

Printed Pages—4

EIC701

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2750

Roll No.

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B.Tech.

(SEM. VII) ODD SEMESTER THEORY EXAMINATION 2012-13

CONTROL SYSTEM—II

Time : 3 Hours

Total Marks : 100

Note : Attempt all questions.

1. Attempt any **four** parts : **(5×4=20)**
 - (a) What is the significance of sampling and holding operations ? With the help of a simple R-C circuit, explain the principle of sample and hold.
 - (b) Explain the acquisition time, aperture time and settling time with respect to a Sample and Hold circuit.
 - (c) Explain the relationship between the Laplace and Z transforms. Does the two transforms become same when the sampling period approaches zero ? Explain.
 - (d) Find the z-transform of the following function. Also indicate its ROC :
$$x[n] = -a^n u[-n - 1].$$
 - (e) Find the z-transform of $x[n] = \sin n\theta$.
 - (f) Explain the conditions of stability in the z-transform analysis.

2. Attempt any **four** parts : **(5×4=20)**
 - (a) Explain the pulse transfer function and the z-transfer function. Use the impulse response method to derive the expression for the latter.

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- (b) What is zero order hold ? Derive the transfer function of a ZOH in z-domain.
- (c) Find the characteristic equation in z-domain of a system having forward path transfer function $G(s) = \frac{10}{s(s+5)}$, $H(s) = 1$ and sampling period $T = 0.1$ second.
- (d) The transfer function of a discrete data system is given by $G(s) = \frac{1}{s+a}$ where 'a' is a constant. The input to the system is a unit step function $e(t) = u_s(t)$. Evaluate the output of the system using the modified z-transform method.
- (e) What is W-plane analysis ? A digital control loop transfer function is given by $GH(z) = \frac{0.0952 kz}{(z-1)(z-0.905)}$. Find the $GH(w)$ using w-transformation.
- (f) Write a brief essay on digital PID controllers.

3. Attempt any two parts : (10×2=20)

- (a) Define controllability and observability. What are complete state controllability and complete output controllability ?

Check the controllability and observability of the coefficient matrices of the following digital control system :

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, D = [1 \ 2].$$

- (b) What is Caley-Hamilton theorem ? How can the state transition matrix be calculated using the Caley-Hamilton theorem ?

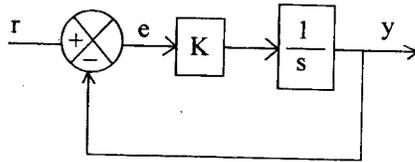
Find the state transition matrix using the theorem for the

$$\text{matrix } A = \begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$$

- (c) What is Liapunov stability analysis ? How does it get modified for systems with dead time ?

4. Attempt any **two** parts : (10×2=20)

- (a) Write about the formulation of the optimal control problem. For the system shown below, find the value of K that minimizes the ISE (integral square error) for the unit step input :



- (b) What is an optimal state regulator ? Derive its design using Ackermann's formula.
- (c) What is a digital state observer ? How is it designed ? The state equations of a digital process are described by

$$x(k + 1) = A x(k) + B u (k)$$

where $A = \begin{bmatrix} 0 & 1 \\ -1 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

The output equation is $C(k) = D x(k)$

where $D = [2 \ 0]$

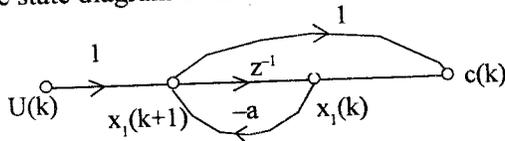
Design a digital observer which observes the states $x_1(k)$ and $x_2(k)$ from the output $C(k)$.

5. Attempt any **two** parts : **(10×2=20)**

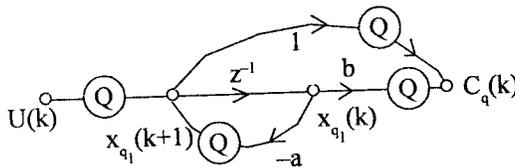
- (a) Write an essay on mechanization of control algorithms using Microprocessors.
- (b) What is a Microcontroller ? What is the difference between a Microprocessor and a Microcontroller ? Which one of the two induces less quantization error and why ?
- (c) Consider a first order digital controller with the transfer function :

$$D(z) = \frac{C(z)}{U(z)} = \frac{1 + bz^{-1}}{1 + az^{-1}}, \quad a < 1$$

The state diagram of the controller is shown below :



The model with quantizers positioned at appropriate locations is shown below :



Find the magnitude of the error bound i.e. $\left| \lim_{N \rightarrow \infty} e_c(N) \right|$.