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**BIEEE-002**

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

## Term-End Examination

00405

## December, 2014

## 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.*

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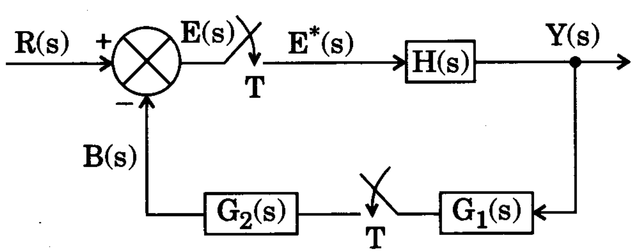
**1.** Derive the transfer function of a zero-order hold (ZOH) in terms of $\omega$ from fundamentals. Comment upon its magnitude and phase angle. *10*

**2.** Obtain the pulse transfer function for the following system : *10*




**3.** Derive Z-transform of the following functions : *2×5=10*

(i) n u(n)

(ii) A sin 2πfn

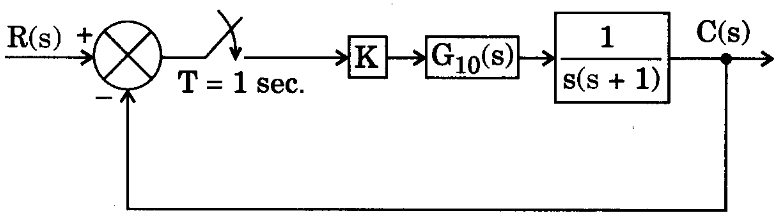
4. A second order discrete data system is described by the difference equation :

$$y(k) + \frac{1}{4} y(k-1) - \frac{1}{8} y(k-2) = 3r(k-1) - r(k-2)$$

for $k \geq 0$. Obtain y(k) for $k \geq 0$.

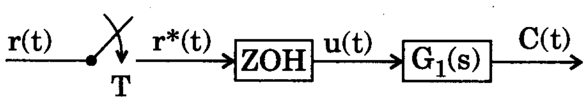
Given $r(k) = (-1)^k u(k), k \geq 0$ and initial condition $y(-1) = 5, y(-2) = 6$. Use Z-transform techniques. *10*

5. Consider the following system.




Determine the range of values of K for which the system is stable. Hence, obtain the continuous time frequency ω. *10*

6. Consider the following open loop digital system :




The state space model describing the above process is

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$C(t) = x_1(t)$

Derive the transfer function $\frac{C(z)}{R(z)}$. *10*

7. What are Eigenvalues and Eigenvectors of a matrix A where 10

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix}$$

8. (a) The input-output difference equation of a control system is given as

$$C(K + 2) + 2C(K + 1) + C(K) = u(K + 1) + u(K).$$

Comment of the controllability of this system. 5

(b) Consider the system given in part (a) for the closed loop state feedback control law

$$u(K) = r(K) - G\,x(K)$$

Comment on the controllability of the closed loop system. 5

9. (a) Derive the condition to test Lyapunov stability for linear discrete data systems in terms of A, P and Q. 5

(b) Consider the following digital system

$$x_1(K + 1) = -0{\cdot}5\, x_1(K)$$

$$x_2(K + 1) = -0{\cdot}5\, x_2(K)$$

Test Lyapunov stability of the above system by deriving the positive definite real symmetric matrix P. 5

**10.** (a) Consider the following discrete data system

$$\overline{x}(K+1)=\overline{A}\,\overline{x}(K)+\overline{B}\,\overline{u}(K)$$

where $A = \begin{bmatrix} 0 & 1 \\ -0.5 & -0.2 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

Determine the constant state feedback gain matrix G such that the control law $\overline{u}(K) = -G\,\overline{x}(K)$ transforms the system from state x(0) to x(2). 5

(b) For the system given in part (a), determine the optimal control law $u^{\circ}(K)$ for K = 0, 1, and optimal state trajectory $x^{\circ}(K)$.

Given $\overline{x}(0) = [1 \quad 1]'$ and $x^{\circ}(2) = 0$. 5