Code No: NR411005 **NR**

IV B.Tech I Semester Supplementary Examinations, November 2005
DIGITAL CONTROL SYSTEMS
(Common to Electronics & Instrumentation Engineering and Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Show that the transfer function for
   (a) a zero-order hold is, $G_0(s) = \frac{1-e^{Ts}}{s}$
   (b) a first-order hold is, $G_1(s) = \frac{Ts+1}{T}\left(\frac{1-e^{Ts}}{s}\right)^2$. [8+8]

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

$$\frac{Y(z)}{U(z)} = \frac{z^{-1}+5z^{-2}}{1+4z^{-1}+3z^{-2}}$$

[8+8]

3. Investigate the controllability and observability of the following system

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

$$\begin{bmatrix} y_1(k) \\ y_2(k) \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

[16]

4. Explain Liapunov stability criterion for the linear time variant systems. [16]

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) $G(Z) = 0.1z + 1 + z^{-1}$ [4× 4]

6. Consider the system

   X(k+1) =GX(k) + H(k)
   y(k) = Cx(k)

and $G = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.5 & -0.2 & 1.1 \end{bmatrix}$ $H = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$ $C = \begin{bmatrix} 0 & 1 & 0 \end{bmatrix}$

Determine the state feedback gain matrix K such that the system will exibit a deadbeat response to any initial state. [16]

7. (a) Give the block diagram representation of a full order observer. Hence write the state equations for the closed loop observer.

   (b) Consider the digital process with the state equations described by
   X(k + 1) = AX(k) + Bu(k)
   C(k) = DX(k)
   Where $A = \begin{bmatrix} 0 & 1 \\ -1 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, D = [2 0]
   Design a full order observer which will observe the states x1(k) and x2(k) from the output C(k), having dead beat response. [8+8]

8. Explain the Discretized Quadratic optimal control problem. [16]

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