No. of Printed Pages : 4 **BIEEE-002**

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

Term-End Examination

December, 2016

00313

BIEEE-002 : DIGITAL CONTROL SYSTEM

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any* ***seven*** *questions. All questions carry equal marks. Use of scientific calculator is allowed.*

1. (a) Describe the important advantages offered by the use of digital computers as compensator devices in a control system. *5*

   (b) What are the main problems associated with implementation of digital control ? *5*

2. State and prove the final value theorem of Z-transform. What is the condition under which the theorem is valid ? *10*

3. Consider the sample-data system of Figure 1. Determine its characteristic equation in 'z'-domain and ascertain its stability using bilinear transformation. *10*

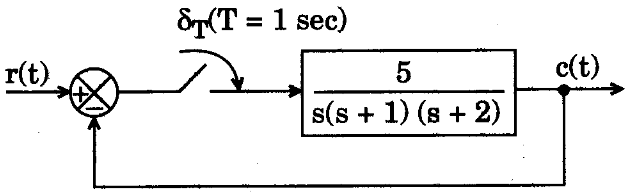

Figure 1

4. Define the regions of stability, marginal stability, and instability on the s-plane. How are these regions translated to z-plane by the mapping : $z = e^{sT}$? *10*

5. A Linear Time Invariant system is characterized by the following homogeneous state equation :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$

Compute the solution of the given equation assuming the intial state vector $\bar{x}(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$. *10*

6. The motion of satellite in the equatorial (r, θ) plane is given by the following state equation :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 3\omega^2 & 0 & 0 & 2\omega \\ 0 & 0 & 0 & 1 \\ 0 & -2\omega & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} u_1 + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} u_2$$

where,

$\omega \rightarrow$ angular frequency

$x_1(t)$, $x_3(t)$ $\rightarrow$ deviations in position variables $r(t)$ and $\theta(t)$ respectively

$x_2(t)$, $x_4(t)$ $\rightarrow$ deviations in velocity variables $\dot{r}(t)$ and $\dot{\theta}(t)$

$u_1(t)$ and $u_2(t) \rightarrow$ the thrusts

u_r and u_θ $\rightarrow$ thrusts in radial and tangential directions

Assuming the tangential thruster becomes inoperable, determine the controllability of the system with the radial thruster alone. *10*

7. Show that a BIBO stable continuous-time linear time invariant system is asymptotically stable only if the system is completely controllable and completely observable. *10*

8. Briefly describe the configuration of a sampled-data system employing state feedback. Modify this configuration by introducing 'Integral state' to improve steady-state performance. *10*

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

(a) Discrete Euler-Lagrange Equation for Optimal Digital Control Systems

(b) Stability Analysis using Lyapunov's method

(c) Digital Compensators