B

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER M. TECH DEGREE EXAMINATION

Electrical and Electronics Engineering

(POWER SYSTEMS)

04EE7111—Nonlinear Control Systems

Max. Marks : 60 Duration: 3 Hours

PARTA

Answer AllQuestions

Each question carries 3marks

1. What do you mean by singular point? How are they classified?
2. Explain direct method of Lyapunov for stability analysis.
3. State reasons why describing function method is only used for stability analysis and not used for nonlinear system design
4. Explain Feedback Linearization. Discuss advantage and disadvantage of feedback linearization approach to nonlinear system design.
5. Explain Stabilization via linearization.
6. Explain about normal form in feedback linearization.
7. Write a note on gain scheduling.
8. Briefly explain about advantage and disadvantage of sliding mode control.

PARTB

Each question carries 6marks

9. Draw the Phase Trajectory for $\ddot{y} + 0.6\dot{y} + y = 0$ from the initial point $y(0) = 1$ *and* $\dot{y}(0) = 0$

OR

10. Inspect the stability using perturbation technique, for a second order system given by:

$$\dot{x} = x - x^3 + z$$
$$\epsilon\dot{z} = -x - z$$

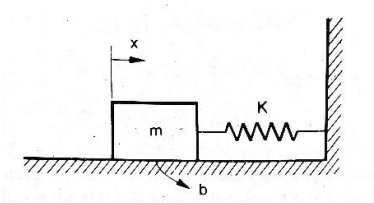
11. For a nonlinear system represented by

$$\dot{x_1} = x_2$$
$$\dot{x_2} = -x_1^2 - x_2$$

Construct the Lyapunov function and derive the stability of the system.

OR

12. A simple mass, spring, and viscous friction system is given in figure. Show that the system is stable.



13. A basic nonlinear system has $G(s) = \frac{10\sqrt{2}}{s(1+0.5s)}$ and the describing function for the nonlinear element to be $K_N(x) = \frac{1}{X} < 45^o$. Find the amplitude and frequency of periodic oscillation if it exists. Is the oscillation sustained?

OR

14. Derive the describing function of the non-linearity relay with hysteresis and dead zone.

15. Write a short note on: Input – output linearization.

OR

16. Discuss about input state linearization of SISO Systems. State different condition for input state linearization. How to perform input state linearization.

17. For a pendulum equation

$$\ddot{\theta} = -asin\theta - b\dot{\theta} + cT$$

Where $a = \frac{g}{l} > 0, b = \frac{k}{m} \geq 0, where\ \theta\ is\ the\ angle\ suptended\ by\ the\ rod\ and\ vertical\ axis$ and T is the torque applied to the pendulum. Design the state feedback to stabilize the output.

OR

18. Consider a first order plus time delay model

$$\frac{Y(s)}{U(s)} = \frac{Ke^{-\theta s}}{\tau s + 1}$$

Derive the equivalent step response model by considering the analytical solution to a unit step change in the input. Calculate the step-response coefficients, {Si}, for the followingparameter values:K = 5, τ=15 min, θ=3 min,and a sampling period of Δt =1 min.

19. Consider a second order system

$$\ddot{x} = f(\dot{x}, x) + u$$

Define a sliding mode and control. Also prove the convergence to the sliding mode

OR

20. What do you mean by chattering in sliding mode control? Explain different method to suppress it.