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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

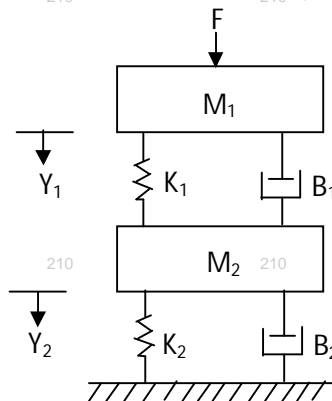
Q.CODE: B369

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1¹⁰ Answer the following questions: (2 x 10)

- Define time delay & time advance theorem of Z-transform.
- Find the Z-transform of unit step function that is advanced by one sampling period T.
- Explain how a point in the Z-plane corresponds to an infinite no of points in the S-plane.
- With diagram, explain aliasing in sampling process.
- State Kalman's & Gilbert's test for Controllability.
- Explain the duality property between Observability & Controllability.
- Find A^{10} using Cayley-Hamilton theorem, where $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$
- What do you understand by jump resonance? Explain.
- Explain Liapunov's direct method for stability analysis.
- 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)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u, \quad Y = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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

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

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)**

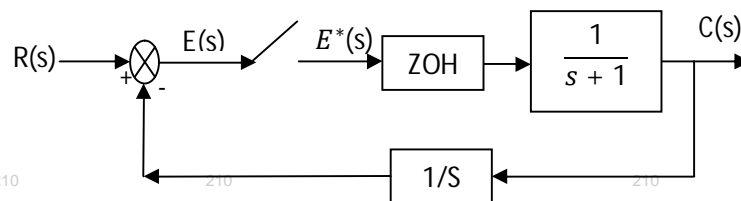
$$X(z) = \frac{z(z+2)}{(z-1)^2}$$

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.

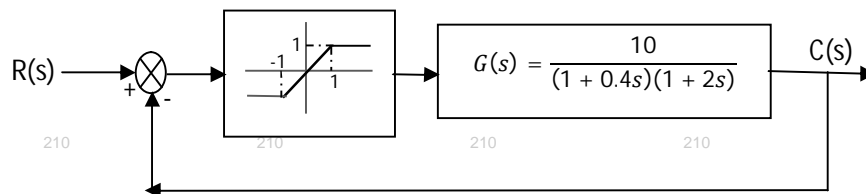
b) A second order non linear system is described by **(5)**

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

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

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

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) Lyapunov's stability criterion