NONLINEAR CONTROL

Full Marks: 70

Time: 3 hours

Answer SIX questions including Q No. 1 which is compulsory.

The figures in the right hand margin indicate marks. *Symbols carry usual meaning*

Q.1 Answer all questions   2x10

a. What is phase plane?

b. Explain the concept of existence of limit cycles.

c. Compare linear system with nonlinear system.

d. State equilibrium point theorem.

e. Define Lypanov's instability theorem.

f. Write short notes on Positive definite function.

g. Differentiate between MIMO and SISO system.

h. How do you generate a linear input-output relation?

i. What is sliding mode control?

j. Briefly explain about Feedback linearisation.

2. (a) What are the various types of non-linearities that occur in control systems ? What are their characteristics and effects on the operation of a control system?   5

(b) What is a describing function? Explain how an element with backlash can be analysed using describing function method.   5

3. (a) Explain how phase plane trajectory using method of isoclines can be constructed for the system described by

$$\frac{d^2x}{dt^2} + \frac{dx}{dt} + x(t) = 0$$

                                                                                          5

(b) What is a singular point? Draw the phase trajectory of the following singular points:

i) Stable node   ii) Unstable node   iii) Saddle point   iv) Vortex point   5

4. (a) Explain the terms-stability in the sense of Lyapunov, asymptotic stability and instability with graphic representation. Give examples.   5

(b) Construct Lyapunov function by Krasoviski's method for non linear systems.   5

5. (a) Check the stability of the system described by

$$\dot{x}_1 = x_2$$
$$\dot{x}_2 = -x_1 - b_1 x_2 - b_2 x_2^3 \; ; \; b_1, b_2 > 0$$

                                                                                          5

(b) Derive the Lypunov equation for linear time invariant systems.

6. (a) Write short notes on Linearization of nonlinear systems.   5

(b) Explain the procedure followed for linearization of SISO system.   5

7. Take an example of pendulum, explain about sliding mode control by taking different values of delta.

                                                                                          10

8. (a) Explain the concept of linearization of MIMO system.   5

(b) Draw the phase portrait for sliding mode control. Explain the procedure followed for designing sliding mode control.

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