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BIEEE-009

B.Tech. – VIEP – ELECTRICAL ENGINEERING (BTELVI)

00874

Term-End Examination

June, 2014

BIEEE-009 : DIGITAL CONTROL SYSTEM DESIGN

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any* ***seven*** *questions. All questions carry equal marks.*

1. Obtain the inverse Z-transform of *10*

$$X(z) = \frac{z^{-2}}{(1 - z^{-1})^3}$$

2. Discuss about the frequency response characteristic of the Zero-Order Hold (ZOH). *10*

3. Find the Z-transform of

$$X(s) = \frac{1}{s\,(s + 1)}$$

Also define z-domain-pulse transfer function. *10*

4. A discrete time system is described by transfer function

$$G(z) = \frac{Y(z)}{R(z)} = \frac{1}{z^2 + a_1 z + a_2}, \quad a_1 = \frac{-3}{4}, a_2 = \frac{1}{8}$$

Find the response Y(K), to the input

(a) Impulse signal

(b) Unit step. *10*

5. Using Jury's stability criterion check if all the roots of the following characteristic equation lie within the unit circle *10*

$$z^3 - 1{\cdot}3z^2 - 0{\cdot}08z + 0{\cdot}24 = 0$$

6. A PID controller is described by the following relation between input e(t) and output u(t).

$$U(s) = K_c\left[1 + \frac{1}{T_I s} + T_D s\right]E(s)$$

Derive the PID algorithm using s-plane to z-plane maps bilinear transformation for integration and backward difference for the derivatives. *10*

7. Explain the design procedure in w-plane for digital control system. *10*

8. Obtain state-space representation of the following pulse-transfer function system in diagonal canonical form *10*

$$Y(z) = \frac{1 + 6z^{-1} + 8z^{-2}}{1 + 4z^{-1} + 3z^{-2}}$$

9. Define Cayley – Hamilton theorem. Evaluate state transition matrix $\phi(k)$ for a given system *10*

$$\dot{x} = Ax \text{ where } A = \begin{bmatrix} 0 & -4 & 0 \\ 0 & 0 & 4 \\ -4 & -12 & -4 \end{bmatrix}$$

10. Consider the complete state controllable system

$$X(K + 1) = G\,X(K) + H\,U(K)$$

Define the controllability matrix as M,

$$M = [H : GH \vdots \text{ .... } \vdots G^{n-1} H]$$

Show that

$$M^{-1} G M = \begin{bmatrix} 0 & 0 & \dots & 0 & \dots & -a_n \\ 1 & 0 & \dots & 0 & \dots & -a_{n-1} \\ 0 & 1 & \dots & 0 & \dots & -a_{n-2} \\ \vdots & \vdots & & \vdots & & \vdots \\ 0 & 0 & \dots & 1 & \dots & -a_1 \end{bmatrix}$$

where $a_1, a_2, a_3, \dots, a_n$ are the coefficients of characteristic equation

$$|zI - G| = z^n + a_1 z^{n-1} + \dots\, a_{n-1} z + a_n$$ *10*
