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

Question Paper Code : 31481

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Sixth Semester

Instrumentation and Control Engineering

IC 2351/IC 61/10133 IC 604 — ADVANCED CONTROL SYSTEM

(Regulation 2008/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define: Controllability

2. What is meant by state transition matrix?

3. What is a limit cycle? What is its effect on the system performance?

4. What are the steps involved in the phase plane analysis?

5. Mention the various approximation methods of linearising nonlinear systems.

6. What are the differences between linear system and non-linear system?

7. What are the various conditions for system's stability?

8. Write the Popov's criterion of stability analysis.

9. State optimal control law.

10. What is meant by multivariable control system?

PART B — (5 × 16 = 80 marks)

11. (a) Consider the second-order system: $\dot{x}(t)=\begin{bmatrix}2 & 3\\ -1 & 4\end{bmatrix}x(t)+\begin{bmatrix}0\\ 1\end{bmatrix}u(t)$ and $Y(t)=[0\ 1]\,X(t)$. (16)

The desired characteristic equation of the observer is given by, $\Phi(s)=s^2+2\zeta\omega_n s+{\omega_n}^2$, where $\zeta=0.8$ and $\omega_n=10$. Design a full-state observer such that the desired performance specifications for the observer are satisfied using,

(i) Comparison of coefficients methods

(ii) Ackermann's formula

Or

(b) (i) Explain the different methods used to find the state feedback gain matrix and compare them. (8)

(ii) Derive the condition for complete state controllability of a continuous system and verify whether the following system is completely state controllable. (8)

$$\dot{x}(t)=\begin{bmatrix}1 & 1\\ 2 & -1\end{bmatrix}x(t)+\begin{bmatrix}0\\ 1\end{bmatrix}u(t).$$

12. (a) (i) Explain the isocline method for construction of phase -plane portrait. (8)

(ii) Draw a phase-plane portrait of the following system: (8)

$$\ddot{\theta}+\dot{\theta}+\sin\theta=0.$$

Or

(b) The state model of a system is given by, (16)

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

Convert the state model in to observable phase variable form.

13. (a) (i) Explain the effect of inherent nonlinearities on static accuracy. (8)

(ii) Derive the describing function for Saturation nonlinearity. (8)

Or

(b) (i) Explain the popular inherent nonlinear elements and their functionalities. (8)

(ii) Derive the describing function for an ON-OFF nonlinearity with hysteresis. (8)

14. (a) What are the different types of stability? Define and explain each of them with examples. (16)

Or

(b) (i) Determine the stability of the system described by,

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -1 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u;\ y=\begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}.$$ (10)

by using Liapunov stability.

(ii) Explain circle criterion for stability analysis. (6)

15. (a) Explain in detail the different configurations and classifications of time varying optimal control with the help of block diagrams. (16)

Or

(b) (i) Explain the block diagram representation of LQR steady state optimal controller. (8)

(ii) How can the optimal parameter estimation and control law be implemented for a controller? (8)
