

Advanced Digital Control
(AEIE 6152)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following:

10 x 1=10

(i) The transfer function of a zero order hold circuit is

- (a) $\frac{1-e^{-Ts}}{s}$ (b) $\frac{1+e^{-Ts}}{s}$ (c) $\frac{1-e^{Ts}}{s}$ (d) $\frac{1+e^{Ts}}{s}$

(ii) The type no. of a system is obtained from

- (a) open loop transfer function (b) closed loop transfer function
(c) both open and closed loop transfer functions (d) none of these.

(iii) For a stable discrete-time control system,

- (a) all poles should lie inside the circle of unity radius.
(b) all poles should lie outside the circle of unity radius.
(c) all zeros should lie inside the circle of unity radius.
(d) all poles and zeros should lie inside the circle of unity radius.

(iv) Jury's stability test is carried out to assess the _____ stability

- (a) absolute (b) relative
(c) marginal (d) both absolute and relative.

(v) Pulse Transfer function of the control system depends on

- (a) system parameters alone
(b) nature of input
(c) nature of output
(d) initial conditions of input and output.

(vi) The transfer function of a system given by $T(s) = \frac{20}{s^2 + 20s + 100}$. The system is

- (a) critically damped (b) under damped
(c) over damped (d) cannot be evaluated.

(vii) The open loop transfer function of a system is defined by $L(z) = \frac{0.3935 K_z}{(z-1)(z-0.6065)}$. The number of loci will be
 (a) 1 (b) 2 (c) 3 (d) not valid locus.

(viii) The z-transform of an unity ramp function is
 (a) $\frac{Tz}{(z-1)^2}$ (b) $\frac{T}{(z-1)^2}$ (c) $\frac{Tz}{(z-1)}$ (d) $\frac{Tz}{(1-z^{-1})^2}$.

(ix) The pair (A,B) is controllable if and only if the pair.
 (a) (A^T, B^T) is observable (b) $(A^T B^T)$ is controllable
 (c) $C^T A^T$ is observable (d) $C^T A^T$ is controllable.

(x) In cascade control system, response of the inner loop should be relatively ____
 (a) faster than the outer loop (b) slower than the outer loop
 (c) same as than the outer loop (d) independent .

Group - B

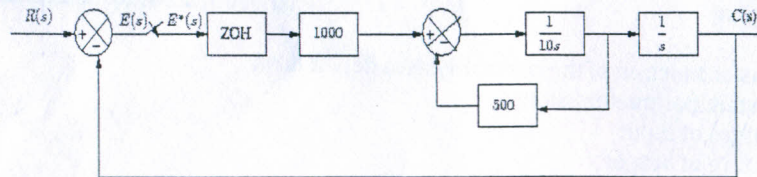
2.(a) Draw the basic digital control scheme and explain each of the components.

(b) Obtain the Z transform of $x(t) = \frac{1}{a}(1 - e^{-at})$, where a is constant. Determine the initial value of x(k) for $x(z) = \frac{z^{-1}}{(1-z^{-1})(1-2z^{-1})}$.

6 + (4 + 2) = 12

3.(a) Compute the discrete equivalent of $H(s) = \frac{1}{s(s+1)}$ using zero order hold equivalent.

(b) A system is shown in Fig. shown below:



Find Steady state error when input to the system is unit step.

6 + 6 = 12

Group - C

4. Design a digital controller with dead beat response assuming i) process transfer function

$G_p(z) = \frac{(z+0.6)}{(3z^2 - z - 1)}$ and ii) the overall system has a pole at origin only.

12

5.(a) What do you mean by IMC strategy? Explain with a block diagram. Show how and under which conditions this strategy helps to track the set point and reject disturbance effects.

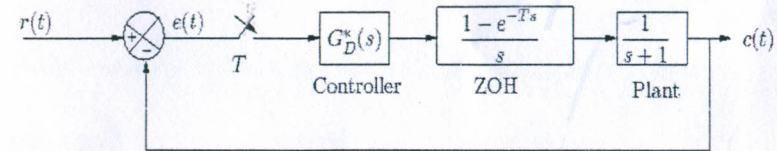
(b) What is the effect of dead time over the stability of a system?

(2 + 2 + 6) + (2) = 12

Group - D

6.(a) A discrete time control system is shown in the figure below. Using the rules for constructing root locus find (Assume $G_D(z) = \frac{Kz}{(z-1)}$)

- i) Angles of asymptotes
- ii) Break away and break in points (if any)
- iii) Angle of departure of the locus.



(b) What is the effect of K on root locus?

10 + 2 = 12

7. (a) The characteristic equation of a discrete time control system is given by $P(z) = z^4 - 1.2z^3 - 0.07z^2 + 0.3z - 0.08 = 0$. Using Jury's stability tests determine the stability of the system.

(b) What is ringing of a digital controller? What are its effects on the system? How can it be minimized?

6 + (2 + 2 + 2) = 12

Group - E

8.(a) What are the different types of adaptive control system? Mention the selection criteria of the different adaptive control systems.

(b) Explain with a neat structure the operation of a Self tuning Adaptive Control.

(2 + 2) + (3 + 5) = 12

9.(a) What is cascade control system? Under which process condition cascade control is adopted?

(b) Draw the block diagram of a cascaded control system and evaluate the transfer function.

(2 + 2) + (3 + 5) = 12