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Name : ....

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Invigilator's Signature : ....

CS/M.TECH (EDPS)/SEM-1/EDPM-102/2011-12

2011

ADVANCED CONTROL SYSTEMS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

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

Answer any *five* of the following questions.

1. a) How a system transfer function can be realized in controllable canonical form ? 8

   b) Obtain the state-space representation using controllable canonical form of the transfer function :

$$G(S) = \frac{2S + 9}{S^3 + 8S^2 + 12S + 10} \qquad 6$$

2. a) How do you determine the feedback gain matrix K using Transformation Matrix T ? 6

   b) Determine the state feedback gain matrix so that the closed loop poles of the following system are located at $(-2 + j4)$, $(-2 - j4)$, -10.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} K$$

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3. A linear time invariant system is characterized by the state equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

where u is a unit step function. Calculate the solution assuming initial condition

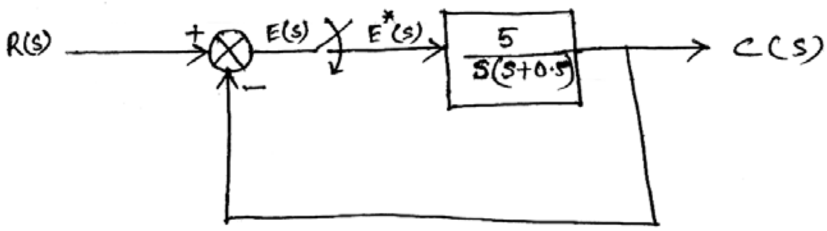
$X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$ 14

4. a) Show that the variation of dependent variable 'Z' in the Z-plane as the independent variable 'ω' varied along the imaginary axis in S-plane is given by a circle of unit radius at the origin of Z-plane, where

$Z = e^{\pm j\omega t}$ 8

b) Determine the pulse transfer function of the sampled data control system as shown below.

Sampling time, $T = 0{\cdot}5$ sec.



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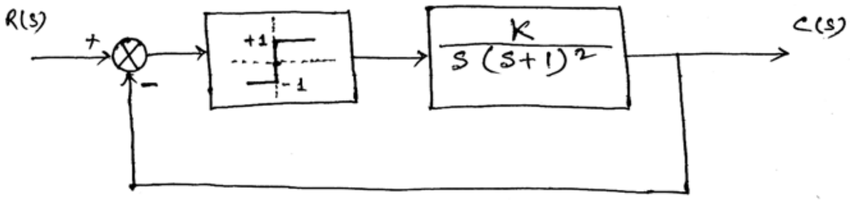
5. a) Determine the describing function of an ideal relay. 6

b) Using describing function analysis, determine the amplitude and frequency of the limit cycle when k = 4



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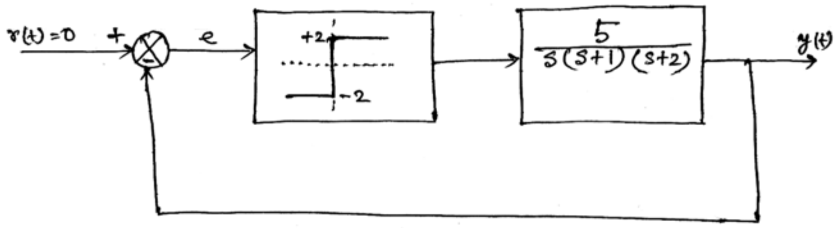
6. a) Define phase plane, phase trajectory and phase portrait. 3

b) Plot the phase trajectory of the system shown with initial condition $e\,(o) = 2$ and $\dot{e}\,(o) = 0$



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7. a) State Lyapunov's direct method for stability analysis. What are the conditions of Lyapunov's stability criterion ? 3 + 3

b) A linear system is described by the state equation

$$X = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x$$

Investigate the stability of this system by Lyapunov's theorem. 8