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Question Paper Code: 45603

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2019

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. The variable which determine the state of a dynamical system, are called

   (a) State-analysis (b) State-vector
   (c) State-variables (d) State-space

2. In a system, all initial states are controllable. The system is said to be

   (a) Partially controllable (b) Uncontrollable
   (c) Infinity (d) Completely controllable

3. 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

4. Non linear systems often have______________ steady-state solutions.

   (a) Single (b) Multiple (c) One or Two (d) Zero

5. In many cases the system presents a nonlinear phenomenon which is fully characterized by its ________ characteristics.

   (a) Dynamic (b) First order (c) Static (d) Second order

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. The system describe by $\dot{x}(t) = F(x(t))$, a state $x_e(t)$ where $F(x_e(t)) = 0$; for all t is called as a/ an __________ of the system.

(a) Un stable (b) Stable
(c) Equilibrium state (d) Un stable equilibrium state

8. In the following equations, which one is named as negative – definite scalar function based on Liapunov's stability criterion?

(a) $\frac{dV(x)}{dt}$ (b) $\frac{dV^2(x)}{dt^3}$ (c) dV(x) (d) $\frac{dV}{dt}$

9. A control system is optimum when the selected performance index is

(a) Maximized (b) Controlled
(c) Non controlled (d) Minimized

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. List the various types of non linearity's in control system.

14. List two analysis of non linear system.

15. What is multivariable control?

PART - C (5 x 16 = 80 Marks)

16. (a) (i) Construct a state model for a system characterized by the differential equation $\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y + u = 0$ (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) Use the method of isoclines to draw the direction field for the following differential equation (16)

$$\frac{dy}{dt} = y - t$$

18. (a) (i) A nonlinear electronic device produces an output that is the cube of its input (i.e. $y = x^3$). Derive the describing function of the device. (8)

(ii) The input x (t) and the output y (t) of a nonlinear system are related through the nonlinear differential equation $y(t) = x^2(dx / dt) + 2x$. Determine the describing function of the system. (8)

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)

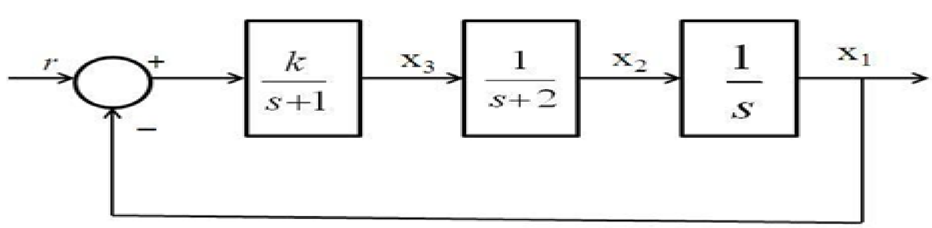

Figure 1

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)

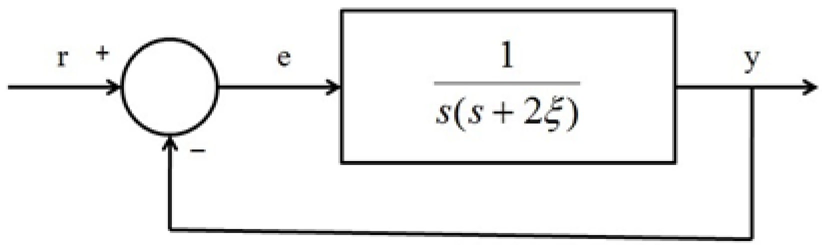

Figure 2

Or

(b) Discover the control law which minimizes the performance index $J = \int_0^\infty (x_1^2 + 0.25u^2)dt$. 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)