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Question Paper Code : 71687

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Sixth Semester

Electrical and Electronics Engineering

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

(Common to Instrumentation and Control Engineering)

(Regulation 2008/2010)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention the limitations of conventional control theory.

2. What is an observer? Under what conditions would you use an observer in your feedback design of a control system?

3. List the common physical non linearities present in a system.

4. Write the drawback of phase plane method.

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. Test the asymptotic stability using Liapunav's direct method for the system of dynamics.

$$\dot{y} = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix} y$$

8. State Popov's criterion.

9. Mention the factors to be considered for designing an optimal controller.

10. What is a singular minimum time problem?

PART B — (5 × 16 = 80 marks)

11. (a) A system is described by $\frac{d^3y}{dt^3}+\frac{6dy^2y}{dt^2}+\frac{11dy}{dt}+2y=6u$ where y is the output and u is the input of the system. Obtain the state space representation of the system and check for its controllability and observability. (16)

Or

(b) The dynamics of the system is represented by $\dot{x}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}x+\begin{bmatrix}0\\ 1\end{bmatrix}u$ and output $y=[\,2\,0\,]x$ with the initial conditions $x(0)=[0.5 \quad 0]^T$. Design a state observer, so that the new pole placement will be at $(-10,-10)$. (16)

12. (a) Construct a phase plane portrait of the control system described by the following derivative equation $\ddot{x}+0.5\dot{x}+2x+x^2=0$. (16)

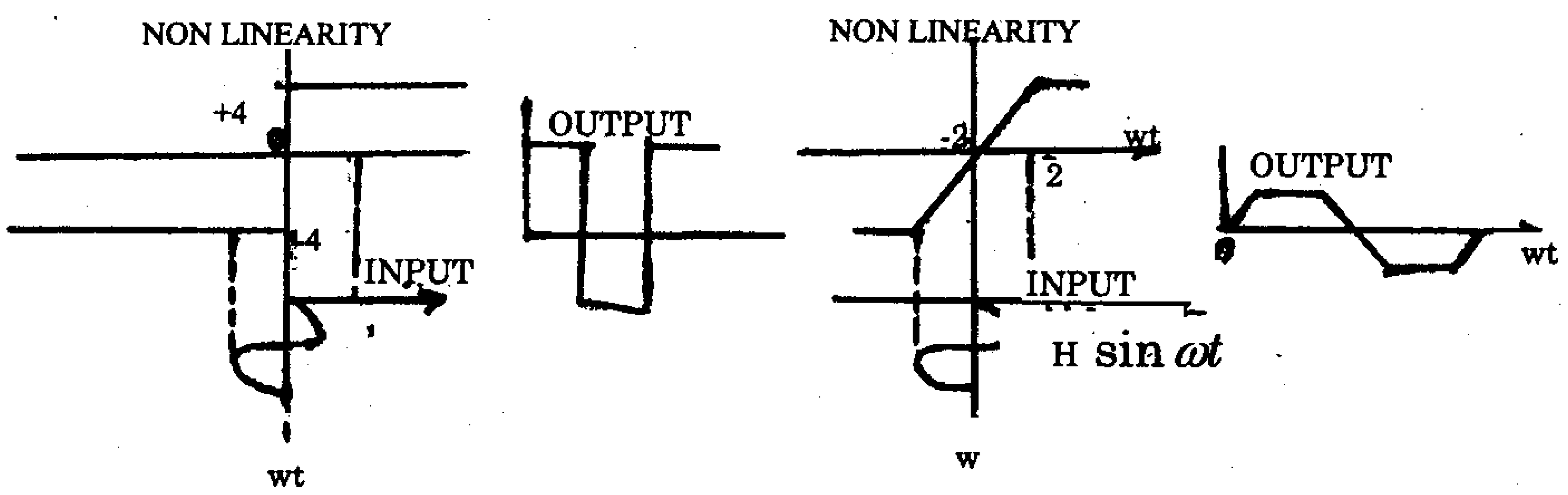
Or

(b) Discuss the algorithm of constructing the phase portrait by isocline method with example. (16)

13. (a) Illustrate the idealized characteristics of a non linearity having dead-zone and its response due to sinusoidal input. (16)

Or

(b) Find out the describing function for the system shown in figure. (16)



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 by the equation $\frac{dx_1}{dt}=x_2, \frac{dx_2}{dt}=-x_2-x_1^3$. (8)

(ii) The differential equation of a nonlinear device is

$\frac{d^2x}{dt^2}+2x^2\frac{dx}{dt}+x=0$. Use Liapunov's 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 a first order system described by the differential equation $\dot{x}(t) = 2x(t) + u(t)$. Find the optimal control law that minimizes the performance index $J = \frac{1}{2}\int_0^{t_f}\left(3x^2 + \frac{1}{4}u^2\right)dt, t_f = 1\,\text{sec}$. (16)

Or

(b) Consider a plant to be controlled which is described by a state space model.

$\dot{x}(t) = Ax(t) + Bu(t)$

$y(t) = Cx(t)$

Outline the process by which you would design a discrete LQ regulator incorporating a current state estimator. (16)
