Registration no:

Total Number of Pages : 02 **B.Tech**

PEEC5414

7th Semester Regular/Back Examination 2017-18
Advanced Control Systems
BRANCH : EEE, ELECTRICAL
Time: 3 Hours
Max Marks: 70
Q.CODE: B369
Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** **(2 x 10)**

a) Define time delay &time advance theorem of Z-transform.

b) Find the Z-transform of unit step function that is advanced by one sampling period T.

c) Explain how a point in the Z-plane corresponds to an infinite no of points in the S-plane.

d) With diagram,explain aliasing in sampling process.

e) State Kalman's& Gilbert's test for Controllability.

f) Explain the duality property between Observability & Controllability.

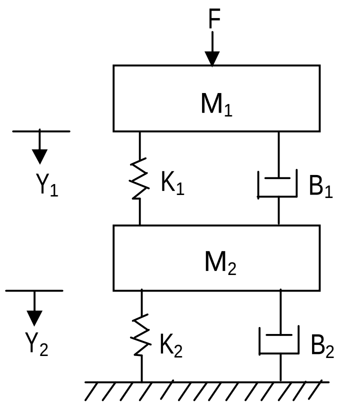
g) Find A^{10} using Cayley-Hamilton theorem, where A=$\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

h) What do you understand by jump resonance? Explain.

i) Explain Liapunov's direct method for stability analysis.

j) Explain various types of equilibrium points encountered in non-linear systems and draw approximately the phase plane trajectories.

Q2 **a)** Construct the state model of the mechanical system shown in Figure below. **(5)**



b) Design a state feed back controller so that eigen values of closed loop systems are at $-2, -1 \pm j1$.The system transfer function is **(5)**

$$\frac{C(s)}{R(s)} = \frac{10}{S^3 + 3S^2 + 2S}$$

Q3 **a)** Determine the state & output controllability of the given system **(5)**

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u \quad , \qquad Y = \begin{bmatrix} 1 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b) Given, A=$\begin{bmatrix} -1 & 1 & 0 \\ 0 & -4 & 2 \\ 0 & 0 & -10 \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}$, $C = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$ **(5)**

Determine the Similarity transformation matrix T to transform the system

$$\dot{X} = AX + Bu \ \ \& \ output \ \ Y = CX$$

to the controllable canonical form

Q4 **a)** Obtain the STM for the following discrete-time system **(5)**

X(k+1)=AX(k)+Bu(k)

Y(k)=CX(k)

Where $A = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $C = [1 \quad 0]$

Obtain the state X(k) & output Y(k), when the input u(k)=1,for k=0,1,2,...

The initial state is given by X(0)=$\begin{bmatrix} 1 \\ -1 \end{bmatrix}$

b) Using inversion integral method,obtain the inverse Z.T of **(5)**

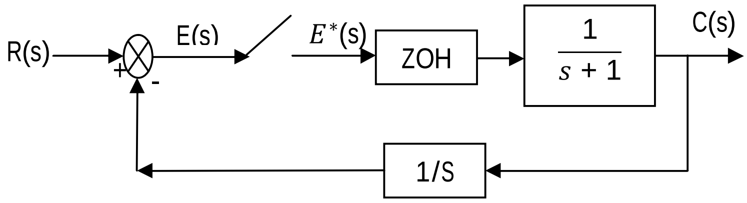
$$X(z) = \frac{z(z+2)}{(z-1)^2}$$

Q5 **a)** Find the stability of discrete system having characteristic equation: **(5)**

$$P(z) = z^4 - 0.6z^3 - 0.81z^2 + 0.67z - 0.12$$

Form Jury table and use Jury's stability criterion.

b) For the sampled-data control system shown in Figure below , find the pulse transfer function. Find the output c(k) for unit step input.Sampling time T=1 sec . **(5)**



Q6 **a)** Consider the autonomous system with **(5)**

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

Using direct method of Lyapunov, determine the stability of the system.

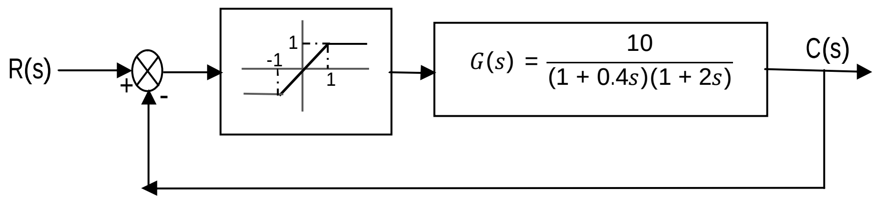
b) A second order non linear system is described by **(5)**

$\ddot{x}$+25(1+0.1 x^2)x = 0

Using delta method obtain the first five pointsin the phase plane for initial condition

X(0)==1.8 $\dot{x}$(0)=-1.6

Q7 **a)** Determine the stability of the system shown below. **(5)**



b) Derive the describing function for Dead-zone & saturation non-linearity. **(5)**

Q8 **Write short answer on any TWO:** **(5 x 2)**

a) Stable and unstable limit cycle

b) Explain the design of state observer

c) Z domain and s domain relationship

d) Lyaponov's stability criterion