Code No: OR421351 **OR**

IV B.Tech II Semester Supplementary Examinations, April/May 2005
DIGITAL CONTROL SYSTEM
(Electronics & Control Engineering)

Time: 3 hours **Max Marks: 70**

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) A slowly changing continuous-time signal f(t) is sampled every T seconds. Assuming that the changes in f(t) are very slow compared to the sampling frequency, show that in the z-domain,
$\frac{1-z^{-1}}{T}$
corresponds to differentiation. Obtain a block diagram of this differentiator using a pure delay element z^{-1}.

   (b) What is an equivalent integrator in the z-domain? Draw a graph of the output in each case when the input is a unit step sequence.

2. (a) Derive the state space model of a discrete control system using the nested programming method.

   (b) Using the above method, obtain the state equation and output equation for the system defined by
$\frac{\mathrm{Y(z)}}{\mathrm{U(z)}} = \frac{z^{-1}+5z^{-2}}{1+4z^{-1}+3z^{-2}}$

3. Show that the following system

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} -1 & -2 & 0 \\ 0 & -3 & 1 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u$$

$$y(k) = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix}$$

is completely state controllable and observable.

4. Explain Liapunov stability criterion for the linear time variant systems.

5. Determine which of the following digital transfer functions are physically realizable

   (a) $G(z) = \frac{10\left[1+0.2z^{-1}+0.5z^{-2}\right]}{z^{-1}+z^{-2}+1.5z^{-3}}$

   (b) $G(z) = \frac{\left[1.5z^{-1}-z^{-2}\right]}{\left[1+z^{-1}+2z^{-2}\right]}$

   (c) $G(z) = \frac{[z+1.5]}{[z^3+z^2+z+1]}$

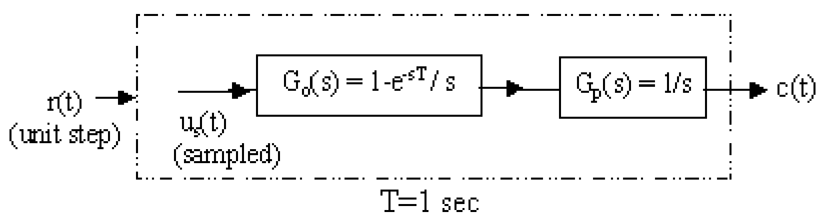
   (d) $\mathrm{G(Z)} = 0.1\mathrm{z} + 1 + \mathrm{z}^{-1}$

6. Consider an n^{th} order, single input system X(k+1) = AX(k)+bu(k) and use a feedback of the form u(k)=-KX(k)+r(k) where r is the reference input signal. Show that the zeros of the system are invariant under state feedback.

7. Consider the system
   X(k+1) = GX(k) + Hu(k)
   y(k) = CX(k)

   where $G = \begin{bmatrix} 0 & 0 & -0.25 \\ 1 & 0 & 0 \\ 0 & 1 & 0.5 \end{bmatrix}$; $H = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$; $C = [1\ 0\ 0]$
   Assuming that the output y(k) is measurable, design a minimum-order observer such that the response to the initial observer error is deadbeat.

8. For the discrete time system shown: Find the optimal transfer function T*(z) so



   that the output c(t) follows r(t) minimizing

   $$Je = \sum_{k=0} [r(kT) - c(kT)^2 with\, ju = \sum_{k=0}^{\infty} u^2(kT) = 0.5$$

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