Sixth Semester B.Tech. Degree Examination, May 2016
(2013 Scheme)
13.601 : ADVANCED CONTROL THEORY (E)

Time : 3 Hours

Max. Marks : 100

PART – A

1. Define state, state apace and state trajectory.

2. State and prove the properties of state transition matrix.

3. Explain Shannon's sampling theorem.

4. Explain multi valued responses shown by nonlinear elements.

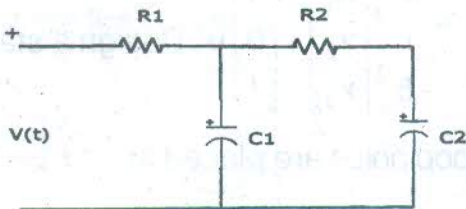5. What are singular points ? How they are classified ?   (5×4=20 Marks)

PART – B

Answer **any full** question from **each** Module.

Module – I

6. a) Obtain the state model of the system shown below. Take voltage across capacitor C_2 as output.

5

b) A system is described by, $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 4 \\ -2 & -5 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u;\ y = \begin{bmatrix} 1 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix};$

$x_1(0) = 1,\ x_2(0) = 0$

$u(t) = 1$, for $t \geq 0$

$= 0$, for $t < 0$

Find :

a) Zero input response

b) Zero state response and

c) Total response.   15

OR

7. a) Check the controllability of the system given below

$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix}u$.   5

b) i) Explain the effect of pole-zero cancellation on the controllability and
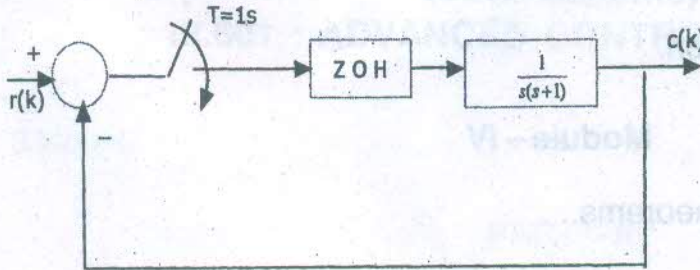observability of systems.   5

ii) A system is described by, $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -6 & -5 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}u$. Design a state

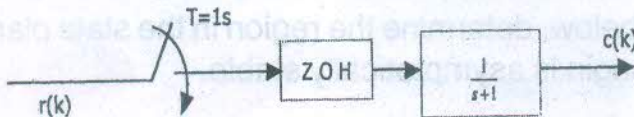feedback controller such that the closed loop poles are placed at $-1 \pm j, -5$.   10

Module – II

8. a) Find the Z transform of $f(t) = t^2$. **5**

   b) Find the impulse response of the system shown below.


15

OR

9. a) Solve the difference equation given below.

   $$x(k + 2) - 3x(k + 1) + 2x(k) = 4^k.$$ **10**

   b) Obtain the pulse transfer function of the system given below. Also determine c(0) and c(1) for a unit step input r(k).

10

Module – III

10. a) What is meant by limit cycles ? How the stability of a nonlinear system is related to limit cycles ? **5**

    b) A unity feedback system having a saturating amplifier of gain 'k' is connected in series with the plant as shown below. Determine the amplitude and frequency of the limit cycle for a gain of k = 2.5.

15
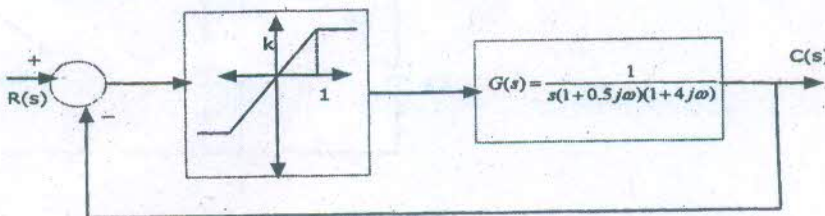
OR

11. a) Define describing function. What are the limitations of describing function analysis ? **5**

b) Derive the describing function of

    i) ON-OFF nonlinearity

    ii) Dead zone with saturation. **15**

Module – IV

12. a) State Liapunov's stability theorems. **5**

b) A linear autonomous system is described by $\dot{x} = Ax$, where $A = \begin{bmatrix} -4k & 4k \\ 2k & -6k \end{bmatrix}$.

    Find restrictions on the parameter 'k' to guarantee stability of the system. **15**

            OR

13. a) Identify the singularities and sketch the phase trajectories near these singularities. $\ddot{x} - \left[0.1 - (\dot{x})^2\right]\dot{x} + x + x^2 = 0$. **10**

b) For the nonlinear system given below, determine the region in the state plane where the equilibrium state at origin is asymptotically stable.

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

$$\dot{x}_2 = -\left(1 - |x_1|\right)x_2 - x_1.$$ **10**

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