(Pages : 3) **C – 2757**

Reg. No. : .....

Name : .....

Sixth Semester B.Tech. Degree Examination, June 2017
(2013 Scheme)
13.601 : ADVANCED CONTROL THEORY (E)

Time : 3 Hours Max. Marks : 100

PART – A

Answer **all** questions :

1. What are the advantages of state space analysis ?
2. Define controllability and observability.
3. What is the purpose of holding circuits in a sampled data control system ? Derive the transfer function of a zero order holding circuit.
4. Explain any four types of nonlinearities.
5. Explain the concept of stability and asymptotic stability in the sense of Liapunov.

(5×4=20 Marks)

PART – B

(Answer **any full** question from **each** Module)

Module – I

6. a) Obtain the state model in phase variable form and diagonal canonical form for the system described by the differential equation

$\dddot{y} + 9\ddot{y} + 23\dot{y} + 15y = 15\ddot{u} + 25\dot{u} + 20u$. **10**

b) Obtain the state transition matrix and transfer function of the system defined by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 4\\ -2 & -5\end{bmatrix}\begin{bmatrix}x1\\ x2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u;\ y = \begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x1\\ x2\end{bmatrix}.$$ **10**

OR

7. a) Obtain the unit step response of the system defined by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x1\\ x2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u;\ y=\begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x1\\ x2\end{bmatrix};\ x_1(0)=1,\ x_2(0)=0.$$ **10**

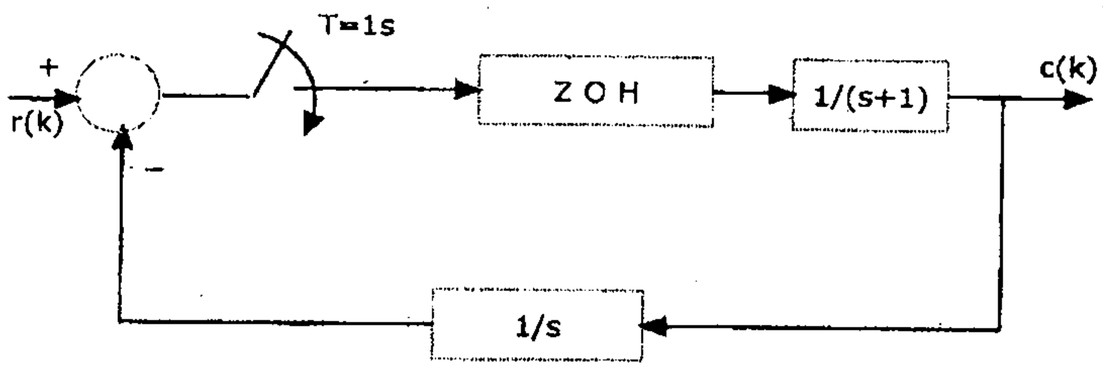
b) Design a feedback controller with state feedback so that the closed loop poles are at $-2, -1 \pm j1$, for the system defined by the transfer function,

$$\frac{Y(s)}{U(s)}=\frac{10}{s^3+3s^2+2s}.$$ **10**

Module – II

8. a) Find the Z transform of $f(k) = ka^{k-3}$. **5**

b) Find unit step response of the system shown below. **15**



OR

9. a) i) Explain the mapping between s-plane and z-plane. **5**

ii) Check the stability of the system with characteristic equation $F(z)= 2z^4 + 7z^3 + 10z^2 + 4z+1$. **5**

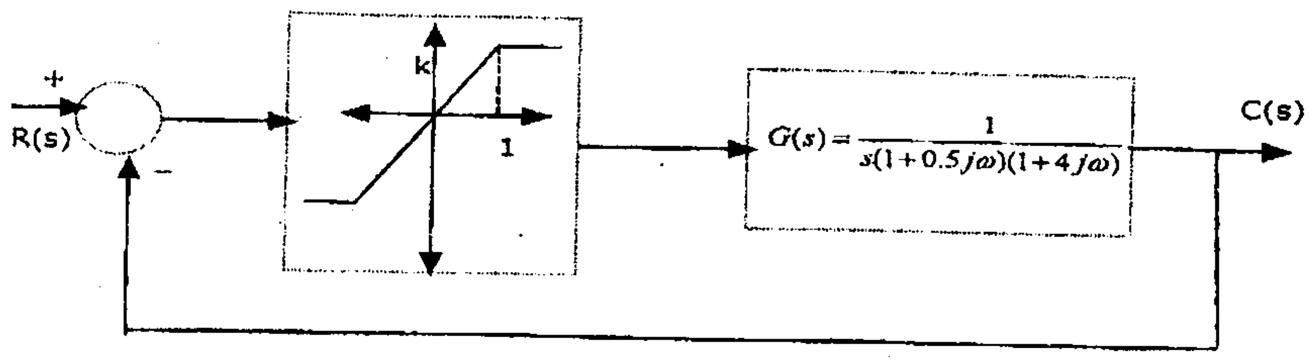
b) The input-output relation of a discrete data system is

$c(k+2)+3c(k+1)+4c(k) = r(k+1) – r(k)$. Find the z-transfer function of the system. Also obtain the discrete impulse response. **10**

Module – III

10. a) Derive the describing function of a saturation nonlinearity. **10**

b) A unity feedback system having a saturating amplifier of gain 'k' is connected in series with the plant as shown below. Determine the maximum value of 'k' for the system to be stable.

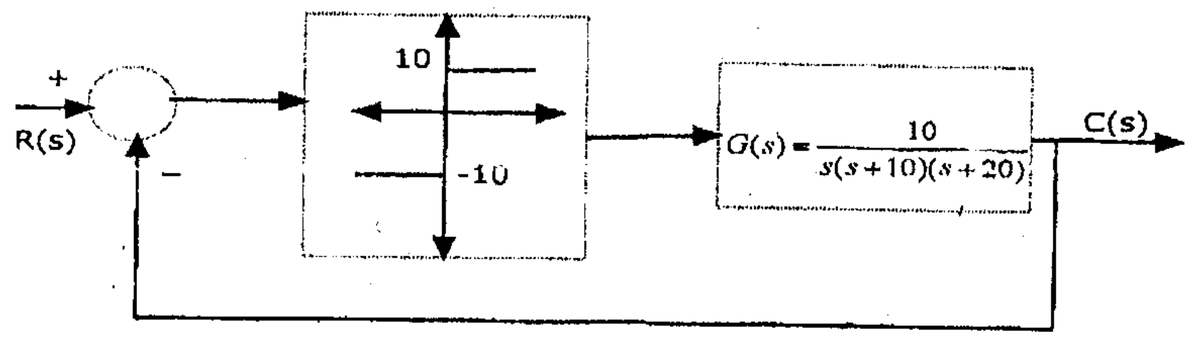


10

OR

11. a) Explain in detail the special characteristics exhibited by non-linear systems. **10**

b) For the system shown below, comment on the stability using describing function method. **10**



Module – IV

12. a) What are singular points? How they are classified? Also sketch the phase portraits in each case. **10**

b) Investigate the stability of the system described by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -2 & 1 \\ -5 & 0 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \end{bmatrix}$$ using direct method of Liapunov. **10**

OR

13. a) Explain phase plane analysis of nonlinear systems. **5**

b) i) Check the sign definiteness of the scalar function, $Q(x) = -2x_1^2$. **5**

ii) For the system given below, find the region in the state plane for which the system is asymptotically stable. **10**

$$\dot{x}_1 = -x_1 + 2x_1^2 x_2$$

$$\dot{x}_2 = -x_2$$