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

PAPER ID : 2750 Roll No.

**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.

(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 :

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

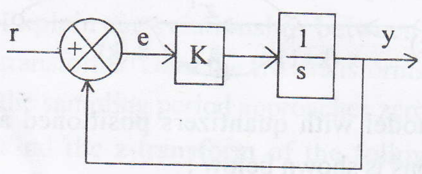
(b) What is Caley-Hamilton theorem ? How can the state transition matrix be calculated using the Caley-Hamilton theorem ?

Find the state transition matrix using the theorem for the 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)**

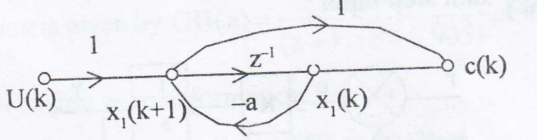
(a) Write an essay on mechanization of control algorithms using Microprocessors.

(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 ?

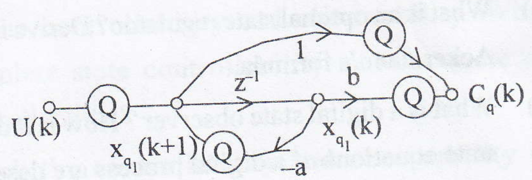
(c) Consider a first order digital controller with the transfer function :

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

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. $\left|\lim_{N\to\infty} e_c(N)\right|$.