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Question Paper Code: 41653

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

Fifth Semester

Instrumentation and Control Engineering

14UIC503 - ADVANCED CONTROL SYSTEM

(Regulation 2014)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. $\phi(s)$ is called the

   (a) State transition matrix (b) Resolution matrix
   (c) Resolvent matrix (d) Transfer matrix

2. The concepts of controllability and observability were introduced by

   (a) Gilbert (b) Kalman (c) Gibson (d) None of these

3. The purpose of intentionally introducing nonlinearities into the system is

   (a) to improve the system performance
   (b) to reduce the system performance
   (c) to complex the construction of the system
   (d) not alter the system performance

4. The coordinate plane with the state variables x_1 and x_2 as two axes is called

   (a) phase trajectory (b) phase portrait (c) phase plane (d) singular point

5. Which of the following is the example of the non linear system

(a) $y = ax^2 + e^{bx}$ (b) $y = ax + b\frac{dx}{dt}$

(c) $y = ax^2 + b\frac{dx}{dt}$ (d) $y = a^2x + e^{bx}$

6. A locus passing through the points of same slope in phase plane is called

(a) limit cycles (b) phase portrait (c) phase plane (d) isoclines

7. An unforced (i.e., $u = 0$) and time invariant system is called

(a) linear system (b) non linear system
(c) autonomous system (d) none of these

8. The linear autonomous system is $\dot{x} = Ax$, where A is

(a) $n \times n$ real constant matrix (b) $m \times n$ real constant matrix
(c) $n \times 1$ real constant matrix (d) $1 \times n$ real constant matrix

9. The control law is

(a) $U = Kx$ (b) $U = -Kx$ (c) $U = K^2x$ (d) None of these

10. The optimal control theory is applicable for

(a) Multivariable system (b) SISO
(c) Autonomous system (d) None of these

PART - B (5 x 2 = 10 Marks)

11. Define observability.

12. List two properties of non linear systems.

13. Define describing function.

14. List two analysis of non linear system.

15. Express Matrix Riccati equation.

PART - C (5 x 16 = 80 Marks)

16. (a) (i) Construct a state model for a system characterized by the differential equation $\frac{d^3 y}{dt^3} + 6\frac{d^2 y}{dt^2} + 11\frac{dy}{dt} + 6y + u = 0$ (8)

(ii) Consider the matrix A. Compute State transition matrix $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ (8)

Or

(b) Consider a linear system described by the transfer function $\frac{Y(s)}{U(s)} = \frac{10}{s(s+1)(s+2)}$.

Design a feedback controller with a feedback so that the closed loop poles are placed at -2, -1 ± j1. (16)

17. (a) Construct a phase trajectory by delta method for a non linear system represented by the differential equation, $\ddot{x} + 4\dot{x} + 4x = 0$. Choose the initial condition as $x(0)$ =1.0 and $\dot{x}(0) = 0$. (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)

18. (a) Derive the describing function of dead-zone nonlinearity. (16)

Or

(b) Derive the describing function of saturation nonlinearity. (16)

19. (a) Using the Lyapunov equation, examine the stability range for the gain K of the system shown in figure-1. (16)

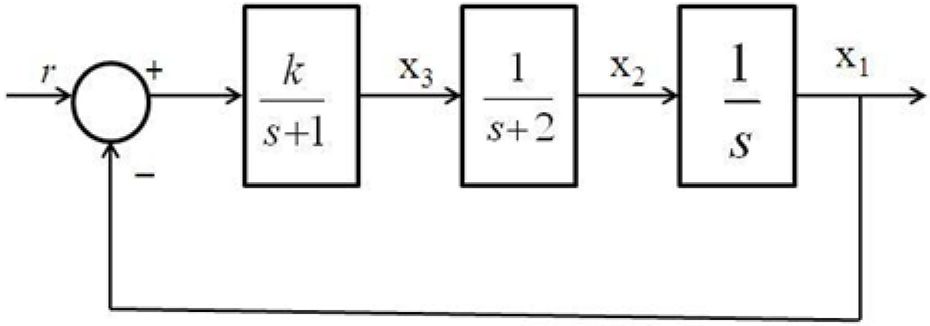

Figure 1

Or

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

20. (a) Consider the second order system as shown in figure 2. Calculate the value of damping ratio ξ, so that the system is subjected to a unit step input r, the performance index $J = \int_0^\infty (e^2 + e^2)\,dt$ is minimized. The system is assumed to be at rest initially. (16)

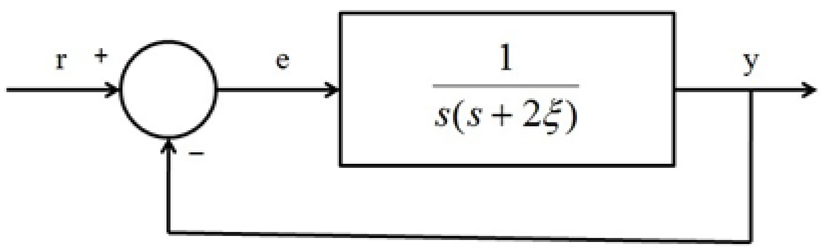

Figure 2

Or

(b) Discover the control law which minimizes the performance index $J = \int_0^\infty (x_1^2 + 0.25\,u^2)\,dt$. For the system $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 100 \end{bmatrix} u$. (16)
