

Paper Code: IC-701

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B. Tech.
SEVENTH SEMESTER EXAMINATION, 2016-17
CONTROL SYSTEM-II

[Time: 3 hrs.]

[Max. Marks: 100]

Note- Attempt All questions. Assume suitable data, if required. All questions carry equal marks.

1. Attempt any *four* parts of the following: -

(5x4=20)

- (a) How D/A converter is used in the sampled data control system? Explain with suitable neat diagram.
- (b) Explain the fundamental parameters of an S/H element during the working of sample and hold operation.
- (c) Explain the concept of constant damping loci.
- (d) Find the Z- transform of the ramp function $f(t) = t u_s(t)$.
- (e) Explain the relationship between the s-plane and the z-plane.
- (f) Consider the characteristic polynomial $\Delta(Z) = 2Z^4 + 7Z^3 + 10Z^2 + 4Z + 1$. Test the stability using Jury's criteria.

2. Attempt any *four* parts of the following: -

(5x4=20)

- (a) Derive the expression for transfer function of a given state space model in general sense.
- (b) Obtain the transfer function of the systems represented by $F = [1 \ 2; -3 \ -4]$, $G = [1; 2]$, $C = [1 \ 1]$.
- (c) Explain the pulse transfer function of the zero order hold and the relation between $G(s)$ and $G(z)$.
- (d) What do you understand by digital PID controller?
- (e) Draw the block diagram of Multirate Discrete Data System and explain in brief.
- (f) Obtain the three different canonical forms of state variable models corresponding to the given transfer function $G(z) = (4Z^3 - 12Z^2 + 13Z - 7) / (Z-1)^2 (Z-2)$.

3. Attempt any *two* parts of the following: -

(10x2=20)

- (a) Define controllability and observability. Give its necessary and sufficient conditions for a system to be controllable. Also determine the controllability and observability properties of the given system

$$F = [-1 \ 0 \ 0; 0 \ -2 \ 0; 0 \ 0 \ -3], G = [1 \ 0; 1 \ 2; 2 \ 1], C = [1 \ 1 \ 2; 3 \ 1 \ 5].$$

- (b) State the Cayley-Hamilton theorem. Find e^{At} where $A = [0 \ 0 \ -2; 0 \ 1 \ 0; 1 \ 0 \ 3]$.

- (c) State and prove the Lyapunov's stability theorem for the digital system. Consider the system given by the equations:

$$x_1(k+1) = -1.5x_1(k) \text{ and}$$

$$x_2(k+1) = -0.5x_2(k)$$

Analyse the system stability.

4. Attempt any *two* parts of the following: -

(10x2=20)

- (a) State the theorem of Lyapunov stability function for linear autonomous system. Also investigate the stability of the given system coefficient is given by $A = [-0.5 \ 0; \ 0 \ -0.5]$.
- (b) Find the optimal value of K so that $J = [e^2(k) + 0.75u^2(k)]$ is minimized. Given that $F = 1$, $G = 1$, $R = 1.5$, $Q = 2$.
- (c) For the given system described by state equation

$$\mathbf{x}(k+1) = [2 \ -1; \ -1 \ 1]\mathbf{x}(k) + [4; \ 3]\mathbf{u}(k)$$

$$\mathbf{y}(k) = [1 \ 1]\mathbf{x}(k) + 7\mathbf{u}(k)$$

Design a controller such that the desired close loop poles are located at $\pm (0.5)j$.

5. Attempt any *two* parts of the following: -

(10x2=20)

- (a) What is digital quantization explain in brief with proper neat diagrams.
- (b) Draw the general block diagram of a microcontroller used in a digital control system. Explain taking any industrial application using a microcontroller.
- (c) Draw the block diagram of a position control system based upon microprocessor and explain.