B.E. (EE) Part-Ill 6th Semester Examination, 2010

Control System-II
(EE-603)

Time : 3 hours **Full Marks : 70**

Use separate answerscript for each half.

Answer SIX questions, taking THREE from each half.

Two marks are reserved for neatness and systematic answer in each half.

Use graph paper {supplied), if required.

Justified datas can be chosen, if required.

FIRST HALF

I. a) (i) Find the Z-transform of the function,

$f(t) = 1 \quad \text{for } t > 0$

$\quad = 0 \quad \text{for } 1 < 0$

(ii) Write down the merits of the digital controller over analog controller.

b) Solve the following difference equation using the Z-transform method

$x(k + 2) + 5x(k+ 1) + 6x(k) = 0$

x(0) = 0, **X("l**>=»-i. **|(3x2)+5|**

2. a) For the system shown in Fig.-1, find the output at the sampling instants c(kT). The input is a unit impulse, and the sampling period is 0.1 sec.

r<30

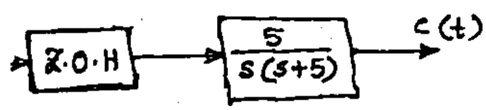

Fig.-l **[Q.No. 2(a)]**

b) Consider the closed-loop discrete time system as shown in Fig.-2, where K is the gain of the plant. It is desired to determine the range of K for which the system is stable. Use Jury's stability test. |S+6I

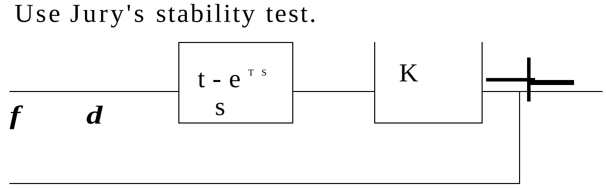

Fig.-2 [Q.No. 2(b)]

3. a) Determine the pulse transfer function and stability of the sampled data control system shown in, Fig.-3 for sampling time T = 0.5 sec.

Fig.-3 **[Q.No.** 3**(a)!**

b) For the system of Fig.-4, find the value of gain K, to yield a damping ratio of 0.7. J5+6|

Fig.-4 **[Q.No.** 3(b)]

4. A system is described by state-space model as

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Construct the state trajectories by Isocline technique and investigate the stability of the system. Explain all steps systematically. [11]

5. a) Derive the describing function for ideal relay the characteristic of which is shown in Fig.-5.

Fig.-5 **[Q.No.** 5(a)]

b) A linear system is described by the state equation

ro n

x = -2 -3j

Investigate the stability of this system by using Lyapunov's theorem. [5+6|

SECOND HALF

6. a) Obtain the state space model of the physical system given in Fig.-6.

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Fig.-6 **[Q.No.** 6(a))

b) Define eigen values and eigen vectors.

c) What do you mean by 'uncertainty' in a state space representation. Give examples of models of uncertainty. [6+2+3]

7. a) Check whether the system below is controllable and /or observable :

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

$y(t) = [1 \quad 0]x(t)$.

b) Define BIBO and Zero Input Stability (ZIS) of an LTI system represented by its state space model.

c) Check whether the system in Q.No. 7(a) is BIBO stable and/or ZIS? What are the eigen values and poles of this system? [3+4+4]

8. a) Find the time response of the system in Q.No. 7(a) to a unit step applied at t = 0 and zero initial conditions,

b) Define the 'Sensitivity' function of a feedback control system. What is its significance? [6+5]

9. a) Design a Linear State Variable Feedback Controller for:

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

to place the closed loop poles at $(-1 \pm j1)$. Check the correctness of your result,

b) What is an observer? What is its model? In an observer how does the estimation error go to zero asymptotically and what conditions does the plant need to fulfill? [5+6]

10. a) Obtain the discrete time state space model of the system in Q.No. 9 (a) preceded by a sampler and a zero-order-hold. The sampling time is 1 sec.

b) Draw the state diagram of the obtained time state space model.

c) What is the diagonal form of a state space representation? Can we diagonalise every state space model? What is the form of the similarity transformation? [5+2+4]