(3 hours) [Total Marks: 80]

Note:

1. Question-1 is compulsory.
2. Answer any three questions from remaining five.
3. Assume suitable data if necessary.
4. Numbers in the right indicate marks.

1. Answer the following questions. (Each question carry 5 marks) 20

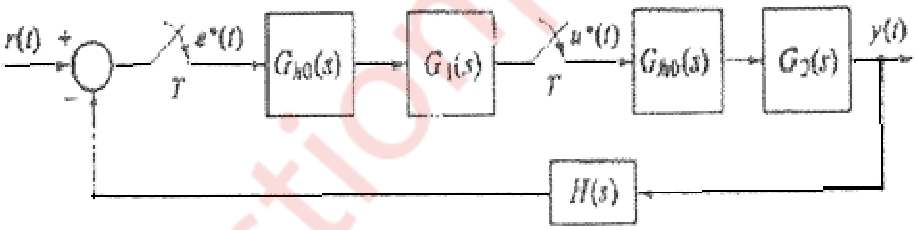
(a) Obtain mathematical model of ideal sample and hold circuit.

(b) Explain the sampling and reconstruction process, state the sampling theorem and discuss Nyquist criteria.

(c) State advantages of state variable approach as compared to classical control design methods.

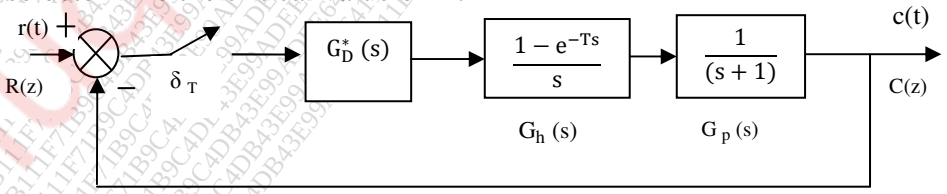
(d) Explain the concept of observability. What is dead beat observer?

2. (a) Find the closed loop transfer function Y(z)/R(z) for the sampled data system shown in the following figure. 10



(b) Determine the stability of the system whose characteristic equation is given by 10
$P(z) = z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$

3. (a) Draw the root locus diagram for the following system for sampling period T=1 sec. 10
Also determine the critical value of K.



Where $G_D(z) = \frac{K}{1-z^{-1}} = K\frac{z}{z-1}$

10

(b) For a given system obtain state transition matrix using Caley-Hamilton theorem.

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

$$y(k)=\begin{bmatrix}1 & 0\end{bmatrix}x(k) \qquad x(0)=[1 \quad 1]$$

4. (a) For a system given by transfer function 10

$$G(z)=\frac{z+1}{z^2+z+0.16}$$

Obtain state space model in controllable canonical form, Observable canonical form and Jordan canonical form.

(b) Consider the system 10

$$x(k+1)=\begin{bmatrix}0 & 1\\ -0.16 & -1\end{bmatrix}x(k)+\begin{bmatrix}0\\ 1\end{bmatrix}u(k)$$
$$y(k)=\begin{bmatrix}1 & 0\end{bmatrix}x(k)$$

Determine the suitable state feedback gain matrix K such that the system has the closed loop poles at z= 0.5± j0.5.

5. (a) Design a dead beat state feedback controller for the system in Q-4 (b). 10

(b) Investigate controllability and observability of the following system. 10

$$x(k+1)=\begin{bmatrix}0 & 1\\ -0.4 & -1.3\end{bmatrix}x(k)+\begin{bmatrix}0\\ 1\end{bmatrix}u(k)$$
$$y(k)=\begin{bmatrix}0.8 & 1\end{bmatrix}x(k)$$

6. Answer any two of the following questions. 20

(a) Obtain the relationship between s-plane and z-plane when bilinear transformation is used for discretization.

(b) Draw and Explain digital PID controller.

(c) Explain with neat diagram, a full order observer having dead beat response.