Code No: A7502 **NR**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech I - Semester Examinations, October/November-2011
DIGITAL CONTROL SYSTEMS
(CONTROL SYSTEMS)

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

Answer any five questions
All questions carry equal marks
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1.a) Explain clearly the configuration of basic digital control scheme with the help of neat block diagram.
b) Explain the advantages and disadvantages of digital control systems.
c) Explain the need of Zero Order Holder and derive its transfer function. [12]

2.a) Find the Z-transform of the following: (i) $F(s) = \frac{a^2}{s^2(s+a)^2}$, (ii) f(t) = $e^{-\alpha t}$ sin ωt.
b) Explain the limitations of Z-Transforms.
c) Find the inverse Z-Transform of the following:
(i) $F(z) = \frac{z-4}{(z-1)(z-2)^2}$, (ii) $F(z) = \frac{3z^2+2z+1}{(z^2-3z+2)}$. [12]

3.a) Describe the pulse transfer function. Derive the pulse transfer function of digital PID controller.
b) Determine the pulse transfer function of two cascaded systems, each described by the difference equation: y(k) = 0.5y(k-1)+r(k) [12]

4. Construct the root locus for the discrete time system shown in Fig 4 with its plant transfer function G (s) = $\frac{K}{s(s+1)}$ and investigate the stability of closed loop system. Consider the sampling period T = 0.4 sec. [12]

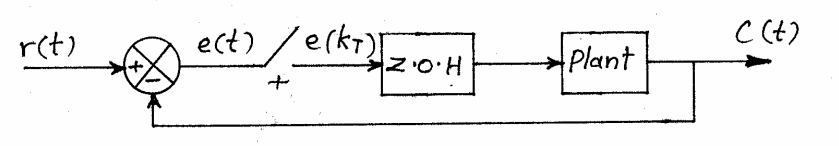


Fig 4

5. The controlled process of a discrete data control system is described by the transfer function: $G_{ho}G_p(z) = \frac{K(z+0.5)}{(z-0.5)(z-1)}$. The sampling period is 0.1 sec. Determine the value of K and design a cascaded phase-lag digital controller with the transfer function $D(z) = K_c \frac{z-z_1}{z-p_1}$, where D(1) = 1, so that the following design specifications are satisfied: (i) The ramp-error constant K_v=100, and
(ii) The dominant roots of the characteristic equation are approximately equal to 0.7±j0.245. Find the actual roots of the characteristic equation with the designed controller. [12]

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6.a) Determine discrete state variable representations for the transfer functions:

(i) $G(z) = \dfrac{2 + z^{-1}}{1 + z^{-1}}$; (ii) $G(z) = \dfrac{5z}{z^2 + 2z + 2}$

b) Using z-transform method, find the transition matrix for the following digital system

$$X(k+1) = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} X(k).$$ [12]

7.a) Examine whether the discrete data system

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

$$y(k) = [1 \quad 0]\, X(k)$$

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

b) Draw the schematic diagram of a digital system with a reduced – order observer and explain the same. [12]

8. A linear digital process is represented by the state equation:

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

Determine the optimal control u(0), u(1), u(2), u(3) and u(4) in the form of state feedback so that the performance index: $J = \dfrac{1}{2}\sum_{k=0}^{5}[x_1^2(k) + x_2^2(k)]$ is minimized. Also find the optimal control for infinite time (N = ∞). [12]

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