4. (a) A linear autonomous system is described by the state equation :

$$\dot{X} = AK$$

$$A = \begin{bmatrix} -4K & 4K \\ 2K & -6K \end{bmatrix}$$

Find the restrictions on the parameter K to guarantee stability of the system. **6**

(b) What is Popov criterion for stability ? Write its assumptions and applications. **9**

Unit III

5. (a) What are basic objectives of using adaptive control ? Draw block diagram of a model-reference adaptive control system and explain in detail, the working of each block. **7**

(b) Explain adaptive control of non-linear systems with the help of a suitable example. **8**

No. of Printed Pages : 05 **Roll No. .....**

BB-24

M. Tech. EXAMINATION, Dec. 2018

(Second Semester)

(B. Scheme) (Re-appear Only)

EE(I&C)

MIC508B

NONLINEAR AND ADAPTIVE CONTROL

Time : 3 *Hours*] [*Maximum Marks :* 75

Before answering the question-paper candidates should ensure that they have been supplied to correct and complete question-paper. No complaint, in this regard, will be entertained after the examination.

Note : Attempt *Five* questions in all, selecting at least *one* question from each Unit. All questions carry equal marks.

Unit I

1. (a) Explain the diffeculties in modelling and control of non-linear control system. **6**

(b) Find out the describing function for the dead-zone non-linearity shown in the fig. 1. : **9**

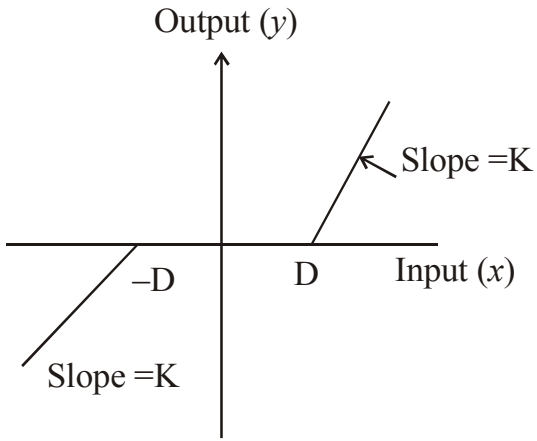

Fig. 1

2. (a) Discuss the phase plane analysis of second order non-linear control systems. **7**

(b) Using a linear second order servo system described by the equation :

$$\ddot{e} + 2\zeta\omega_n\dot{e} + \omega_n^2 e = 0$$

where $\zeta = 0.15,\ \omega_n = 1$

$$e(0) = 1.5,\ \dot{e}(0) = 0$$

Determine the singular points and construct the phase trajectory by using the method of isoclins. **8**

Unit II

3. (a) Consider a non-linear system described by the equation :

$$\dot{x}_1 = -3x_1 + x_2$$

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

Use Krasovskii method to construct the Liapunov function with P as identity matrix Investigate the stability of the equilibrium state. **8**

(b) Write short note on Lyapunov stability analysis for discrete time systems. **7**

6. Write short notes on the following : **8+7**

(a) Composite adaptive control

(b) Robustness of adaptive control systems.

Unit IV

7. (a) For the dynamical system model :

$$\dot{x} = \begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix} x + \begin{bmatrix} 1 \\ -1 \end{bmatrix} u$$

construct the switching surface

$$\sigma(x) = Sx = 0$$

Such that the system in sliding along the surface has its pole at –2. **7**

(b) Define 'sliding mode control'. What are its benefits ? Discuss the use of sliding modes in solving optimization problems. **8**

8. Briefly describe the following with the help of suitable examples : **8+7**

(a) Sliding in Multi-Input Systems

(b) Non-ideal Sliding Mode.

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