Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH(ME)/SEM-2/ME-204/2013

2013

ADVANCED CONTROL SYSTEM

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* questions. 5 × 14 = 70

1. a) State and prove the final value theorem of *z*-transform. 5

b) Obtain the *z*-transform of $\frac{1}{s^2(s+2)}$. 4

c) Find the inverse *z*-transform of $\frac{z}{(z-1)^3}$. 5

2. a) Obtain the transfer function of zero order hold and discuss its frequency response characteristics. 8

b) Solve the difference equation

$$x(k+2)-1\cdot 3x(k+1)+0\cdot 4x(k)=u(k)$$

using *z*-transform when $x(k)$ and $u(k)$ are given by

$$x(k)\begin{cases}=0 \text{ for } k=0,1\\ =0 \text{ for } k<0\end{cases} \text{ and}$$

$$u(k)\begin{cases}=1 \text{ for } k=0,1,2,3,\ldots \text{etc.}\\ =0 \text{ for } k<0\end{cases}$$ 6

3. In the following figure, the controller $G_D(z)$ is designed for the system to have a pair of dominant closed loop poles. Find the damping ratio, settling time and static velocity error of the system.

Where, $G_D(z)=12\cdot 67\left(\dfrac{z-0\cdot 6703}{z-0\cdot 2543}\right)$

and $G_P(s)=\dfrac{1}{s(s+2)}$.

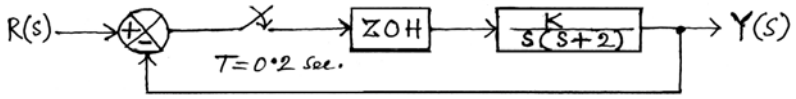
4. a) Explain the mapping between *s*-plane and *z*-plane. 7

b) Discuss about controllability and observability of the system

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

$$y(k)=\begin{bmatrix}1 & 0\end{bmatrix}\underline{x}(k)$$ 7

5. a) Find the range of values of *K* for which the system given below is stable.



7

b) Given a system

$$\underline{x}(k+1)=\begin{bmatrix}0 & 1\\ -0\cdot16 & -1\end{bmatrix}\underline{x}(k)+\begin{bmatrix}0\\ 1\end{bmatrix}u(k)$$

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

$$u(k)=r(k)-\begin{bmatrix}k_1 & k_2\end{bmatrix}\underline{x}(k)$$

Find the state feedback gain matrix $[k_1\ k_2]$ so that the closed loop poles of the system are placed at $0\cdot5(1\pm j)$.

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6. a) Obtain the zero-stable response of a system.

$$\dot{\underline{x}}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \underline{x}(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

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

where $u(t)$ is a unit step function occurring at $t = 0$. 8

b) Find the pulse-transfer function matrix for a linear time invariant system and show that it is invariant under similarity transformation. 6

7. a) Obtain pulse transfer function of PID controller in positional form. 8

b) Calculate the describing function for an ideal relay. 6

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