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No. of Printed Pages : 4

BIEEE-009

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

Term-End Examination

December, 2015

BIEEE-009 : DIGITAL CONTROL SYSTEM DESIGN

Time : 3 hours *Maximum Marks : 70*

Note :

*(i) Attempt any **seven** questions.*

(ii) All questions carry equal marks.

(iii) Use of scientific calculator is permitted.

(iv) Missing data, if any, may be suitably assumed and mentioned.

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1. (a) Draw the block diagram of a digitally controlled plant-with proper labelling. *5*

   (b) Determine the Z-transform of the unit step function u(t). *5*

2. (a) Given the transfer function

$$\frac{Y(z)}{R(z)} = \frac{0{\cdot}3679z + 0{\cdot}2642}{z^2 - z + 0{\cdot}6321},$$

   determine the linear constant coefficient difference equation. *5*

(b) A second order system is represented as

$$H(z) = \frac{z}{z^2 + a_1 z + a_2}.$$

What will be the time response, if the roots are real ? 5

3. (a) A linear constant coefficient discrete time system is represented as

$$z^3 - 3z^2 + 2\cdot25z - 0\cdot5 = 0.$$

Determine the stability using Jury's criterion. 5

(b) Explain mapping of the primary strip in the left half of the s-plane into the z-plane by the Z-transform. 5

4. (a) Explain cascade compensation by continuous data controllers using bilinear transformation. 5

(b) What are the degrees of freedom compensation ? 5

5. (a) For an open-loop transfer function with zero at 'b' and poles at 'a_1' and 'a_2', write down the circle equation for the root locus. Thus, write down the centre radius of the root locus. 5

(b) For the open-loop transfer function

$$\frac{0\cdot0175k\,(z + 0\cdot876)}{(z - 0\cdot67)\,(z - 1)},$$

determine the centre and radius of the root locus and the points where the root locus enters or leaves the real axis. 5

6. (a) Use the bilinear transformation $z = \frac{r+1}{r-1}$ to map the unit circle $|z| = 1$ onto the imaginary axis of the r-plane. Show pictorial presentation only. 5

(b) Verify the stability of the system with characteristic equation

$z^3 - 1{\cdot}25z^2 - 1{\cdot}375z - 0{\cdot}25 = 0$, using the bilinear transformation $z = \frac{r+1}{r-1}$. 5

7. (a) A state feedback model is given as

$$\bar{x}(k+1) = F\bar{x}(k) + g\,u(k),$$

$$\bar{y}(k) = C\bar{x}(k) + d\,u(k),$$

$$u = -kx.$$

Given

$$F = \begin{bmatrix} 1 & 0{\cdot}1 \\ 0 & 1 \end{bmatrix}, \quad g = \begin{bmatrix} 0{\cdot}005 \\ 0{\cdot}1 \end{bmatrix}.$$

Determine k, as a dead beat controller. 5

(b) Define state space model (vector) of discrete data system. Use the similarity transformation to derive an equivalent model. 5

8. (a) Use Cayley-Hamilton theorem to determine F^k from the eigenvalues of the matrix

$$F = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}.$$ 5

(b) Given the state space model

$$X(k+1) = FX(k) + gu(k),$$

where

$$F = \begin{bmatrix} 1 & 0{\cdot}0787 \\ 0 & 0{\cdot}6065 \end{bmatrix}, g = \begin{bmatrix} 0{\cdot}0043 \\ 0{\cdot}0787 \end{bmatrix}.$$

Test the system for its controllability. *5*

9. Write short notes on any ***two*** of the following : *2×5=10*

(a) Mathematical model of ZOH

(b) Routh stability criterion on r-plane

(c) Jordan canonical form