M.E. ELECTRICAL ENGINEERING - FIRST YEAR - FIRST SEMESTER - 2018

DIGITAL CONTROL THEORY (CS)

Time : 3 hours | Full Marks : 100

Answer any FIVE questions.

Answer all parts of a question in the sequential order.

1. a) Explain the advantages and disadvantages of digital control systems.

b) Explain the sampling process and its significance for the discretization of a continuous-time analog signal. Hence, define the following:

(i) Acquisition time, (ii) Aperture time, (iii) Settling time, (iv) Sampling duration.

c) Explain the effect of conversion time of an A/D converter while discretization of an analog signal. Hence explain how this bottleneck can be overcome.

[4+6+10=20]

2.a) Explain how the absolute stability of a discrete-time closed-loop system can be tested.

b) Consider the discrete-time system described by the following model:

$$y(k) - 0.6y(k-1) - 0.81y(k-2) + 0.67y(k-3) - 0.12y(k-4) = x(k)$$

Where x(k) is the input and y(k) is the output of the system. Determine the stability of the system and comment on the result.

[10+10=20]

3. a) The block diagram of a closed-loop sampled data control system is shown in Figure P3. Derive an expression for the transfer function of the system. State your assumptions clearly..

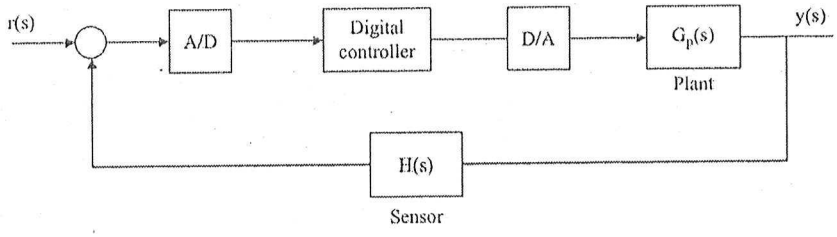

Fig. P3

b) Now, a unit step signal is applied to the sampled data digital system shown in Figure P3. Calculate and plot the output response of the system. Assume that T = 1 s.

[10+10=20]

4.a) Derive the steady-state errors of Type-0, Type-1 and Type-2 LTI discrete-time control systems in response to standard test signals.

b) Explain the significance of bilinear transform in the digital control theory.

[15+5=20]

5. A closed-loop system has the characteristic equation:

$$1 + GH(z) = 1 + K\frac{0.368(z + 0.717)}{(z - 1)(z - 0.368)} = 0.$$

Where K is the variable gain of the controller. Draw the root locus and hence determine the stability of the system. [20]

6.a) Explain the principle of mapping of the points between s-plane and z-plane. How the imaginary axis of the s-plane will be transformed in the z-plane? Hence comment on its significance in discrete-time system analysis.

b) Derive the closed-loop Pulse Transfer Function for deployment of the samplers at different locations of the system.

[10+10=20]

7.a) Show the non-uniqueness of the discrete-time state-space representation.

b) Solve the LTI discrete-time state equation and hence derive the state-transition matrix.

c) State and explain the Controllability and Observability conditions of LTI discrete-time systems.

[6+6+8=20]