M.E. ELECTRICAL ENGINEERING 1st YEAR 2nd SEMESTER EXAMINATION- 2018

NON-LINEAR AND ADAPTIVE CONTROL (CS)

Time : 3 hours

Full Marks : 100

Answer any FIVE questions.

Answer all parts of a question in the sequential order.

1. a) Explain the typical behaviors manifested by nonlinear dynamic systems.

b) Explain the following with suitable example:

(i) Inherent nonlinearity, (ii) Intentional nonlinearity, (iii) Continuous nonlinearity, (iv) Hard nonlinearity.

c) Describe with suitable sketches, (i) various friction nonlinearities, (ii) Backlash nonlinearity and (iii) Dead-zone nonlinearity.

[5+4+11=20]

2. a) State the properties of the phase plane portraits.

b) Describe any one method of generating phase plane portraits.

c) A system is represented by the following differential equation:

$$\ddot{y} + ky = 0$$

Draw the phase trajectory of the system.

[4+7+ 9=20]

3. a) State and explain Lyapunov Theorem of Local Stability and Global Stability.

b) Explain any technique to find Lyapunov candidate function to assess the stability of the nonlinear systems.

[10+10=20]

4. a) Explain the basic concept of Describing Function method for analyzing nonlinear systems.

b) Derive the describing function for a nonlinear system containing an electromechanical relay.

[7+13=20]

5. a) Explain the basic concept of feedback linearization. Hence, explain its strengths and weaknesses.

b) Derive the feedback control law for the following system employing Integrator Backstepping:

$$\dot{\eta} = f(\eta) + g(\eta)\xi$$
$$\dot{\xi} = u$$

Where η and ξ are the system states and u is the control input.

[10+10=20]

6. a) Explain, with suitable schematic diagrams, the various adaptive control schemes.

b) Write a note on Linear Parametric Modelling.

[12+8=20]

7. a) State and explain the basic concept of Variable Structure Systems.

b) Explain the various steps to design a Sliding Mode Controller for a second order nonlinear system with model uncertainties.

[5+15=20]

8. Write short note on **any two** from the following:

      a) Frequency response of a typical nonlinear system.

      b) Stability analysis by phase plane portraits.

      c) Strict Feedback Form and Backstepping design.

[10x2=20]