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

Total number of printed pages – 3

B. Tech

PEEC 5401B

Seventh Semester Examination – 2011

ADVANCED CONTROL SYSTEM

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) Show the difference between continuous-time analog signal and the continuous-time quantized signal. Is there any difference between sampled signal and quantized signal ?

   (b) Explain the necessity of a HOLD in the sampled data control system.

   (c) What is Aliasing in connection with sampling and why it occurs ?

   (d) Derive the condition for complete state controllability of a linear time invariant discrete-data system.

   (e) Explain and illustrate the phenomenon of Jump Resonance in non-linear systems.

   (f) Classify equilibrium points and illustrate.

   (g) Explain how a state observer helps in pole placement of closed loop poles.

   (h) Prove the non - uniqueness of State Variables.

   (i) What interence you get by mapping of the left half of s-plane into the z-plane ? Explain.

   (j) What do you understand by Eigenvector ? Explain.

2. (a) (i) State and prove the final value theorem of z-transform. 3

   (ii) If x(t)=0 for t<0 and x(t) has the z-transform x (z), prove $Z\left[x(t-nT)\right]=z^{-n}X(z)$. 2

P.T.O.

(b) Find the inverse z-transform of the followings :

(i) $X(z)=\dfrac{Z(z+1)}{(z-1)^3}$ 2

(ii) $X(z)=\dfrac{z^2}{(z-1)^2(z-e^{-aT})}$ 3

3. (a) Derive the range of values of K for the given sampled-data control system shown in fig.-1 with a sampling period $T=\frac{1}{4}$ second, to be stable. Use bilinear transfer motion. 5

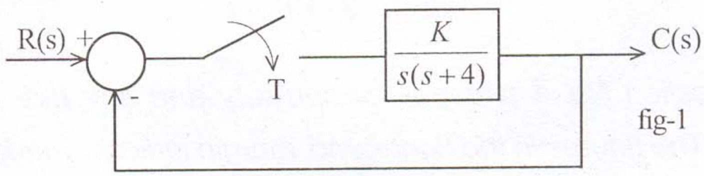

fig-1

(b) A linear discrete-time system is represented by a pulse transfer function $\dfrac{Y(z)}{U(z)}=\dfrac{b_0+b_1z^{-1}+b_2z^{-2}+....+b_nz^{-n}}{1+a_1z^{-1}+a_2z^{-2}+....+a_nz^{-n}}$

Determine the state-space representation in controllable cononical form. 5

4. (a) Find the state model for the system discribed by $T(s)=\dfrac{-5s^2+4s-12}{s^3+6s^2+s+3}$. 5

(b) Using Laplace transforms method, obtain STM for $A=\begin{pmatrix}0 & 1\\ -20 & -9\end{pmatrix}$. 5

5. (a) Determine the state feedback gain matrix K of the system :

$\dot{X}=AX+Bu$; y=Cx, where A=$\begin{pmatrix}0 & 1\\ 20.6 & 0\end{pmatrix}$, B=$\begin{pmatrix}0\\ 1\end{pmatrix}$, C=$\begin{bmatrix}1 & 0\end{bmatrix}$, such that the closed-loop poles are at $-1.8\pm j2.4$. 6

(b) Determine the transfer function of the system define by:

$\dot{X}=AX+Bu$; y=Cx, where $A=\begin{pmatrix}-1 & 0 & 1\\ 1 & -2 & 0\\ 0 & 0 & -3\end{pmatrix}$, B=$\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}$, C=$\begin{bmatrix}1 & 1 & 0\end{bmatrix}$. 4

6. (a) What is a limit cycle ? Explain the stability of Limit Cycle which may exhibit in non-linear system. 2

(b) (i) Derive the expression for describing function of the non linearity whose output/input characteristic is shown in fig.-2(a). 3

(ii) Determine the amplitude and frequency of limit cycle for the system as shown in fig.-2(b) with the same non-linearity as in fig.-2(a). 5

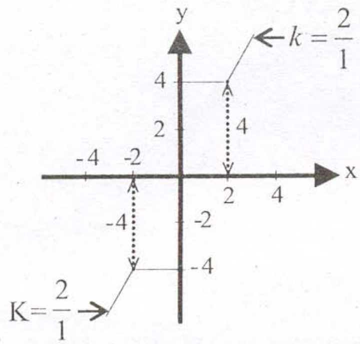

fig.-2(a): Input/Output characteristic of a n.l.e.

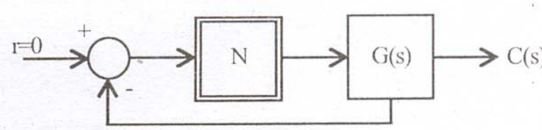

fig.-2(b): A closed loop n-l system and N=D.F of the n.l.e. shown in fig.-2(a).

Where $G(s)=\dfrac{2}{s(s+1)(s+2)}$

7. (a) Draw the Phase Trajectory of a system described by $\ddot{x}+x\dot{x}+x=0$.

Given the initial condition $x_0=+\sqrt{2},\ y_0=0$. 6

(b) Investigate the stability of the system described by :

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$. Use lyapunov's method of stability. You may take a

Lyapernov function $V(x)=x_1^2+x_2^2$. 4

8. Answer any *four* of the followings : 2.5×4

(a) A control system is described by $\ddot{x}+f(\dot{x})+g(x)=0$. Suggest and illustrate a suitable method of construction of Phase Trajectory.

(b) How do you linearize the non linear differential equation around the equilibrium point ? Explain and illustrate.

(c) Explain the procedure for Jury's stability Test.

(d) Explain the concept of Controllability and Observability.

(e) Explain how the state equation of linear continuous time system is discretized to get a discrete-time state equation.