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Name.........................

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SIXTH SEMESTER B.Tech. (ENGINEERING) DEGREE EXAMINATION JUNE 2007

EE 04 603—CONTROL SYSTEMS—I

(2004 admissions)

Time : Three Hours

Maximum : 100 Marks

I. (a) Define the terms "State Variable" and "State space".

(b) What is meant by Zero Input Response of a system ?

(c) State Shanon's sampling theorem.

(d) Obtain the mapping of the s-plane to the Z-plane.

(e) Sketch the polar plot of the transfer function $G(s) = \dfrac{10}{(1-s)}$.

(f) What is meant by gain margin of a system ?

(g) What is meant by cascade compensation in control systems ?

(h) Discuss the effect of PD compensators in the transient response of a second order system.

(8 × 5 = 40 marks)

II. (a) (i) Enumerate the advantages of State-space model over the Transfer Function model.

(ii) Derive the state variable representation of a field controlled d.c. servo motor driving a load with a moment of inertia J_L and friction constant B_L. Take the output position and its derivatives as the state variables.

Or

(b) (i) A system is characterised the state equation :

$$\dot{X} = Ax + Bu \text{ and}$$
$$y = Cx + Du$$

where u is the input and Y is the output and the elements of A, B, C and D matrices are constants.

(ii) Obtain the unit step response of the system described by the state equation

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

$$y = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

given $x_1(0) = x_2(0) = 0$.

(15 marks)

Turn over

III. (a) (i) Find the inverse Z-transform of :

$$F(z) = \frac{1}{(z+1)(z+2)}.$$

(ii) Obtain the solution of the difference equation :

$c(k+2) + 3c(k+1) + 2c(k) = U(t).$

with $c(o) = 1$ and $c(k) = 0$ for $k < 0$.

$U(t)$ is unit step function.

Or

(b) (i) Explain the Jury's test for stability.

(ii) Investigate the stability of a discrete time system having the characteristic equation

$F(z) = z^4 - 1.368z^3 + 0.4z^2 + 0.8z + 0.002 = 0.$

(15 marks)

IV. (a) A unity feedback control system has the forward path transfer function

$$G(s) = \frac{K(s+1)}{s(s+2)(s+3)}.$$

Sketch the root loci for the system and determine the value of K for a damping ratio of 0.866.

Or

(b) The forward path transfer function of a unity feedback control system is given by

$$G(s) = \frac{K}{S(s+1)(s+2)}.$$

Sketch the Nyquist plot and determine the maximum value of k beyond which the system becomes unstable.

(15 marks)

V. (a) The open loop transfer function of a unity feedback control system is given by,

$$G(s) = \frac{K}{S(s+1)(s+5)}.$$

Design a phase lead compensator to satisfy the specification (i) velocity error constant, $K_v \geq 50$; (ii) Phase Margin $\geq 20°$.

Or

(b) Discuss the various design methods adopted for discrete data systems using frequency response methods.

(15 marks)

(4 × 15 = 60 marks)