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Question Paper Code : 60687

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Sixth Semester

Electrical and Electronics Engineering

IC 2351/IC 61/10133 IC 604 — ADVANCED CONTROL SYSTEM

(Common to Instrumentation and Control Engineering)

(Regulations 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Check the controllability of the following system :

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & 5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

2. Obtain a state model for the following system :

$$G(s) = \frac{1}{s^2 + 5}$$

3. Write any two properities of nonlinear systems.

4. Distinguish between subharmonic and self excited oscillations.

5. What are the assumptions to be considered for describing function analysis of steady-state oscillations in non linear systems?

6. Define limit cycle.

7. What are the various conditions for system's stability?

8. Write the Popov's criterion of stability analysis.

9. What is decoupling?

10. What is optional control?

PART B — (5 × 16 = 80 marks)

11. (a) Consider the system whose state equation is given by

$$\dot{x} = \begin{bmatrix} 1 & 2 \\ 1 & 1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u, y = [1\ 0]\, u .$$

(i) Evaluate the state transition matrix. (6)

(ii) Determine the state and output response of the system for unit step input. (10)

Or

(b) Consider a system whose transfer function is given by

$$\frac{Y(s)}{U(s)} = G(s) = \frac{1}{s^4 + 3s + 5}$$

(i) Obtain the state model in controllable canonical form. (6)

(ii) Design a state feedback controller to place the closed Loop poles at –1, –2. (10)

12. (a) Consider a system with an ideal relay as shown in Fig. Q. 12 (a). Determine the singular point. Construct the phase trajectories corresponding to the initial conditions.

C (0) = 2, C (0)= 1.5. Taker r = 2 Volts and M 1.2 Volts. (16)

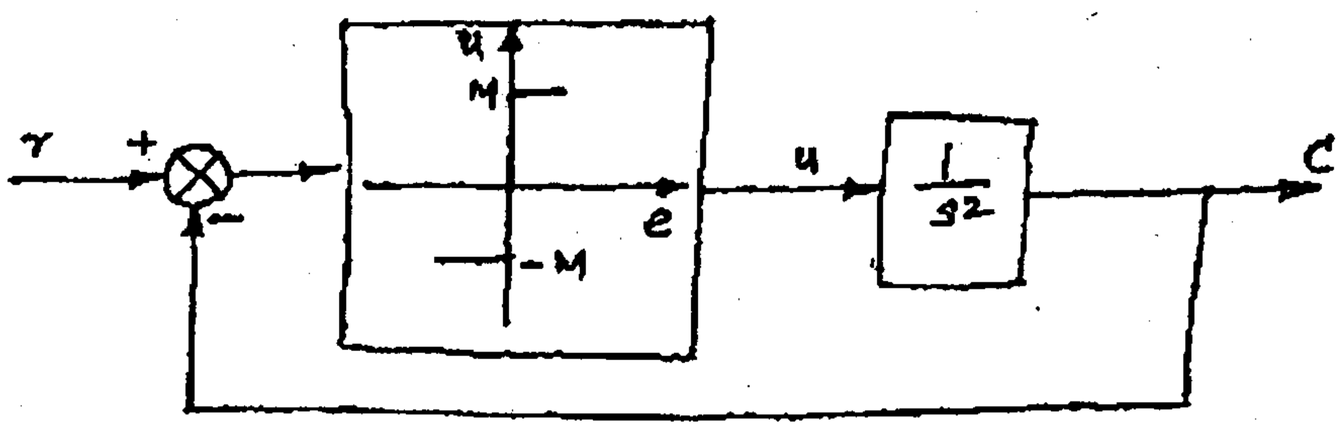

Figure Q.12 (a)

Or

(b) (i) What is phase trajectory? Describe how the phase trajectories is constructed by analytical and Isocline methods. (10)

(ii) Explain the limit cycle behavior of non-linear system. (6)

13. (a) (i) Explain the effect of inherent nonlinearities on static accuracy. (8)

(ii) Derive the describing function for Saturation nonlinearity. (8)

Or

(b) (i) Explain the popular inherent nonlinear elements and their functionalities.

(ii) Derive the describing function for an ON-OFF nonlinearity with hysteresis. (8)

14. (a) (i) Verify that $V = x_1^4 + 2x_2^2 + 2x_1 + x_2 + x_1^2$ is a Liapunov function for the system describe the equation $\frac{dx_1}{dt} = x_1, \frac{dx_2}{dt} = -x_2 - x_1^3$. (8)

(ii) The differential equation of a nonlinear device is $\frac{d^2x}{dt^2} + 2x^2\frac{dx}{dt} + x = 0$. Use Liapunovs method to determine its stability. (8)

Or

(b) State and prove Liapunovs stability theorem, Also explain what the sufficient conditions of stability. (16)

15. (a) Consider the system described by the state model.

$$X^{\circ} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 20 \end{bmatrix} u$$

$$y = [1 \quad 0]X$$

Find the optimal control law that minimizes.

$$J = \frac{1}{2}\int_0^{\infty} (y^2 + u^2)\,dt \ .$$

Or

(b) For the system of Fig –15 (b), compute the value of K that minimizes ISE for the unit — step input.

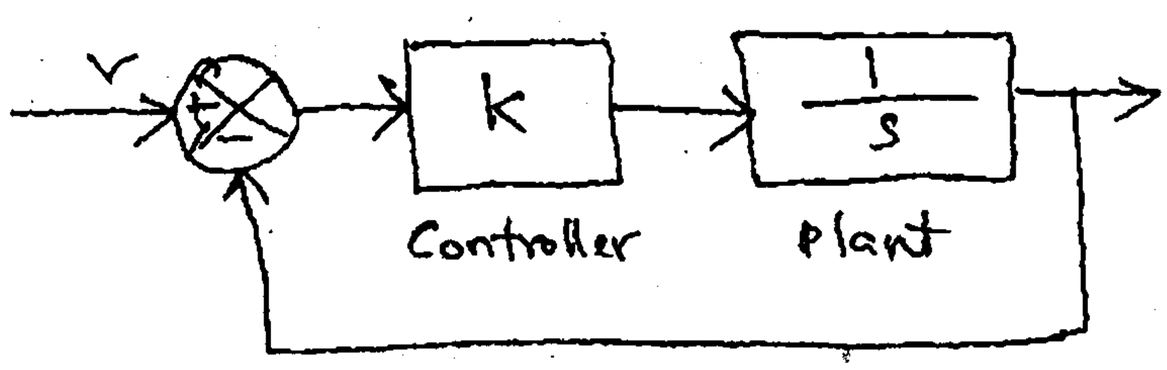

Fig. 15 (b)