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EEE011

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 121655

Roll No. | | | | | | | | | | |

B. Tech.

(SEM. VI) THEORY EXAMINATION, 2014-15

DIGITAL CONTROL SYSTEM

Time : **3** Hours] [Total Marks : **100**

Note : Attempt all questions.

1 Attempt any four parts of the following : 5×4=20

(a) Draw the basic digital control system and explain the function of each block. Also discuss the sampling effects.

(b) Define an ideal sampler. Also explain the relationship between Z-transform and Laplace transform.

(c) Predict the nature of the transient response of a discrete-time system whose characteristic equation is given by

$$Z^2 - 1.9Z + 0.9307 = 0$$

The sampling interval T = 0.02 sec.

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(d) Obtain the companion first form realizations for the transfer function

$$\frac{Y(z)}{R(z)} = \frac{4z^3 - 12z^2 + 13z - 7}{(z-1)^2(z-2)}$$

(e) Explain the suitable method for the stability of a discrete time system. Also explain the bilinear transformation.

(f) What do you understand by performance measure ? Explain in view of optimal control problems.

2 Attempt any two parts of the following : 10×2=20

(a) (i) If $Z[f(t)] = F(z)$, then prove that

$$Z[f(t+T)] = Z[F(z) - f(0)] \text{ where}$$

$$F(0) = f(0)$$

(ii) Find $z^{-1}\left[\frac{z}{3z^2 - 4z + 1}\right]$

(b) (i) Determine the pulse transfer function of ther system shown in Fig.1

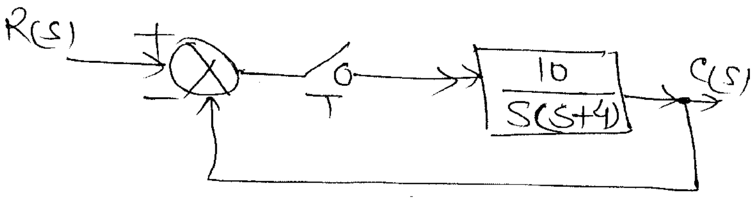

Fig. 1

(ii) Solve the following difference equation :

$$y(k+2)+3y(k+1)+2y(k)=0$$

$$y(-1)=-\frac{1}{2}, y(-2)=\frac{3}{4}$$

(c) Consider the difference equation

$$y(k+2)+a_1y(k+1)+a_2y(k)=b_0r(k+2)$$

$$+b_1r(k+1)+b_2r(k)$$

Assuming that the system is initially at rest, and r(k) = 0 for k < 0, obtain the transfer function $G(z)=\frac{Y(z)}{R(z)}$.

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3 Attempt any two parts of the following : 10×2=20

(a) Discuss the transient and frequency domain specification that describe the performance of feedback control system in Z-plane.

(b) A sampled data feedback control system is shown in fig. 2. The controlled process of the system is described by the transfer function

$$G(s) = \frac{k}{s(s+1)};\ 0 \le k < \infty$$

The sampling time period T = 1 sec.

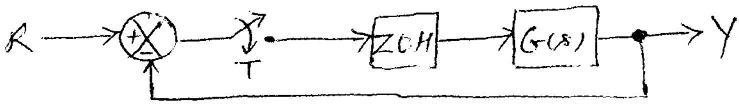

Fig. 2

Sketch the root locus plot for the system on the Z-plane and from there obtain the value of 'k' that results in marginal stability.

(c) Investigate the controllability and observability of the following system :

$$X(k+1) = \begin{bmatrix} 1 & -2 \\ 1 & -1 \end{bmatrix} X(k) + \begin{bmatrix} 1 & -1 \\ 0 & 0 \end{bmatrix} u(k)$$

$$Y(k) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} X(k)$$

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4 Attempt any two parts of the following : 10×2=20

(a) Explain various methods available to investigate the controllability and observability.

(b) A discrete - time regulator system has the plant

$$X(k+1)=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -4 & -2 & -1\end{bmatrix}X(k)+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u(k)$$

Design a state feedback controller which will place the closed loop poles at $-\frac{1}{2}\pm j\frac{1}{2},0$. Also give a block diagram of the control configuration.

(c) State and explain Lyapunov stability criterion in brief. For the system

$$X_1(k+1)=2X_1(k)+0.5X_2(k)-5$$
$$X_2(k+1)=0.8\,X_2(k)+2$$

Investigate the stability of the equilibrium state. Use the direct method of Lyapunov.

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5 Attempt any two parts of the following : 10×2=20

(a) Using the Lyapunov's direct method, find the stability range for the gain 'K' of the system shown in Fig.3

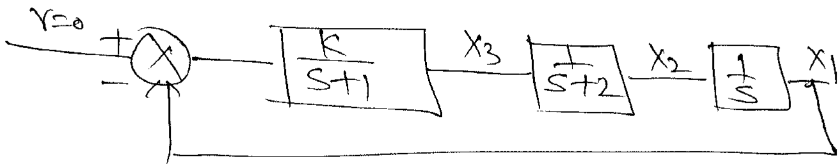

Fig. 3

(b) Determine the optimal control law for the system

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} X .$$

Such that the following performance index is minimized.

$$J = \int_0^{\infty} \left(y_1^2 + y_2^2 + u^2 \right) dt$$

(c) Write short notes on any two of the following :

(i) Principle of optimality

(ii) Infinite regulator problem

(iii) Compensator design.