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Question Paper Code: 45603

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2018

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. 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

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. The describing function is a linear approximation of the static nonlinearity limited to the _________ harmonic.

   (a) 1 (b) 2 (c) 3 (d) 4

7. 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

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

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

10. The linear quadratic regulator (LQR) is a well-known design technique that provides practical

   (a) Forward gains (b) Feedback gains
   (c) Feed forward gains (d) Gains

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. 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) Describe the limit cycles in linear and non-linear systems with examples. (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) (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) The input x (t) and the output y (t) of a nonlinear device are related through the differential equation y (t) = $(dx / dt)^3$ + x^2 (dx / dt). Determine the describing function for this device. (16)

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

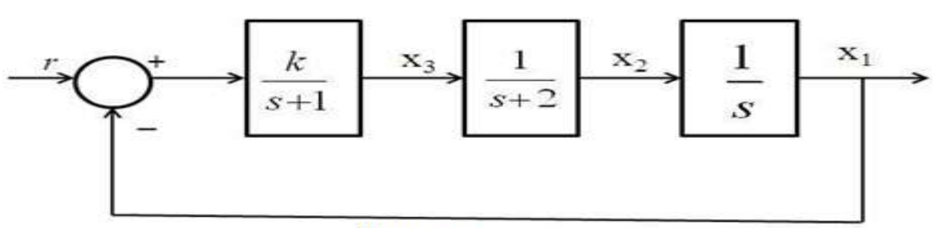

Figure 1

Or

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

20. (a) Explain the time varying optimal control in detail, with an example. (16)

Or

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