(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 any four of the following questions. (Each question carry 5 marks) 20

(a) Derive the relationship between discrete state space model and pulse transfer function.

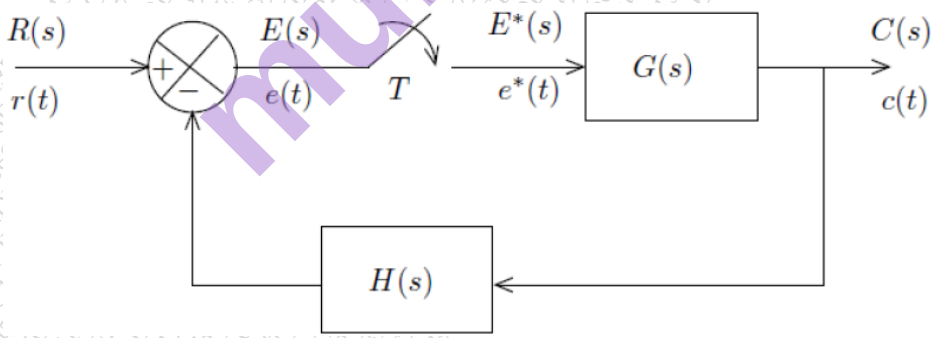
(b) What is an observer? Why is it required?

(c) What are the advantages of state variable method for analysis of digital control system?

(d) State and explain Jury's stability criterion.

(e) Is it possible for an unobservable system to be detectable? Justify your answer.

2. (a) Obtain the closed loop transfer function for the following system 10
G(s) = 1/s(s+1), H(s) = 1



(b) Derive the relation between s plane and z plane using Bilinear Transformation technique. 10

3. (a) For the given system obtain the state transmission matrix using Cayley-Hamilton method 10

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

$$y[k] = [1 \quad 0]x[k], \qquad x[0] = [1 \quad 1]^T$$

(b) Consider the following system 10

$$\frac{Y(z)}{U(z)} = \frac{z+1}{z^2+1.3z+0.4}$$

Represent the system in controllable canonical form, observable canonical form and diagonal canonical form.

4. (a) Investigate the controllability and observability for the following system 10

$$x[k+1] = \begin{bmatrix} 0 & 1 \\ -0.4 & -1.3 \end{bmatrix} x[k] + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u[k]$$

$$y[k] = [0.8 \quad 10]x[k]$$

(b) State and prove the Nyquist sampling theorem. 10

5. (a) Show that the following system is not completely observable 10

$$x[k+1] = Gx[k] + Hu[k]$$
$$y[k] = Cx[k]$$

where, $G = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$, $H = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$, $C = [4 \quad 5 \quad 1]$

(b) Obtain the block diagram for the following pulse transfer function by 1) direct programming 2) standard programming 3) ladder programming 10

$$\frac{Y(z)}{U(z)} = \frac{2-0.6z^{-1}}{1+0.5z^{-1}}$$

6. Answer any two of the following questions. 20

(a) Distinguish between reachability and controllability in discrete time systems.

(b) Explain dead beat control using state feedback.

(c) Write short note on state observer based controller design.

(d) Digital PID controller.