify the advantages of Phase Lead compensator [K2]

a) Low frequency characteristic are maintained.

b) Bandwidth is reduced.

c) High Frequency performance is improved.

d) Stability margins are improved.

8. Assertion (A): In step invariance method of transformation, the analog system is preceded by a Zero Order Hold. [K2]
Reason (R): Step invariance method does not yield a stable digital system even if the given analog system is stable.

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.

9. Assertion (A) : In Phase Lag compensator, the bandwidth is increased [K2]
Reason (R) : The problem of high frequency noise is overcome.

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.

10. Recall the sequence of steps followed to determine the stability of a system using bilinear transformation coupled with Routh's Hurwitz Criterion [K1]

a) Apply the Routh's Hurwitz criterion.

b) Obtain the characteristic equation of the system.

c) Using bilinear transform obtain the transformed equation.

d) Determine the Pulse Transfer function of the system

PART B (10 x 2 = 20 Marks)

11. Define starred transform and list its properties. [K_1]

12. Identify the advantages and problems of using higher order hold in closed loop systems. [K_2]

13. Recall the state space equation for a time varying system and recognize the various terms in the equation. [K_1]

14. Interpret whether the following system having the transfer function [K_3]

$$\frac{Y(z)}{X(z)} = \frac{(z+1)(z+4)}{(z+1)(z+2)(z+3)}$$

is controllable and observable.

15. Describe the warping effect in bilinear transformation. [K_2]

16. Differentiate between impulse invariance method and step invariance method. [K_2]

17. Define Delay time and Maximum Overshoot. [K_1]

18. Describe how a constant attenuation locus in s-plane is mapped onto z-plane. [K_2]

19. Define Compensation. Cite an example for a lead – lag compensator. [K_1]

20. List the performance specification of a control system. [K_1]

PART C (10 x 5 = 50 Marks)

21. Calculate [K_4]

$$Z\left(k(k-1)a^{(k-2)}\right)$$

and generalize for $Z\left(k(k-1)\ldots\ldots(k-h+1)a^{(k-h)}\right)$

22. Determine the response $y(kT)$ of the system [K_3]

$$\frac{Y(s)}{X^*(s)} = \frac{1}{(s+1)(s+2)}$$

where $x(t)$ is a unit step function and $x^*(t)$ is its impulse sampled version. Assume sampling time T = 0.1 sec.

23. Estimate the state space representation of the system whose pulse transfer function is given [K_4]

by $\frac{Y(z)}{X(z)} = \frac{1}{(z+1)(z+2)(z+3)}$

such that the state matrix is a diagonal matrix. Obtain $x_1(0)$, $x_2(0)$ and $x_3(0)$ in terms of $y(0)$, $y(1)$ and $y(2)$

24. Estimate the state transition matrix $\mathbf{\Psi}(k)$ for the discrete time state equation [K_4]

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -0.24 & -1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

25. Apply the step invariant transformation to obtain the discrete equivalent of analog system [K_3]

$$H(s) = \frac{4s^2 + 17s + 12}{s^2 + 5s + 6}$$

Assume sampling time T = 0.2 sec.

26. Calculate the digital equivalent of the analog system given by the equation [K_3]

$$H(s) = \frac{s + 0.1}{(s+0.1)^2 + 16}$$

using bilinear transformation. Assume sampling time T = 0.5 sec.

27. Evaluate the damping frequency ω_d, rise time t_r, peak time t_p, maximum overshoot M_p and settling time t_s (5% criterion) for $\xi = 0.6$ and $\omega = 5$ rad/sec. [K_3]

28. Assess the stability of the system represented by the characteristic equation $z^3 + 2.1z^2 + 1.44z + 0.32 = 0$ using Jury's stability test. What do you infer of the roots of the characteristic equation? [K_5]

29. Calculate the transfer function of an Integrator and Differentiator. [K_3]

30. Describe the steps involved in the design of phase lead compensator [K_2]

PART D (2 x 10 = 20 Marks)

31. i) Solve the following difference equation (5) [K_4]

$$x(k+2) - x(k+1) + 0.25x(k) = u(k+2)$$

where $x(0) = 1$ and $x(1) = 2$. The input function $u(k) = 1$ for k = 0,1, 2, ….

ii) Consider a system having n poles with m multiple poles at $z = p_1$ with $n>m$. Assuming suitable transfer function show that this can be written in Jordan Canonical form. (5) [K_4]

32. Estimate the region in the z-plane for the regions shown in the s-planes given in figures below and discuss. Assume the sampling period T = 0.3 sec. [K_5]

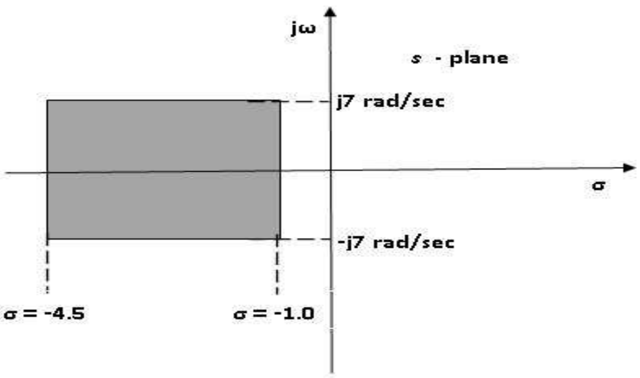

Figure 1

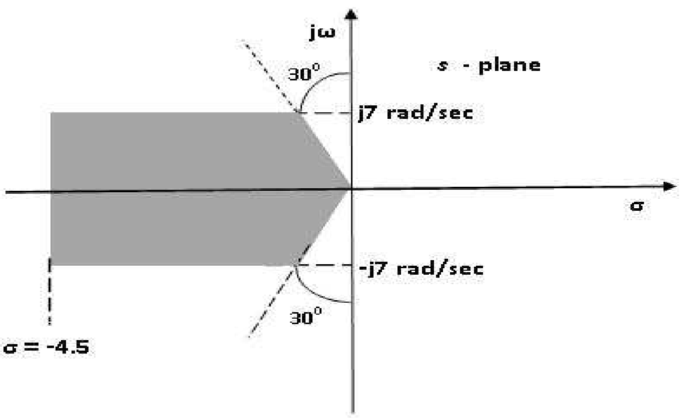

Figure 2

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