END SEMESTER EXAMINATION

B. Tech. – V Semester, Electrical Engineering
Session: 2014-2015
Subject: Advance Control System (EE-1502)

Max. Time: 3.00 Hrs. **Max. Marks: 60**

NOTE: Attempt any four questions from Part-A and any four questions from Part-B. Use of graph paper is allowed.

PART-A

Prob. 1: For a linear time invariant continuous time system represented by the following transfer function

$$\frac{d^3y}{dt^3}+6\frac{d^2y}{dt^2}+8\frac{dy}{dt}=\frac{du}{dt}+3u \qquad (7)$$

Represent the system in controllable canonical form. Realize the system in a block diagram. The system is used with an unity gain output feedback. The input is then defined by $u = r - y$, where variable r representing the reference input to the system. Obtain the resultant state space model in the same form and modified block diagram of the system.

Prob. 2: A discrete time system is defined by following z-transfer function.

$$\frac{Y(z)}{R(z)}=\frac{3z^2-4z+6}{\left(z-\frac{1}{2}\right)\left(z-\frac{1}{3}\right)^2} \qquad (7)$$

Obtain the Jordan canonical form of realization of state space model for this system. Write the state transition matrix and obtain the solution of the states for zero input and initial condition $x(0) = [1\ 0\ 1]^T$.

Prob. 3: For the sampled-data control system shown in Fig. 1, obtain the response c(kT) for the unit step input r(t) for first five samples with zero initial output. (7)

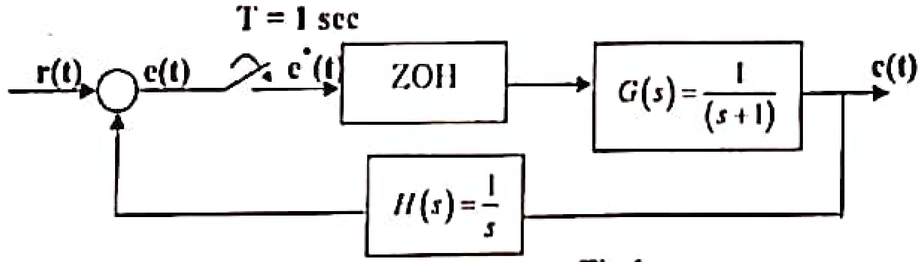

Fig.1

Prob. 4: Sketch the root-loci of the unity-feedback digital control system with the following open-loop z-transfer function. Obtain the range of K for stability.

$$G(z)=\frac{Kz}{(z-1)(z-0.5)} \qquad (7)$$

Prob. 5: It is desired to design a state feedback control for an n^{th} order discrete-time state space model $x(k+1)=Fx(k)+gu(k);\quad y(k)=cx(k)$, such that the system response after state feedback settles in n-steps. Write the design steps for such a state feedback control. Verify that the system after design will settle in n-steps.

(7) PTO

PART-B

Prob. 6: Consider discretization based on bilinear transformation mapping from s-plane to z-plane. What type of approximation it follows? How this mapping is different from exact mapping from s-plane to z-plane? Explain how this transformation is helpful in testing the stability of discrete time system represented by z-transfer function.

(8)

Prob. 7: For a sampled-data control system with dead time shown in Fig. 2, find C(z)/R(z). The sampling period is T = 1.5 s and dead time is $\tau_D = 3.5$ sec.

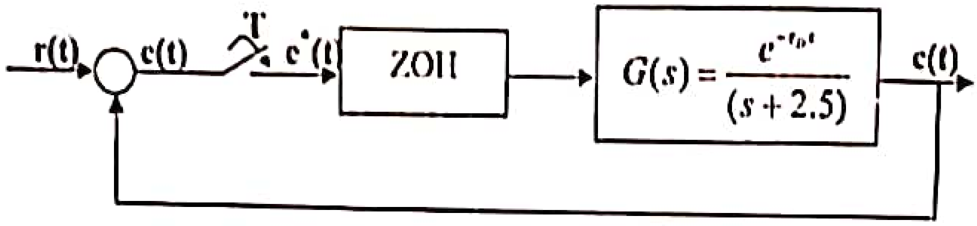

Fig. 2 **(8)**

Prob. 8: A closed-loop digital control system is shown in Fig. 3. A digital PD controller is implemented for speeding up the response time of the system having following differential equation, $e_2(t) = 10e_1(t) + 2\frac{de_1(t)}{dt}$. The PD controller is discretized using backward difference approximation for differentiation.

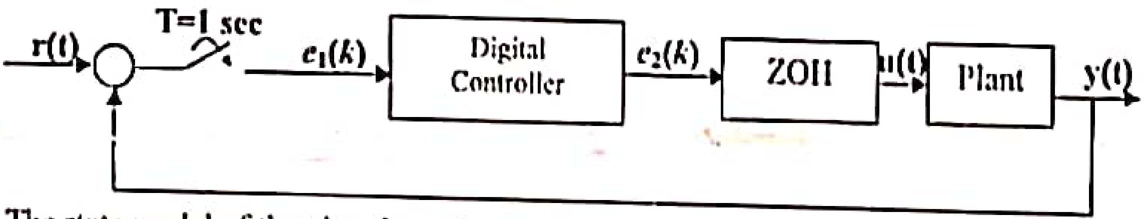

Fig. 3

The state model of the plant is as given below.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

(8)

Obtain the discrete-time state model for the closed loop system.

Prob. 9: Consider the system $x(k+1) = Fx(k+1) + gu(k)$; $y(k) = cx(k)$, where

$$F = \begin{bmatrix} 0.16 & 2.16 \\ -0.16 & -1.16 \end{bmatrix} \quad g = \begin{bmatrix} -1 \\ 1 \end{bmatrix} \quad c = \begin{bmatrix} 1 & 1 \end{bmatrix}$$

(8)

(i) Design a state feedback control which places the closed loop poles at 0.6 ±j0.4.

(ii) Design a full order observer for dead beat performance.

(iii)Obtain the combined state space model.

Prob. 10: For a general continuous-time nonlinear system explain the concept of Lyapunov stability criteria. As a special for continuous time linear system how the Lyapunov stability criteria simplifies. Why the stability need to be tested about an equilibrium point? What is the difference between equilibrium point for linear and nonlinear systems?

(8)