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

**Question Paper Code : 20749**

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022.

Sixth Semester

Instrumentation and Control Engineering

IC 8651 — ADVANCED CONTROL SYSTEM

(Common to : Electrical and Electronics Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by a state variable and eigen value?
2. Define controllability and observability.
3. How does pole placement reflect on system stability?
4. Differentiate linear and nonlinear systems.
5. Give the relationship of S-domain to Z-domain transformation.
6. Give the circuit function for LEAD compensator.
7. What is meant by stability of nonlinear systems?
8. Classify the different methods available for inverse Z-transform.
9. Write the merits of optimal control.
10. Mention any two application of steady state optimal control.

PART B — (5 × 13 = 65 marks)

11. (a) Determine the state controllability for the system represented by the state equation

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}2 & 1\\ 0 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 0\end{bmatrix}u.$$

Or

(b) Obtain the state model of the system whose transfer function is given as ,

$$\frac{Y(s)}{U(s)}=\frac{10}{s^3+4s^2+2s+1}.$$

12. (a) Describe the control system design via pole placement by state feedback with suitable example.

Or

(b) The state model of a system is given by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 0 & 1\\ -2 & -3 & 0\\ 0 & 2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 2\\ 0\end{bmatrix}[u];\ y=\begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}.$$

Convert the state model to controllable phase variable form.

13. (a) Determine the inverse $z$-transform of the following function,

$$F(z)=\frac{1}{1-1.5z^{-1}+0.5z^{-2}}.$$

Or

(b) Discuss the two methods used in two methods of analyzing the behaviour or response of a Linear discrete systems.

14. (a) If the response of a system is $y=ax^2+e^{bx}$, explain the procedure to test whether the system is linear or nonlinear.

Or

(b) Write briefly about the following

(i) Jump resonance (4)

(ii) Characteristics of nonlinear systems (5)

(iii) Concepts of phase plane method. (4)

15. (a) A first order system is described by the differential equation $\dot{x}(t) = 2x(t) + u(t)$. It is desired to find the control law that minimizes the

PI $J = \frac{1}{2}\int_{t_0}^{t_f}\left(3x^2 + \frac{1}{4}u^2\right)dt$, $t_f = 1\,\text{sec}$.

Or

(b) Discuss briefly the two approaches to the design of control systems and also outline the steps to be followed during the analytical approach of parameter optimization.

PART C — (1 × 15 = 15 marks)

16. (a) A single input system is described by the following state equations.

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}-1 & 0 & 0\\ 1 & -2 & 0\\ 2 & 1 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}10\\ 1\\ 0\end{bmatrix}[u].$$

Design a state feedback controller which will give closed-loop poles at –1,+j1 or –j2,–6.

Or

(b) Determine the $z$-transform and their ROC of the following discrete sequence (i) $f(k) = \{3,2,5,7\}$ (ii) $f(k) = \{2,4,\underset{\uparrow}{5},7,3\}$.

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