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

Total number of printed pages – 3

B. Tech

PEEC5414

Seventh Semester Examination – 2013

ADVANCED CONTROL SYSTEM

BRANCH : EC, AEIE, EEE, ELECTRICAL, ETC, IEE

QUESTION CODE : C-130

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) Find out the z-transform of the sequence $x[n] = -a^n u[-n-1]$.

(b) Determine the initial value $x[0]$ if the z-transform of $x[t]$ is given by

$$X(z) = \frac{(1-e^{-T})z^{-1}}{(1-z^{-1})(1-e^{-T}z^{-1})}$$

(c) What should the minimum sampling frequency and why is it so ?

(d) What is discrete convolution ?

(e) Derive the expression used to determine the transfer function of a system from its state equations.

(f) Show that the eigenvalues of a system remain invariant under similarity transformation.

(g) Draw the signal flow graph of a system when its state model is expressed in controllable phase variable form.

(h) What do you mean by a pole placement ? State the necessary and sufficient condition for arbitrary pole placement.

(i) Draw the characteristics of a relay with dead zone and hysteresis. State whether a relay is an incidental or an intentional non-linearity.

(j) Differentiate between the behavior of linear and non-linear systems.

P.T.O.

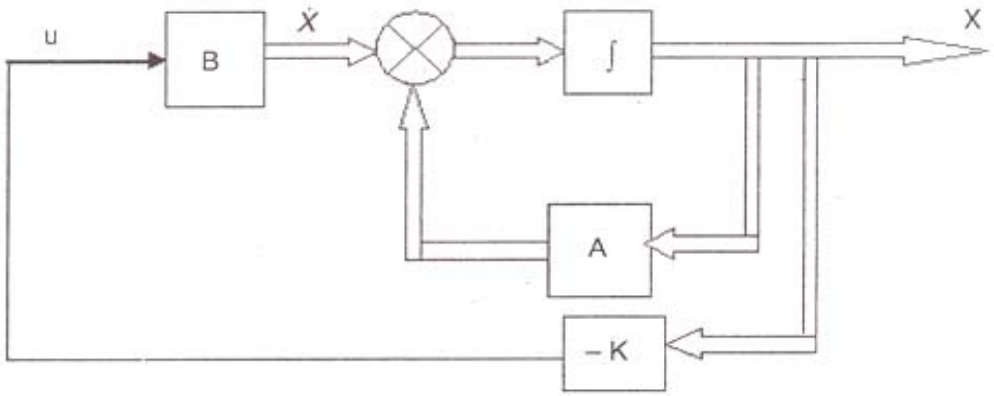
2. (a) What is meant by a hold device? Determine the Z-transform of a zero order hold. 5

(b) Determine the Z-transform of $f(kT) = e^{-akT} \sin wkT$. 5

3. (a) If $\begin{bmatrix} -2 & 0 \\ 0 & -3 \end{bmatrix}$, find by power series method. Verify the result by Laplace Transform method. 5

(b) What is Cayley-Hamilton theorem ? Find $f(A) = e^{AT}$ for $A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}$ using Cayley-Hamilton theorem. 5

4. Consider the regulator system shown in figure. The plant is given by $\dot{X} = AX + Bu$, where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$



The system uses the state feedback control $U = -kX$. If the desired closed-loop poles are located at $s = -2 + j4$, $s = -2 - j4$, $s = -10$. Determine the state feedback gain matrix K using any two methods. 10

5. (a) Determine the inverse Z-transform of : 5

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

(b) State and prove the final value theorem for Linear Discrete Systems. 5

6. (a) Using Kalman's test, comment on the complete state observability of the following system : 5

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

(b) Discuss the various types of stability defined for non-linear systems. 5

7. (a) What do you mean by Describing Function ? Derive the expression of DF for the Saturation Non-linearity. 5

(b) Show by example, how the prediction and stability of Limit Cycle can be judged by using the Describing Function method. 5

8. Write short notes on any **two** : 5×2

(a) Pulse Transfer Function

(b) Jump Resonance

(c) Singular Points in non-linear systems

(d) Jury's stability test.
