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

Question Paper Code: 31653

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2016

Fifth Semester

Instrumentation and Control Engineering

01UIC503 – ADVANCED CONTROL SYSTEM

(Regulation 2013)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions.

PART A - (10 x 2 = 20 Marks)

1. Write the state model of LTI system.
2. State the condition for controllability by Gilbert's method.
3. Define limit cycles.
4. How are calculated, when the Eigen vectors values are distinct?
5. Define describing function.
6. Define limit cycles.
7. Give the general state equation for a nonlinear system.
8. How the Sylvester's criterion expressed in quadratic form?
9. Define optimal control.
10. Write down the linear continuous-time state equation.

PART - B (5 x 16 = 80 Marks)

11. (a) A system represented by state equation $\dot{X}(t) = AX(t)$. The response is $X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$ and $X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$ when $X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$. Determine the system matrix *A* and the state transition matrix. (16)

Or

(b) Obtain the time response of the following system $\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$ where *u(t)* is unit-step function occurring at *t*=0. (16)

12. (a) Draw and explain the construction of phase trajectories by using delta method. (16)

Or

(b) A linear second order servo is described by $\ddot{e} + 2\rho\omega_n\dot{e} + {\omega_n}^2 e = 0$ where ρ = 0.15, ω_n=1rad/sec, e (0) = 1.5, $\dot{e}(0)$ = 0. Determine the singular point and construct the phase trajectory using the method of isoclines. Choose slope as -2, -0.5, 0, 0.5, and 2. (16)

13. (a) Deduce the expression for input-output characteristic describing function of backlash nonlinearity. (16)

Or

(b) Derive the describing function for a system with saturation nonlinearity. (16)

14. (a) Determine the sign definiteness of the quadratic function

$$Q = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_2x_1 - 2x_2x_3 - 4x_1x_3 \quad (16)$$

Or

(b) Describe Popov's criterion for stability analysis. (16)

15. (a) Discover the control law which minimizes the performance index

$$J = \int_0^\infty ({x_1}^2 + 0.25\,u^2)\,dt$$

For the system $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ 0 & 0\end{bmatrix}x + \begin{bmatrix}0\\ 100\end{bmatrix}u$. (16)

Or

(b) Derive an iterative method for solving reduced matrix Riccati equation. (16)

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