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Question Paper Code: 31563

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2016

Fifth Semester

Instrumentation and Control Engineering

01UIC503 - ADVANCED CONTROL SYSTEM

(Regulation 2013)

Duration: Three hours Maximum: 100 Marks

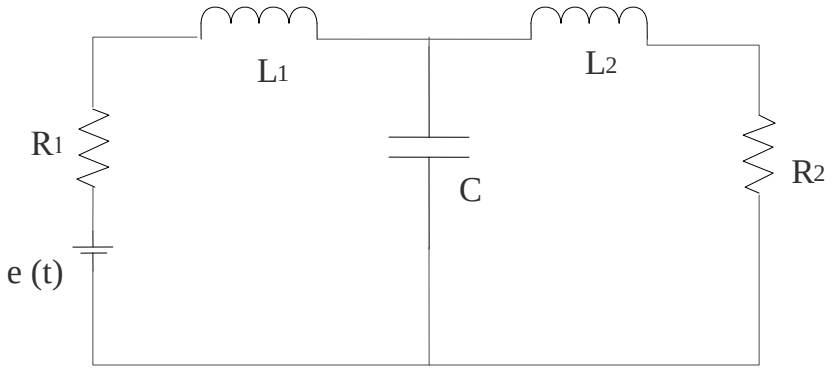
Answer ALL Questions

PART A - (10 x 2 = 20 Marks)

1. What is meant by state space and state trajectory?
2. Write the diagonal canonical state model of a system.
3. Write the diagonal canonical state model of a system.
4. What is phase plane and phase trajectory?
5. Define memory type and memory less nonlinearity.
6. Write the describing function of relay with hysteresis.
7. Give the Sylvester's criteria for negative definiteness.
8. State Stability theorem of Liapunov's direct method.
9. Give the performance index of output regulator problem.
10. What are the main theoretical approaches for optimal control?

PART - B (5 x 16 = 80 Marks)

11. (a) Obtain the state model of the electrical network by choosing minimal number of state variables. (16)



Or

(b) Check the controllability and observability of the following system

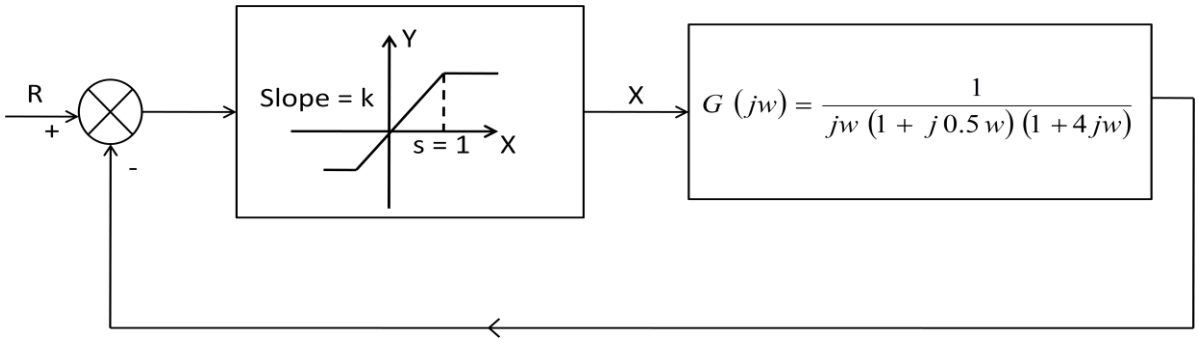
$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix} u$$

$$y = \begin{bmatrix}4 & 5 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}. \quad (16)$$

12. (a) Construct a phase trajectory by delta method for a nonlinear system given by the differential equation, $\ddot{x} + 4|\dot{x}|\dot{x} + 4x = 0$. Choose the initial conditions as $x(0) = 1.0, \quad \dot{x}(0) = 0.$ (16)

Or

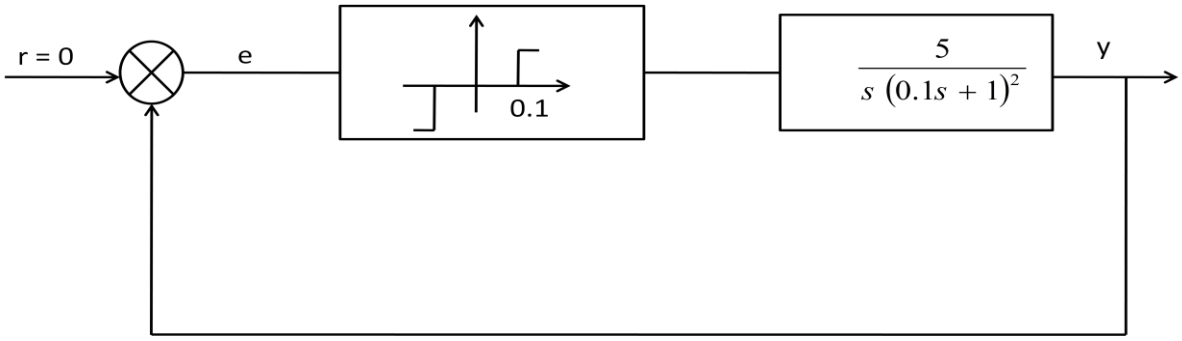
(b) Consider a unity feedback system shown in figure, having a saturating amplifier with gain *K*. Determine the maximum value of *K* for the system to stay stable. What would be the frequency and nature of limit cycle for a gain of *K*=2.5? (16)



13. (a) Derive the describing function for saturation non-linearity with neat sketch. (16)

Or

(b) Consider the following system, use the describing function technique to investigate the possibility of limit cycle in the system. (16)



14. (a) State and prove any four theorems of Liapunov's method. (16)

Or

(b) (i) State and prove the direct method of Liapunov. (10)

(ii) Determine whether the following quadratic form is positive definite $V(x) = 10\,x_1^{\,2} + 4\,x_2^{\,2} + x_3^{\,2} + 2\,x_1\,x_2 - 2\,x_2\,x_3 - 4\,x_1\,x_3$. (6)

15. (a) (i) Derive the control law which minimizes the performance index $J = \int_0^\infty \left(x_1^{\,2} + u^2\right) dt$ for the system as follows

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u. \quad (8)$$

(ii) Find the set of necessary conditions for optimal control for the given specifications is to be controlled to minimize the performance measure

$$\dot{x}_1(t) = x_2(t), \quad \dot{x}_2(t) = u(t) \quad J(x, u) = \frac{1}{2} \int_0^2 u^2\, dt. \quad (8)$$

Or

(b) With necessary diagram explain in detail about optimal estimation for linear continuous time system. Also derive the expression for estimation error. (16)

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