Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 86596

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth Semester

Electrical and Electronics Engineering

EE 1354 – MODERN CONTROL SYSTEMS

(Common to Electronics and Instrumentation Engineering)

(Regulations 2008)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. What is State observer?

2. What are eigen values and eigen vectors?

3. Explain sampling theorem.

4. What is zero order hold?

5. What is the effect of sampling time on controllability?

6. What are the advantages of canonical models?

7. Define backlash.

8. When a non-linear system becomes asymptotically stable?

9. What is meant by decoupling?

10. Why is state model preferred for MIMO system?

PART B — (5 × 16 = 80 marks)

11. (a) Obtain state variable model in Jordan canonical form for the system with transfer function.

$$\frac{y(s)}{v(c)} = \frac{2s^2+6s+2}{(s+1)^2(s+2)}.$$

(i) Find the response $y(t)$ to a unit-step input using the state model. (8)

(ii) Give a block diagram for analog computer simulation of the transfer function. (8)

Or

(b) A regulator system has the plant.

$$X^0 = \begin{bmatrix} 0 & 1 \\ 20.6 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u\,;$$

$$Y = [1\ \ 0]\,X.$$

(i) Design a control law u = – KX so that the closed-loop system has eigen values at $-1.8 \pm j2.4$. (8)

(ii) Design a full-order state observer to estimate the state vector. The observer matrix is required to have eigenvalues at –8, –8. (8)

12. (a) (i) Explain the signal reconstruction and sampling theorem. (8)

(ii) Explain any four Z-Transforms theorem in detail. (8)

Or

(b) (i) Explain the response of sampled data system to step and ramp Inputs. (8)

(ii) Find the inverse Z transform of the following function. (8)

(1) $$\frac{5z}{(z-1)(z-3)}$$

(2) $$\frac{z(z+1)}{(z-1)^2}$$

13. (a) Design and analyze the discrete-time pole placement Controller for the following :

$$X(K+1) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -4 & 2 & -1 \end{bmatrix} X(K) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U(K).$$

Desired closed loop pole locations are – 0.5+j0.5, – 0.5 – j0.5 and 0. (16)

Or

(b) Obtain three different companion forms of state models and analyze them with suitable block diagrams. (16)

$$\frac{Y(z)}{R(z)} = \frac{-2z^3 + 2z^2 - z + 2}{z^3 + z^2 - z - \frac{3}{4}}.$$

14. (a) A linear second order servo is described by the equation

$$\ddot{e} = 2\zeta w_n \dot{e} + w_n^2 e = 0.$$

Where $\zeta = 0.15, w_n = 1$ rad/sec, $e(0) = 1.5$ and $\dot{e}(0) = 0$. Determine the singular point. Construct the phase trajectory using the method of isoclines.

Or

(b) (i) Consider a linear autonomous system

$$x(k+1) = \begin{pmatrix} 0.5 & 1 \\ -1 & -1 \end{pmatrix}^{x(k)}$$

Using direct method of Liapunov determine the stability of the equilibrium state. (8)

(ii) Derive the describing function of Dead zone nonlinearity. (8)

15. (a) (i) What is MIMO system? What are the different models of MIMO system? Explain. (8)

(ii) Explain the transfer function representation of MIMO system. (8)

Or

(b) Explain the following:

(i) Multivariable Nyquist Plot. (8)

(ii) Model Predictive Control. (8)