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May 2019

M.Tech. IInd Semester

NON LINEAR CONTROL SYSTEM

(MEI201)

Time : 3 Hours] [Max. Marks : 75

Instructions :

(i) It is compulsory to answer all the questions (1.5 marks each) of Part A.

(ii) Answer any four questions from Part -B in detail. Part (a) is of 8 marks and Part (b) is of 7 marks.

(iii) Different sub-parts of a question are to be attempted adjacent to each other.

PART–A

1. Answer in brief of the following :

(a) What is the meaning of the term canonical in Jordon canonical form.

(b) Describe mathematically a non-linear Time Variant system.

(c) Explain Frequency Entrainment and Asynchronous quenching.

(d) Explain the limitations of describing function method.

(e) What are phase plane portraits?

(f) Multi Valued Response & jump resonance in Non-Linear System.

(g) Draw phase trajectory for $x_2 = -x_1 - x_1^3$.

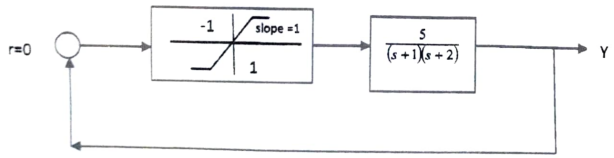
(h) How do you ascertain stability using Liapunov second method.

(i) What does a matrix A being positive definite signify?

(j) What do you mean by existence of Limit Cycle in non-linear system?

PART–B

2. (a) Determine the existence of the limit cycle if it exists in the system shown.



(b) Describe the inherent and intentional non-linearities with one example.

3. (a) Use second method of Liapunov to estimate the region of asymptotic stability of the equilibrium state $[2/3\ 2/3]^t$ of the dynamical system model

$$\dot{x}_1 = (1 - x_1 - 0.5x_2)x_1$$

$$\dot{x}_2 = (1 - 0.5x_1 - x_2)x_2.$$

(b) Give analysis of singular points.

4. (a) Check the stability of the origin of the given system described by

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = -x_1^3 - x_2.$$

(b) Obtain describing function for Hysteresis with dead zone type of non-linearity.

5. (a) Determine the stability of the equilibrium state of the following system :

$$x_1(k+1) = x_1(k) + 3x_2(k)$$

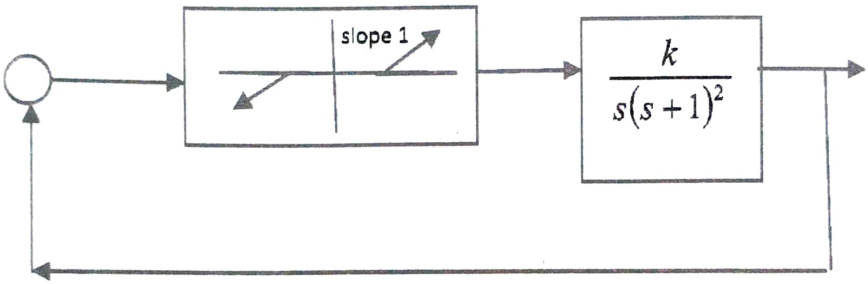
$$x_2(k+1) = -3x_1(k) - 2x_2(k) - 3x_3(k)$$

$$x_3(k+1) = x_1(k)$$

(b) Determine if the following quadratic form is positive definite

$$Q = x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 6x_2x_3 - 2x_1x_3.$$

6. (a) Using the describing function technique, show that a stable limit cycle cannot exist in this system for any $k > 0$.



(b) Describe any method to construct phase trajectory.

7. (a) Obtain describing function for saturation type of non-linearity.

(b) Check if the given system is globally asymptotically stable using Liapunov's direct method

$$\dot{x}_1 = x_1 + x_2 + x_1(x_1^2 + x_2^2)$$

$$\dot{x}_2 = -x_1 - x_2 + x_2(x_1^2 + x_2^2).$$