Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech

PEEC 5414

Seventh Semester Regular Examination – 2014

ADVANCED CONTROL SYSTEMS

BRANCH(S) : AEIE, EC, EEE, ELECTRICAL, ETC, IEE

QUESTION CODE : H 273

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 ×10

(a) What do you understand by a discrete time control system ? Draw the block diagram of such a system.

(b) What do you understand by a Hold circuit ? Show how a waveform gets modified after passing through the lowest order hold circuit ?

(c) Determine the z-transform of a ramp signal $f(t) = t$.

(d) Given the transfer function of a system as $(s) = \frac{a}{s(s+a)}$, determine its Z-transform.

(e) Show the relationship between s-domain and z-domain. Is the relationship a one-to-one relationship ?

(f) What are the eigen values of the system represented by

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix} X \ ?$$

P.T.O.

(g) The transfer function of a certain system is

$$\frac{Y(s)}{U(s)} = \frac{1}{s^4 + 5s^3 + 7s^2 + 6s + 3}$$

Write down the A, B matrix pair of the equivalent state-space model.

(h) The state equation of a system is given as follows :

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

Comment on the controllability of the system.

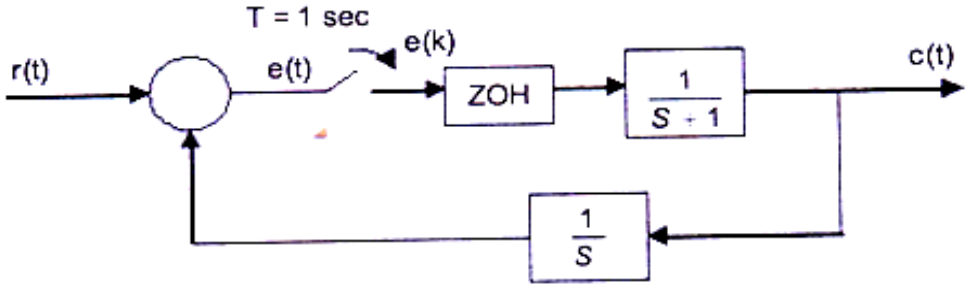
(i) What do you understand by 'Limit Cycle' ? Differentiate between stable and unstable limit cycles.

(j) Enumerate the conditions which must be satisfied by a function V(x) to qualify as a Lyapunov Function.

2. (a) Find the Z-transform of ka^{k-1}, $k \geq 1$. 5

(b) Find the inverse Z-transform of $\frac{3z^2 + 2z + 1}{z^2 + 3z + 2}$. 5

3. For the sampled data control system shown in figure, find the output c(k) for r(t) = unit step. 10



4. (a) A state variable system $\dot{X}(t) = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} X(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$ has initial condition $X(0) = [-1 \quad 3]^T$. Find out the state transition matrix to a unit step input. 5

(b) A dynamic system is represented by the differential equation

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y(t) = r(t),$$

where y(t) is the output and r(t) is the input. Obtain a state model in controllable canonical form. 5

5. (a) Find $f(A) = A^4 + 2A^3$, where $A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$. 5

(b) Derive the method used. 5

6. (a) What do you understand by the terms 'Controllability' and 'Observability'? 4

(b) Comment on the controllability of the system given below using Kalman's test. 6

$$\dot{X}(t) = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 3 & 1 \end{bmatrix} X(t) + \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

7. (a) Describe the various types of stability considered for a non-linear system. 5

(b) Explain about different common physical non-linearities. 5

8. Write short notes on any two : 5×2

(a) Bilinear Transformation

(b) Eigen Values and Eigen Vectors

(c) Jump Resonance

(d) Stability Analysis by Describing Function Method.