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Reg. No. :

Question Paper Code : 21481

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Sixth Semester

Instrumentation and Control engineering

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

(Regulation 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by state observer?
2. Why is state model not unique?
3. What are the features of non-linear systems?
4. What is limit cycle?
5. Define: Describing function.
6. What are common nonlinearities?
7. Define: Popov's criterion.
8. What is Liapunov's stability concept?
9. What is decoupling?
10. What is optional control?

PART B — (5 × 16 = 80 marks)

11. (a) Consider the system

$$X^{\circ} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix} y = [1 \quad 0] X.$$

(i) Determine the stability of the system

(ii) Find the output response of the system to unit-step input.

Or

(b) A regulator system has the plant

$X^{\circ} = AX + bu; y = CX$

With $A = \begin{bmatrix} 0 & 0 & -6 \\ 1 & 0 & -11 \\ 0 & 1 & -6 \end{bmatrix}; b = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} c = [0 \quad 0 \quad 1],$

Compare K so that the control law $u = -KX$, places the control loop poles at $-2 \pm j3.464, -3$. Give the state variable model of the closed loop system.

12. (a) A linear second-order servo is described by the equation

$y^{\circ\circ} + 2s\ w_n y^{\circ} + w_n^{\ 2}\ y = wn^2$

where $w_n = 2$; $y(0) = 2$; $y^{\circ}(0) = 0$

(i) s = 0

(ii) s = 0.15. Construct the phase trajectory in each case.

Or

(b) Consider the system shown in Fig –1, in which the nonlinear element is a power amplifier with gain equal to 1.0, which saturates for error magnitudes greater than 1.0. Given the initial condition: e(0) = 2, e°(0) = 0, Plot phase trajectories with and without saturation, and comment upon the effect saturation on the transient behaviour of the system.

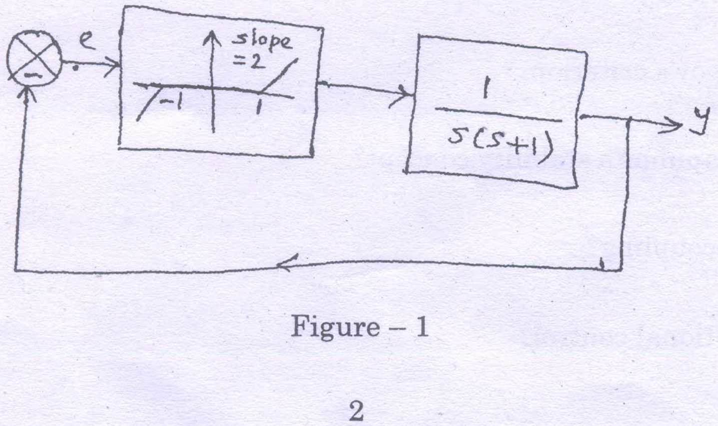

Figure – 1

13. (a) Consider the system shown in Fig – 2. Using the describing function analysis, show that a stable limit cycle exists for all values of k>0. Find the amplitude and frequency of the limit cycle when k = 4 and plot y(t) versus t.

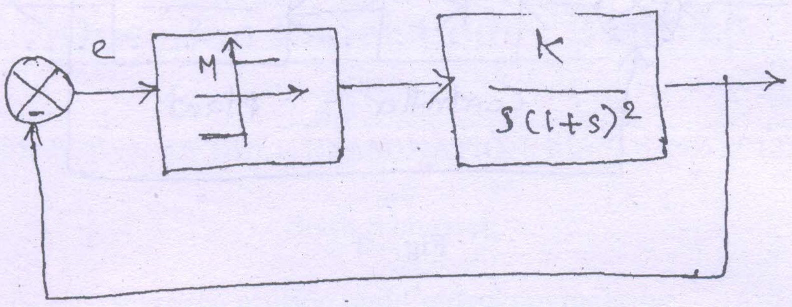

Fig – 2

Or

(b) Derive the describing function for any two common nonlineraties.

14. (a) Consider the nonlinear system described by the equations.

$$x_1^\circ = -x_2$$
$$x_2^\circ = -x_1 - (1 - |x_1|)x_2$$

Or

(b) Use the variable gradient method to find a Lyapunov function for the nonlinear system.

$$x_1^\circ = -x_1$$
$$x_2^\circ = -x_2 + x_1 . x_2^2$$

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 – 3, compute the value of K that minimizes ISE for the unit – step input.

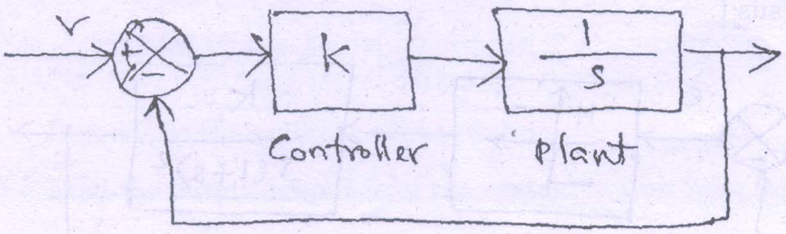

Fig – 3
