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BIEEE-009

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

Term-End Examination

June, 2016

00036

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.

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1. (a) Determine pulse transfer function for the system shown in Figure 1. *5*

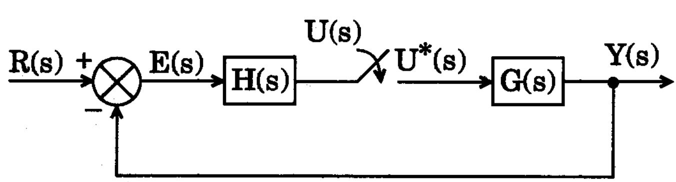

Figure 1

(b) Determine Z-transform of the function sin ωt. *5*

2. (a) What is the trapezoidal rule of zero order hold (ZOH) ? Draw the block diagram of mathematical model for ZOH. 5

(b) Explain multirate discrete data systems in detail. 5

3. (a) State and explain Cayley-Hamilton theorem for computation of state transition matrix. 5

(b) Explain the procedure for pole placement design, using state feedback for a SISO system. 5

4. (a) Define critical gain. 5

For the open loop transfer function

$$F'(z) = \frac{Ak\,(z - b)}{(z - a_1)\,(z - a_2)}$$

Write down the expression for critical gain. Assume all the poles and zeros be situated at real axis.

(b) A system is represented by $F(z) = z^2 - 0{\cdot}25$. Use bilinear transformation $z = \frac{r+1}{r-1}$ to test the stability of F(z), where r is a complex variable. 5

5. (a) A system has to be designed with maximum damping factor of σ_1. Use pictorial presentation to show mapping for s-plane to z-plane. 5

(b) A lag compensator may be represented as $D(\omega) = \frac{1+\omega T}{1+\beta\omega T}$, where $\beta > 1$. Draw the approximate Bode plot on plain paper to show gain and phase over frequency. 5

6. (a) Write one benefit of using PI controller. A PI controller may be represented as 5

$$D(W) = K_p + \frac{K_I}{W}$$

On a plain paper draw the approximate sketch of Bode plot of PI controller by suitably converting the expression for D(W).

(b) A system $G_p(z) = \frac{z+0\cdot5}{z^2-z-1}$ is cascaded with a digital controller

$$(z) = \frac{z^2-z-1}{(z-1)(z+0\cdot5)}$$

For a step input R(z), show that the response is deadbeat. 5

7. (a) Consider the matrix,

$$F = \begin{bmatrix} 1 & 1 & 2 \\ 0 & 1 & 3 \\ 0 & 0 & 2 \end{bmatrix}$$

Determine eigenvalues and eigenvectors. 5

(b) For a discrete data system, the state feedback control locus is given as $u = -K\bar{X}$.

Given, $F = \begin{bmatrix} 1 & 0 \\ 0 & 1 \cdot 105 \end{bmatrix}$, $g = \begin{bmatrix} 0 \\ 0 \cdot 105 \end{bmatrix}$.

Desired closed loop system is given as

$$z^2 - 1 \cdot 5894\, z + 0 \cdot 6971 = 0$$

Verify whether the system is controllable. 5

8. (a) A state space model is given as 5

$$X(k+1) = AX(k) + Bu(k)$$

$$u(k) = R(k) - GX(k)$$

where,

$$A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Using $G = [g_1 \;\; g_2]$ test the controllability of AB.

(b) Describe the causes and effects of loss of controllability and observability due to sampling. 5

9. Attempt any ***two*** of the following : *2×5=10*

(a) Pulse transfer function in z-domain

(b) Nyquist stability criterion

(c) Computer base simulation