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SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

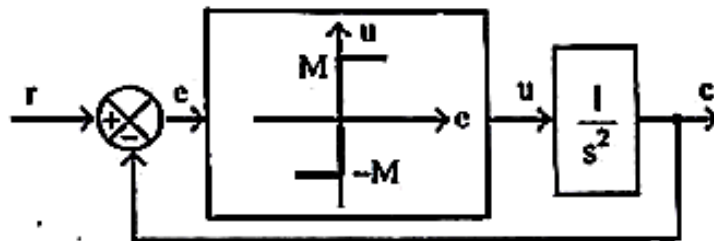
(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIRST SEMESTER M.TECH DEGREE EXAMINATION (Regular), DECEMBER 2022**ROBOTICS AND AUTOMATION****(2021 Scheme)****Course Code: 21RA105-C****Course Name: Non-linear Control Systems****Max. Marks: 60****Duration: 3 Hours****PART A****(Answer all questions. Each question carries 3 marks)**

1. State any 3 characteristics of a nonlinear system.
2. Derive describing function for an ideal relay.
3. Define an equilibrium point.
4. Identify the role of integral control in feedback linearization.
5. State circle criteria.
6. Brief the model reference adaptive control scheme.
7. State the conditions for choosing switching surface in Sliding Mode Control.
8. Explain the reaching time in SMC.

PART B**(Answer one full question from each module, each question carries 6 marks)****MODULE I**

9. a) Distinguish the importance of singular point in phase plane method of analysis of nonlinear control system? (2)
- b) Consider a system with an ideal relay shown below. Determine the singular point. (Take $r=2$ volts, $M=1.2$ volts). (4)

**OR**

10. Explain following nonlinearities with neat diagram (6)
- Saturation
 - Dead zone
 - Backlash.

MODULE II

11. Outline the nonlinearity associated with relay? Derive describing function of relay with dead zone. (6)

OR

12. Derive describing function of relay with hysteresis. (6)

MODULE III

13. Determine whether the following quadratic form is positive definite (6)
- $$Q(x_1, x_2, x_3) = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - x_2x_3 - 4x_1x_3.$$

OR

14. Explain the concept of Lyapunov first method of stability analysis. (6)

MODULE IV

15. Explain the input state linearization with neat diagrams. (6)

OR

16. Demonstrate the feedback linearization with an example. (6)

MODULE V

17. With a neat block diagram, explain the concept of gain scheduling in adaptive control system. (6)

OR

18. Explain the concept of absolute stability in nonlinear system. Also, state and explain the Popov's criterion of stability. (6)

MODULE VI

19. Illustrate chattering in sliding mode control with neat diagrams. Show, how it can be reduced? (6)

OR

20. Explain about continuous approximation of switching control law. (6)
