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Question Paper Code : P 1359

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Fifth Semester

Instrumentation and Control Engineering

IC 1301 — NON–LINEAR CONTROL SYSTEM

(Regulation 2004)

Time : Three hours Maximum : 100 marks

(Graph sheets may be provided)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Eigenvalues and Eigenvectors.
2. Explain the concept of controllability.
3. What are singular points?
4. Define limit cycles.
5. What is a describing function?
6. List the condition for stability using describing function analysis.
7. Define circle criterion.
8. What is Kalman's conjecture?
9. List the advantages of optimal controller.
10. What is parameter optimization?

PART B — (5 × 16 = 80 marks)

11. (a) Compare linear and non-linear systems. Draw and explain the typical characteristic features of some common physical non-linearities. (16)

Or

(b) What are state equations? Define transfer function. Consider a typical example and explain the conversion of state variables models to transfer functions. (16)

12. (a) What is phase plane, phase trajectory and phase portrait? Draw and explain how to determine the stable and unstable limit cycles using phase portrait? (16)

Or

(b) A linear second order servo is described by the equation $\ddot{e} + 2\zeta\omega_n\dot{e} + \omega_n^2 e = 0$ where $\zeta = 0.15$, $\omega_n = 1$ rad/sec, e(0) = 1.5 and $\dot{e}(0) = 0$. Determine the singular point. Construct the phase trajectory, using the methods of isoclines. Choose slope as –2.0, –0.5. 0, 0.5 and 2.0. (16)

13. (a) The input-output relationship of dead-zone nonlinearity is shown in the Figure 13(a). The output is zero, when the input is less than D/2. The input-output relationship is linear when the input is greater than D/2. The response of the nonlinearity when input is sinusoidal signal $(x = X \sin \omega t)$. (16)

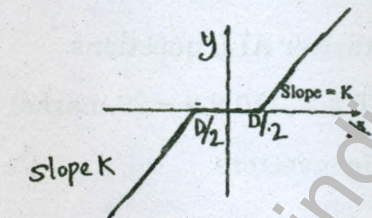

Fig. 13 (a)

Or

(b) Discuss the stability of a nonlinear system shown in Figure 13 (b). The controller is of relay type without any dead-zone or hysteresis. (16)

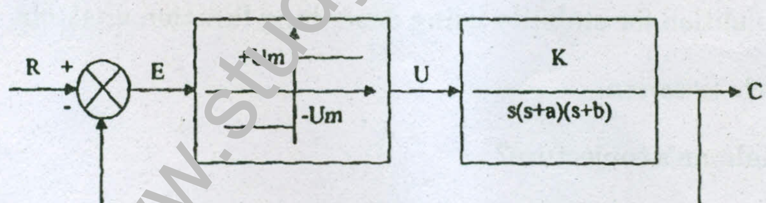

Fig. 13 (b)

14. (a) (i) Define Liapunov stability. Explain Liapunov's direct method. (8)

(ii) Investigate the stability using Liapunov method for a non-linear servo system described by the following equation:

$\ddot{E} + K\dot{E} + K_1(\dot{E})^3 + E = 0$. (8)

Or

(b) (i) Explain Popov's criterion. (8)

(ii) Examine the stability of the system in Fig. 14 (b) below using Lure's first canonic form method if $G(s) = \frac{(s+0.1)}{(s+0.4)(s+0.8)(s+1)}$. (8)

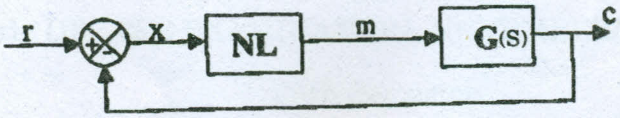

Fig. 14 (b)

15. (a) Explain the theory and basic principle of model predictive control. Why is nonlinear Model Predictive Control a variant of model predictive control? (16)

Or

(b) Consider a typical computer-implemented mathematical model and explain how a state feedback and observer is used to model and solve a real system. (16)
