(Pages : 4) **F – 3154**

Reg. No. : ....

Name : ....

Sixth Semester B.Tech. Degree Examination, December 2018
(2013 Scheme)
13.601 : ADVANCED CONTROL THEORY (E)

Time : 3 Hours Max. Marks : 100

PART – A

Answer **all** questions : **(5×4=20 Marks)**

1. Prove that State model of a system is not unique taking an example as RLC series network.

2. Explain the concept of controllability and observability. Give the Kalman's test to check both the properties.

3. Derive transfer function of ZOH.

4. Explain the concept of enclosure as referred to describing function method of nonlinear system analysis.

5. With the help of diagrams distinguish between local stability and asymptotic stability as applied to nonlinear systems.

PART – B

Answer **any one full** question from **each** Module : **(20×4=80 Marks)**

Module – I

6. a) Obtain the state space representation of the given system using Jordan canonical representation and draw a state diagram. **8**

$$G(s) = \frac{s^3 + 3s^2 + 6s}{s^3 + 6s^2 + 9s + 4}.$$

P.T.O.

b) A linear time invariant system is described by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \; [y] = [1 \;\; 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Obtain the complete response for a unit step input. Given $\begin{bmatrix} x_1 & (0) \\ x_2 & (0) \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$. **12**

OR

7. a) The transfer function of a LTI system is given by $G(s) = \frac{(s+3)(s+1)}{s(s+2)(s+5)}$

Obtain state models in :

i) Observable canonic form and

ii) Controllable canonic form. **10**

b) Consider the LTI system described by the state equation. Design a state feedback controller such that closed loop poles are to be placed at

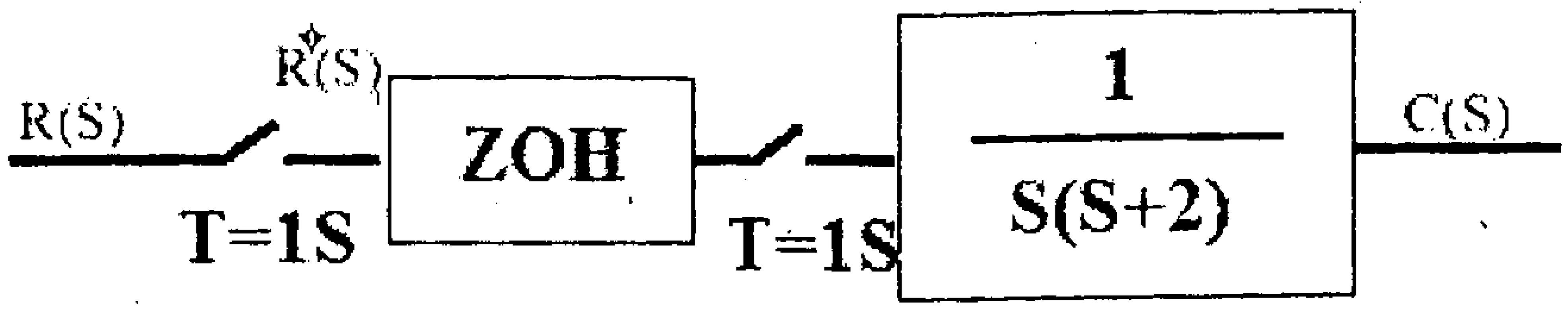
$s = -2 \pm 4j,\ s = -10 \quad A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} \; B = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$. **10**

Module – II

8. a) Find the time response of the system described by the difference equation, where u(K) is the input and y(K) is the output.

$y(K) + y(K-1) - 2y(K-2) = u(K-1) + 2u(K-2)$, with initial conditions $y(-1) = -0.5$, $y(-2) = 0.25$, $u(K) = 1$ for $K \geq 0$. **10**

b) Find the pulse transfer function of the overall system shown in figure. Also obtain the unit step response. **10**

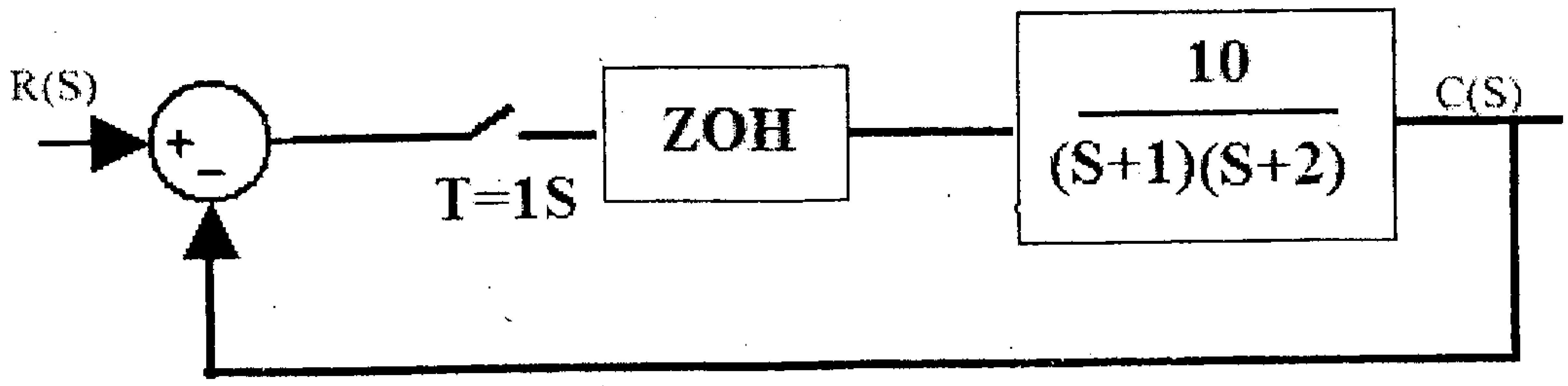


OR

9. a) Consider a closed loop sampled data system with characteristic equation,

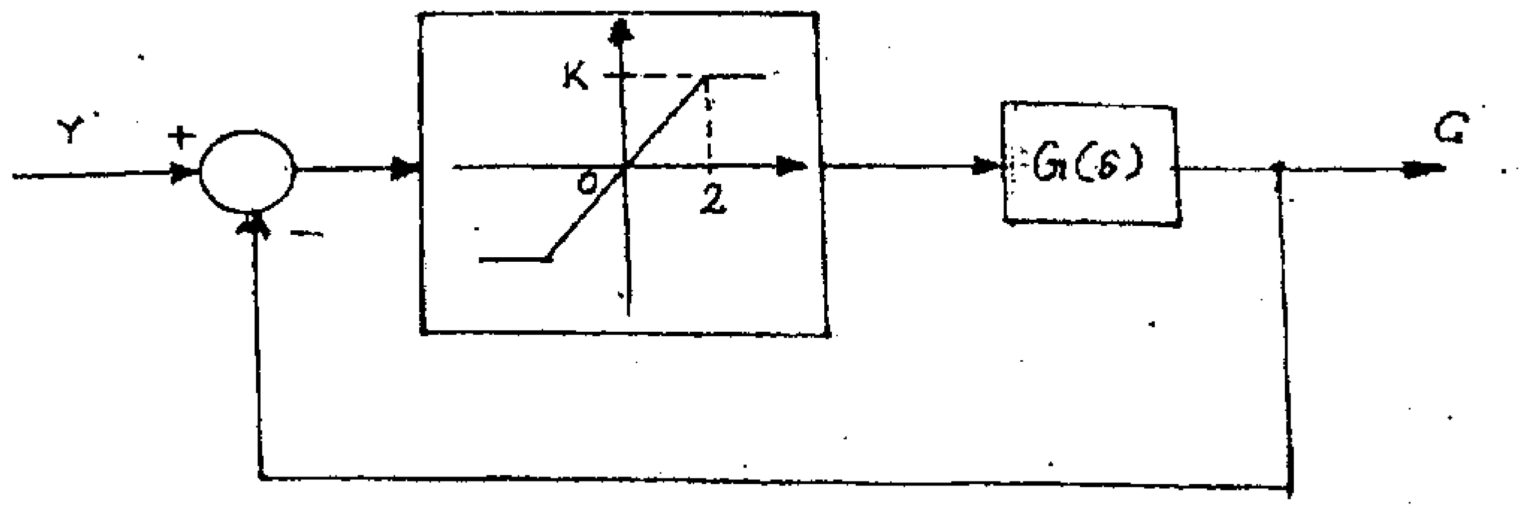
$45Z^3 - 117Z^2 + 119Z - 39 = 0$. Apply modified Routh criterion to determine the number of roots outside the unit circle and hence comment on the stability of the system. **8**

b) Obtain the unit step response of the discrete time system shown. **12**



Module – III

10. A system is represented as shown in the diagram. The input to the non-linear element is m(t) = M sin ωt and $G(s) = \frac{12}{s(s+1)(s+3)}$



a) Obtain the describing function for the non linear element.

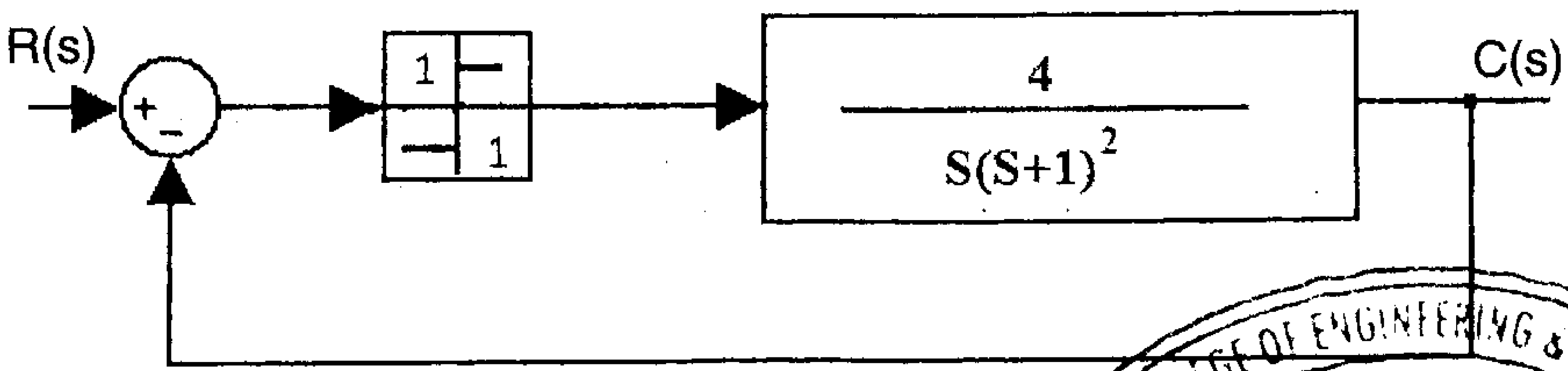
b) Analyse the system to investigate for what range of values of K, there is a possibility of a limit cycle.

c) If a limit cycle exists, comment on its stability and determine the amplitude and frequency of oscillations, when K = 3. **20**

OR

11. a) Derive the describing function of an ideal relay nonlinearity. **10**

b) For the nonlinear system shown in Figure below, predict the possibility of a limit cycle. If exists investigate the stability and determine the amplitude and frequency. **10**



Module – IV

12. a) State and explain Lyapunov's stability theorems. **10**

b) A system is described by the following equations

$x_1^{\bullet} = -x_1 + x_2 + x_1\left(x_1^2 + x_2^2\right),\ x_2^{\bullet} = -x_1 - x_2 + x_2\left(x_1^2 + x_2^2\right).$

Determine asymptotic stability using Lyapunov's method. **10**

OR

13. Determine the type and locations of singular points and construct a phase trajectory for the linear second order system described by

$e^{\bullet\bullet} + 2\delta\omega_n e^{\bullet} + \omega_n^2\, e = 0,\ \delta = 0.15,\ \omega_n = 1\, e^{\bullet}(0) = 0$ and $e(0) = 1.5.$ **20**