BE – VIII / Digital Control System / 18.12.15

DCS (ZN3T)

**QP Code : 2770**

**(3 Hours)** **[Total Marks : 100**

N.B.

1. Q.1 is compulsory. Attempt any four from the remaining questions.
2. All questions carry equal marks.
3. Figures to the Right indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt any four — 20

a. Derive the Lyapunov equation for a system $x(k+1) = Gx(k)$.

b. State sampling theorem. Explain folding and aliasing in brief.

c. Specify the region in $z$-plane that corresponds to the shaded region in $s$-plane as shown in Fig. 1.

d. Explain digital control system with neat block diagram.

e. Explain sampler as an impulse modulator.

f Explain operation of extrapolative and interpolative FOH.

Q.2 A. Define pulse transfer function. Obtain C(z)/ R(z) for the system shown in Fig.2. — 10

B. Determine the stability of the system having characteristic equation — 10

$$P(z) = z^3 - 2.661z^2 + 2.508z - 0.8187 = 0$$

using Jury's Stability criterion.

Q.3 A. Derive the transfer function for the ZOH. — 10

B. Prove using similarity transformation that state space representation is not unique. Also prove the invariance of eigenvalues under the similarity transformation. — 10

Q.4 A. Obtain the pulse transfer function for the digital control system described by — 10

$$x(k+1) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -0.05 & 0.07 & 0.6 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x(k)$$

B. Represent the following system into the controllable canonical form. — 10

$$G(z) = \frac{0.5z - 0.25}{z^3 - 0.4z^2 - 0.39z + 0.126}$$

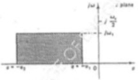


Fig. 1

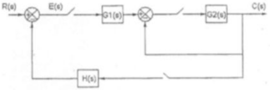


Fig. 2

[TURNOVER

**QP-Con. 11904-15.**

Q.5 A. Obtain the steady state error constants for a digital control system for step, ramp and parabolic inputs. 10

B. Obtain the solution to the system of equation $x(k+1) = \begin{bmatrix} 0 & 1 \\ -0.15 & 0.8 \end{bmatrix} x(k)$. Assume initial condition $x(0) = (1,\ 0)'$ and sampling time $0.5 sec$. 10

Q.6 A. Design the deadbeat observer for the following system. 10

$$\Phi(k+1) = \begin{bmatrix} 0 & 1 \\ 1 & 2 \end{bmatrix} \Phi(k),\ \ y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \Phi(k)$$

B. Write the steps for controller design via pole placement using ackermann's method 10

Q.7 A. Explain Lyapunov stability theorems for a digital control system. 10

B. Determine the stability of the system using Lyapunov equation. 10

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -0.72 & 1.8 \end{bmatrix} x(k)$$

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