Sem-VII / INST / CBGS / ACS / 25-05-16

Advanced Control Systems

QP Code : 31337

(3 Hours) **[Total Marks: 80]**

NB:

1. Q.1 is ***compulsory***. Attempt ***any three*** from Q.2 to Q.6
2. Figures in ***right*** indicate ***full marks***.
3. Assume ***suitable data*** if necessary.

Q.1 Attempt ***any four*** **20**

(a) What is the relative degree for the nonlinear system with respect to output?

(b) Differentiate Linear and Nonlinear systems.

(c) Draw block diagram for internal model control system and write the output equation for reference and disturbance inputs.

(d) Explain Harmonic Linearization.

(e) Explain Lyapunov stability analysis with neat sketches.

(f) Explain jump resonance for a spring.

Q.2 (A) Draw the phase trajectory for the following system using delta method. Assume initial condition $x = 1, \dot{x} = 0$. **10**

$$\ddot{x} + 2\dot{x} + 4x = 0$$

(B) Consider the system given by **10**

$$\dot{x_1} = x_2$$

$$\dot{x_2} = -x_1 + x_1(1 - x_2^2 - x_1^2)x_2$$

Find the equilibrium point and show that the unit circle is a limit cycle for the system.

Q.3 (A) Investigate stability of the system using Variable Gradient Method given by **10**

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

$$\dot{x_2} = -x_2$$

(B) Derive the describing function for relay with hysteresis nonlinearity. **10**

Q.4 (A) Design the optimal controller via Riccati equation for the system **10**

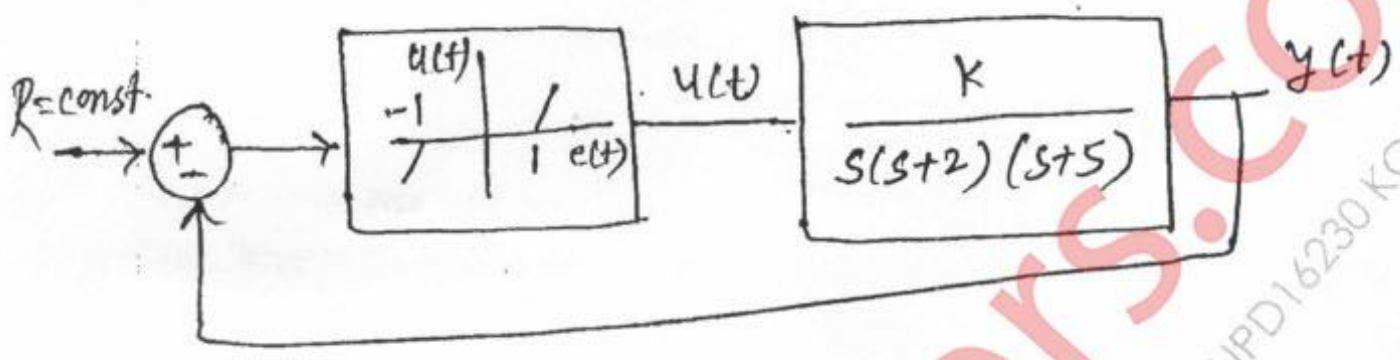
$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

to minimize the performance index $J = \int_0^\infty (x_1^2 + x_2^2 + u^2)\, dt$.

(B) Explain feedback linearization for simple pendulum. **10**

5 (A) Design IMC controller for plant model $\bar{G}(s) = \frac{(-s+1)}{2s+1}$ in order to achieve the response with time constant of 1.2 sec. 10

(B) Investigate stability of the given system using describing function analysis. 10



Q.6 Write short note on 20

(i) Singular Points

(ii) Perfect Control

(iii) Krasovskii Method