009704

Dec. 2021

B.Tech. (EIC) - VII SEMESTER

Non-Linear Control System (EIEL-709)

Time : 90 Minutes]   [Max. Marks : 25

Instructions :

1. *It is compulsory to answer all the questions (1 mark each) of Part-A in short.*

2. *Answer any three questions from Part-B in detail.*

3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART - A

1. (a) Name four Non-linearities present in Control systems.   (1)

    (b) A non-linear system is given by $w = x + \dfrac{x^3}{2}$, where x is the input and w is the output. Find the describing fn. of the system.   (1)

    (c) Define Relative degree of a system.   (1)

    (d) What is lie derivative of a function?   (1)

    (e) What do you mean by diffeomorphism?   (1)

(f) Draw the block diagram of an adaptive controller. (1)

(g) State Lyapunov Stability criterion. (1)

(h) Differentiate between inherent & intentional non-linearity. (1)

(i) What is the difference between robust control & adaptive control? (1)

(j) Define positive semi-definiteness of a scalar function. (1)

PART - B

2. (a) What are the assumptions made in deriving describing function of Non-linear Systems? (2)

    (b) $d^2y/dt^2 + 0.5dy/dt + 2y + y^2 = 0$. Find the singularities of the system and classify the singular points. (3)

3. (a) Derive the expression for the describing function of a Relay with dead zone. (3)

    (b) Find the sign definiteness of the function
    $$4x_1^2 + 2x_2^2 + 2x_1x_2 + x_2x_3 + 2x_1x_3.$$ (2)

4. (a) Explain in brief the variable gradient method. (3)

    (b) For the given system, generate Lyapunov function using Krasovskii's method
    $$\dot{x}_1 = -6x_1 + 2x_2$$
    $$\dot{x}_2 = 2x_1 - 6x_2 - 2x_2^3$$ (2)

5. (a) For the given system, find the Jacobian matrix for feedback linearization.
    $$\dot{x} = \begin{bmatrix} x_1x_2 - x_1^3 \\ x_1 \\ -x_3 \\ x_1^2 + x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 + 2x_3 \\ 1 \\ 0 \end{bmatrix} u$$
    $$y = h(x) = x_4.$$ (2)

    (b) Write all the steps for finding the existence of a limit cycle in a non-linear system. (3)

6. (a) Write in steps for constructing a phase trajectory using method of isoclines. (2)

    (b) Write short note on MRAC. (3)

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