Code No: B4305 **NR**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH II - SEMESTER EXAMINATIONS, APRIL/MAY 2012
DIGITAL CONTROL SYSTEMS
(POWER ELECTRONICS)

Time: 3hours **Max. Marks: 60**

Answer any five questions
All questions carry equal marks
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1\. Consider a signal f(t) which has discrete values f(kT) at the sampling rate 1/T. If the signal f(t) is imagined to be impulse sampled at the same rate, it becomes

$$f^*(t) = \sum_{k=0}^{N} f(kT)\delta(t-kT)$$

a) Prove that $F(z)\big|_{z=e^{sT}} = F^*(s)$

b) Determine $F(z)\big|_{z=e^{sT}}$ in terms of F(s). Using this result explain the relationship between the z-plane and the s-plane.

2.a) Consider a second order discrete time system described by the difference equation

$$y(k+2) - \frac{3}{2}y(k+1) + \frac{1}{2}y(k) = r(k+1) + \frac{1}{2}r(k)$$

The system is initially relaxed and is excited by the input $r(t) = \begin{cases} 0; & k = 0 \\ 1; & k > 0 \end{cases}$

Find the solution of above difference equation through z-transform method.

b) Find the Z-transform of the following:
i) $f(t) = t^2$,
ii) $f(t) = e^{-\alpha t} \sin \omega t$

3\. Obtain a discrete-time state space representation of the following continuous-time system:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

Assume sampling period, T =1 sec. For $y(k) = x_1(k)$, obtain the state transition matrix.

4.a) Derive the necessary conditions for the digital control system
X(k + 1) = AX(k) + Bu(k)
Y(k) = CX (k) +DU(k) to be controllable and observable.

b) Examine whether the discrete data system

$$X(k+1) = \begin{bmatrix} 0 & 1 \\ -2 & -2 \end{bmatrix} X(k) + \begin{bmatrix} 1 \\ -1 \end{bmatrix} u(k) \quad \text{and } y(k) = [1 \quad 0]X(k) \text{ is}$$

(i) State controllable (ii) Output controllable and (iii) Observable.

5.a) A discrete time system X(k + 1) = AX(k) + Bu(k) has the system matrix
$A = \begin{bmatrix} 1 & a \\ 2 & 1/2 \end{bmatrix}$ For what value of **a** is the system stable.

b) Consider the digital system shown in Fig P5

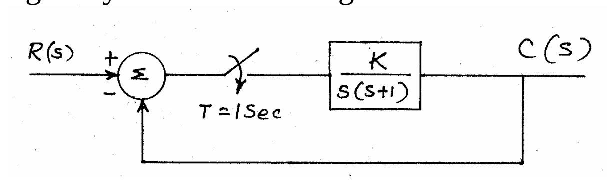

Fig. P5

Using Jury's stability test, find the range of values of K for which the system is stable.

6.a) For the system configuration give below, Design $G_c(z)$ that accomplishes a deadbeat response. Assume that: (i) $G(s) = \frac{1}{(s+1)(s+2)}$, (ii) The samples are ideal and operate synchronously with a sampling period of T= 1 sec. (iii) The input is a unit step.

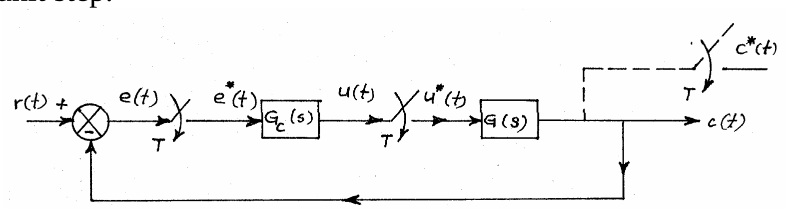

Fig P6

b) Explain the design procedure of digital PID controllers.

7.a) Explain any two methods of pole-placement for design of digital controller.

b) Consider the single input digital control system

$$X(k+1) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

Determine, the state feedback matrix K such that the state feedback

u(k) = -KX(k), places the closed loop system poles at 0.3 ±j0.3.

8.a) Consider the system

$$X(k+1) = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix} X(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$y(k) = [1 \quad 1]X(k)$

Design a current observer for the system. It is desired that the response to the initial observer error be deadbeat.

b) Explain the linear quadratic regulators.

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