QP Code : 597700

(3 Hours) **[Total Marks : 80**

N.B. : (1) Question No. **1** is compulsory
(2) Attempt **any three** questions out of remaining **five** questions.
(3) Assume suitable data if necessary.

1. Attempt the following :- **20**

(a) Construct state model for the following differential equation.

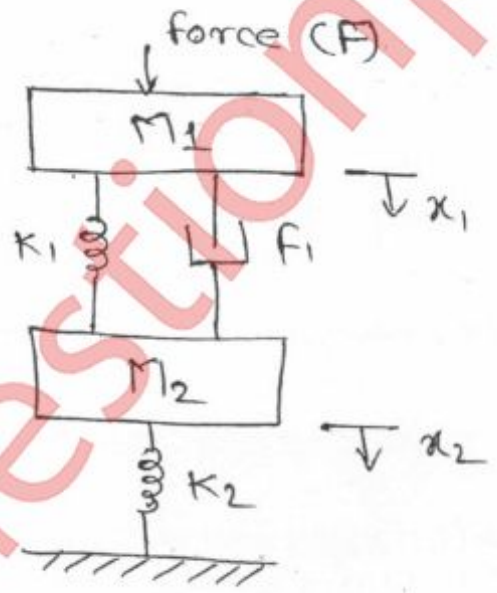
$$\frac{d^3y}{dt^3}+3\frac{d^2y}{dt^2}+2\frac{dy}{dt}=\frac{du}{dt}+u$$

(b) Differentiate between lead, lag and lag-lead compensator.

(c) What are the limitations of transfer function. How those can be overcome by state variable analysis.

(d) Explain the need of compensator.

2. (a) Construct state model of the given mechanical system. **10**



(b) Given the system. **10**

$$\dot{x}=\begin{bmatrix}-4 & 3\\ -6 & 5\end{bmatrix}x$$

Determine eigen values and eigen vector of matrix A. Also find state transition matrix using cayley Hamilton method.

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3. (a) Design lag-lead compensator using root locus technique. **10**

   (b) A unity feedback system with an open loop transfer function **10**

$$G(s)=\frac{k}{s(s+1)}$$

Design a suitable compensator to meet the following specifications.
Velocity error constant (K_v)=12/sec phase Margin (ϕ_m)=40°

4. (a) Explain Ziegler Nicholos tunning rules for tuning of PID controller. **10**

   (b) Find $f(A) = e^{At}$ for ,

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

5. (a) Obtain the M matrix and Diagonal Matrix, **10**

Where, $A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 8 & -12 & 6\end{bmatrix}$

   (b) Explain design procedure of lead compensator using Bode Plot. **10**

6. (a) For a regulator system the plant is given by $\dot{x}=Ax+BU$. **10**

Where $A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -1 & -5 & -6\end{bmatrix}$ $B=\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}$

The system uses state feedback control u = - Kx. Desired closed loop poles are at S= - 2 ± j4, -10.
Determine state feedback gain matrix K.

   (b) A unity feedbac type-2 system with $G(s)=\frac{K}{s^2}$. It is desired to compensate the system so as to meet the following transient response specifications **10**

$Ts \leq 4$ sec

$\%Mp \leq 20\%$
