

December 2023

**B.Tech. (EIC) - VII SEMESTER- Reappear**

Advanced Control System/Non Linear Control System (EIEL-709)

Time: 3 Hours

Max. Marks:75

- Instructions:**
1. It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.
  2. Answer any four questions from Part -B in detail.
  3. Different sub-parts of a question are to be attempted adjacent to each other.
  4. Assume relevant data, if not provided.

**PART -A**

- Q1 (a) What is the significance of describing function analysis? (1.5)  
 (b) Name common types of non linearity. (1.5)  
 (c) What do you mean by parameter estimation? (1.5)  
 (d) What is the principle of applying control mechanism in MRAC? (1.5)  
 (e) Draw the diagram of Jump response in Non-linear system exhibited by Hard Spring. (1.5)  
 (f) Define the term Asymptotically stable-in-the-large. (1.5)  
 (g) Why it is difficult to study non-linear system? (1.5)  
 (h) Why limit cycles exist? (1.5)  
 (i) Define singular points. (1.5)  
 (j) Draw a system response, which exhibits hysteresis. (1.5)

**PART -B**

- Q2 Consider a nonlinear system described by the equations:- (15)  

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

$$\dot{x}_2 = x_1 - x_2 - x_2^3$$
 Investigate the stability of equilibrium state.
- Q3 (a) Derive the describing function of Dead-zone and Saturation Non-Linearity (10)  
 (b) The response of a system is  $y = ax^2 + e^{bx}$ . Test whether the system is linear or non-linear. (05)
- Q4 What is phase plane, phase trajectory and phase portrait? Draw and explain how to determine the stable and unstable limit cycles using phase portrait. (15)
- Q5 Consider a non-linear system described by the equations (15)  

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

$$\dot{x}_2 = -(1 - |x_1|)x_2 - x_1$$
 Find the region in the state-plane for which the equilibrium state of the system is asymptotically stable. (Let Liapunov function as  $V = x_1^2 + x_2^2$ )
- Q6 Draw the isoclines with their direction markers and sketch several solution curves, including the curve satisfying the given initial condition  $y' = 2x^2 - y, y(0) = 0$  (15)
- Q7 Explain in detail the Self tuning control, emphasizing its two essential components with suitable example. (15)

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