Code No: R2022044 **R20** **SET - 1**

II B. Tech II Semester Regular Examinations, June/July - 2022

LINEAR CONTROL SYSTEMS

(Common to ECE&EIE)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit

All Questions carry **Equal** Marks

~~~~~~~~~~~~~~~~~~~~~~~~~

UNIT-I

1 a) Define control system, open loop and closed loop control systems. Compare their merits and demerits. [7M]

b) Derive the transfer function of Translational Mechanical System. [7M]

Or

2 a) Define transfer function. Explain its advantages and limitations. [7M]

b) Design the force voltage analogy & force- current analogy circuit and develop the transfer function of the mechanical system shown in figure 1? [7M]

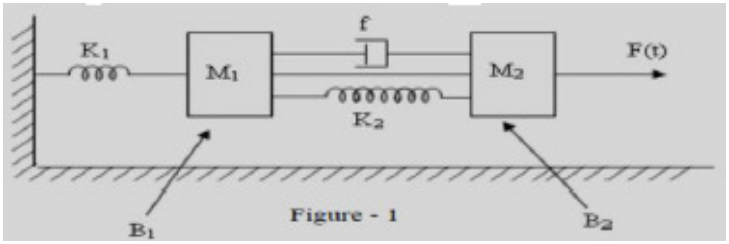
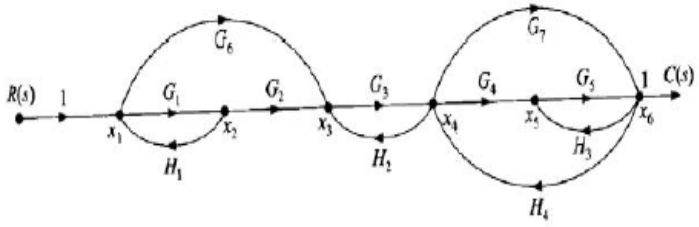


Figure - 1

UNIT-II

3 a) Derive the transfer function and develop the block diagram of Armature controlled DC servo motor. [7M]

b) Apply Mason's gain formula to find the transfer function of the system shown below? [7M]



Or

4 a) Obtain the time response of a first order system for a unit step input and plot its response. [7M]

b) Damping factor and natural frequency of the system are 0.12 and 84.2 rad/sec respectively. Determine the rise time (t_r), peak time (t_p), maximum peak overshoot (m_p) and settling time (t_s). [7M]

|''|''|||''|'''|||'|
~~~~~~~~~~~~~~~~~~~~~~~~~

UNIT-III

5 a) Differentiate Qualitative Stability & Conditional Stability. [7M]

b) Explain the construction rules for root locus technique. [7M]

Or

6 a) Test the stability of the system with the following characteristic equation by Routh's test [7M]

$s^6 + 2s^5 + 8s^4 + 20s^2 + 16s + 16 = 0$

b) Define and derive the breakaway point on the root locus. [7M]

UNIT-IV

7 a) Explain the design rules of Bode Plot. [7M]

b) Explain about correlation between time & frequency response. [7M]

Or

8 a) Sketch the Bodeplot and determine the following. [7M]

(i) Gain cross over frequency ii) Phase cross over frequency

(iii) Gain Margin (iv) Phase margin

For the transfer function is given by

$$G(s) = \frac{10}{s(1 + 0.4s)(1 + 0.1s)}$$

b) State and explain the Nyquist stability criterion. [7M]

UNIT-V

9 a) Define the controllability and observability. [7M]

b) Determine the state controllability and observability of the system described by [7M]

$$[\dot{X}] = \begin{bmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} x + \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{bmatrix} u;\ y = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} x$$

Or

10 a) Explain the concepts of state, state variables and state model [7M]

b) Determine the state model of the system characterized by the differential equation [7M]

$(s^4 + 2s^2 + 8s^3 + 4s + 3)\ Y(s) = 10\ U(s)$

Code No:R2022044 **R20** **SET - 2**

II B. Tech II Semester Regular Examinations, June/July - 2022
LINEAR CONTROL SYSTEMS
(Common to ECE & EIE)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
~~~~~~~~~~~~~~~~~~~~~~~~~

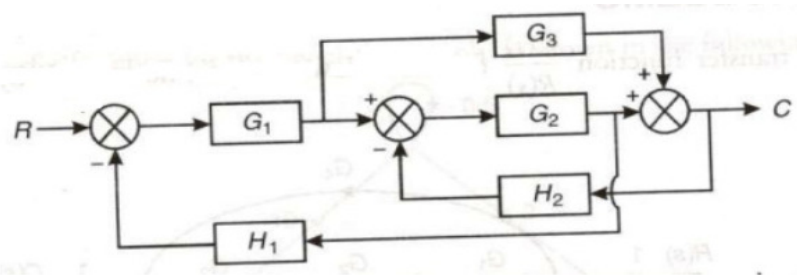
UNIT-I

1 a) Analyze in detail the effects of feedback on overall gain, sensitivity of the system. [7M]

b) Define control system, Explain traffic control system with suitable diagram. [7M]

Or

2 Determine the transfer function of the following block diagram. [14M]



UNIT-II

3 a) Discuss the response of a standard under damped second order system for unit step input. [7M]

b) Determine the step, ramp and parabolic error constants of the following unity feedback control system whose open loop transfer function is given by [7M]

$$G(s) = \frac{1000}{(1+2s)(1+0.5s)}$$

Or

4 a) Explain the field controlled DC servomotor and develop its transfer function. [7M]

b) Discuss the response of a standard first order system for unit step input. [7M]

UNIT-III

5 a) Define the following terms [7M]
i) absolute stability ii) marginal stabilityiii) conditional stability
iv) relative stabilityv) instability

b) Summarize the advantages and limitations of Routh-Hurwitz criterion? [7M]

Or

|''|''|||''|'''|||'|
~~~~~~~~~~~~~~~~~~~~~~~~~

6 a) Determine the stability of the closed loop system that has the following characteristic equation and also determine the number of roots that are in the right half s-plane and on the imaginary axis using Routh-Hurwitz criterion [7M]

$$s^4 + 4s^3 + 7s^2 + 16s + 12 = 0$$

b) The characteristics equation of feedback control system is $s^3 + 3Ks^2 + (K+2)s + 4 = 0$. Examine the range of K for which system is stable? [7M]

UNIT-IV

7 a) List out steps involved in the design of phase –lag controller. [7M]

b) Obtain a frequency response plot for this system when K>0 and K<∞. By using the Nyquist criterian, find the range of values for K over which the Unity feedback closed-loop systems will be stable? [7M]

Or

8 a) Explain about Polar Plot- how it is used for stability analysis. [7M]

b) Construct the polar plot of $G(s)H(s) = \frac{K}{s(s+3)(s+5)}$ and there from determine range of K for stability using Nyquist Criterion? [7M]

UNIT-V

9 a) What are the advantages and limitations of state space analysis over conventional methods? [7M]

b) Consider the following system with differential equation is given by [7M]
$\dddot{y} + 4\ddot{y} + 9\dot{y} + 4y + u = 0$.
Find the state space model in diagonal canonical form.

Or

10 A system is characterized by the following state space equations. [14M]

$$\begin{bmatrix}\dot{X}_1 \\ \dot{X}_2\end{bmatrix} = \begin{bmatrix}-3 & 1 \\ -2 & 0\end{bmatrix}\begin{bmatrix}X_1 \\ X_2\end{bmatrix} + \begin{bmatrix}0 \\ 1\end{bmatrix}u(t);\ y = \begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}X_1 \\ X_2\end{bmatrix}$$

(i) Find the transfer function of the system.
(ii) Determine the state transition matrix.
(iii) Solve the state equation for the unit step input under zero initial conditions.

Code No:R2022044 **R20** **SET - 3**

II B. Tech II Semester Regular Examinations, June/July - 2022

LINEAR CONTROL SYSTEMS

(Common to ECE & EIE)

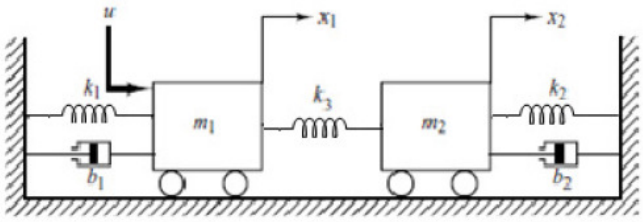
Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks

~~~~~~~~~~~~~~~~~~~~~~~~~

UNIT-I

1 a) Draw the free body diagram and write the differential equations describing the dynamics of the system shown in below figure and obtain the transfer function $X_1(s)/U(s)$? [7M]



b) Discuss about the Open Loop and closed loop control systems and their differences. [7M]

Or

2 a) Write and explain feedback characteristics with an example. [7M]

b) What is the classification of control systems? Discuss the importance of mathematical modeling of a control system. [7M]

UNIT-II

3 a) Explain theoperationand Derive the transfer function of field controlled DC Servo motor. [7M]

b) Explain about the signal flow-graph with an example. [7M]

Or

4 a) A unity feedback system has an open-loop transfer function $G(s) = \frac{K}{s(s+10)}$ Determine K so that the system will have a damping ratio 0.5. For this value of K, determine peak over shoot and time for peak over shoot for the unit step input? [7M]

b) Calculate the steady state errors due to a unit step input, a unit ramp input and a unit parabolic input for a unity feedback control system whose open loop transfer function is [7M]

(i) $G(s) = \frac{1}{s^2(s+6)}$ (ii) $G(s) = \frac{1}{s^2+3s+1}$

|''|''|||''|'''|||'|
~~~~~~~~~~~~~~~~~~~~~~~~~

Code No:R2022044 **R20** **SET - 3**

UNIT-III

5 Sketch the root locus of the system whose open loop transfer function is $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$ .Find the value of k for damping ratio of 0.5 [14M]

Or

6 a) For a unity feedback system with open loop transfer function $G(s)H(s) = \frac{K}{s(s+4)(s+6)}$. Find the range of K for which the system will be stable using RH – Criterion? [7M]

b) Using Routh-Hurwitz criterion, determine the stability of the closed loop system thathas the following characteristic equation and also determine the number of roots thatare in the right half s-plane and on the imaginary axis$P(s) = s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16$. [7M]

UNIT-IV

7 Consider a unity feedback system having an open loop transfer function $G(s) = \frac{K}{s(1+0.5s)(1+2s)}$sketch the Bode plot and determine the value of 'k' sothat gain margin is 20 dB and phase margin is 20^0? [14M]

Or

8 a) Find resonant peak, resonant frequency and bandwidth of the unity feedback system whose open loop transfer function is as follows: $G(s) = \frac{0.5}{s^2+3s+2}$ [7M]

b) The forward path transfer function of a unity feedback system is given by $(s) = \frac{K}{(s+3)^2}$ .Using Nyquist Stability Criterion; determine the range of K for the closed loop system to be stable? [7M]

UNIT-V

9 a) A system is characterized by the following state space equations. [7M]

$$\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix} = \begin{bmatrix}-3 & -1\\ -2 & 0\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u(t);\ y = [1 \quad 0]\begin{bmatrix}X_1\\ X_2\end{bmatrix}$$

(i) Find the transfer function of the system.
(ii) Compute the state transition matrix and the Eigen values of A.
(iii) Solve the state equation for the unit step input under zero initial conditions.

b) The transfer function of a control system is given by $\frac{Y(s)}{U(s)} = \frac{s+2}{s^3+9s^2+24s+24}$ check for controllabilityand observability. [7M]

Or

10 a) Draw the electrical circuit diagram that represents the Lead Compensator and explain in detail. [7M]

b) Draw the electrical circuit diagram that represents the Lag Compensator and explain in detail. [7M]

Code No:R2022044 **R20** **SET - 4**

II B. Tech II Semester Regular Examinations, June/July - 2022

LINEAR CONTROL SYSTEMS

(Common to ECE & EIE)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit

All Questions carry **Equal** Marks

~~~~~~~~~~~~~~~~~~~~~~~~~

UNIT-I

1 a) Explain the reduction of parameter variation by feedback. [7M]

b) Derive transfer function of Rotational Mechanical Systems. [7M]

Or

2 a) With a neat diagram, explain temperature control systems? [7M]

b) Define differential equation and derive differential equations of electrical circuits. [7M]

UNIT-II

3 a) Describe the AC servo motor and draw its torque Vs speed characteristics. [7M]

b) Derive steady state errors & error constants. [7M]

Or

4 a) Explain the construction and principle of operation synchro transmitter. [7M]

b) Explain the working of DC servo motor and find its transfer function. [7M]

UNIT-III

5 a) Explain the special cases in Routh's stability criterion. [7M]

b) Sketch the root locus for the characteristic equation is s (s+1) (s+2) + k (s + 1.5) = 0 [7M]

Or

6 a) Write and explain limitations of Routh's stability. [7M]

b) Define the following terms: (i) Stability (ii) Absolute Stability (iii) Marginal Stability (vi) Conditional Stability [7M]

UNIT-IV

7 a) Sketch the Bode plot and determine the Gain margin and phase margin for the transfer function is given, G(s) == 10/s(1+0.4s) (1+0.1s) [7M]

b) Derive the relation between phase margin and damping ratio. [7M]

Or

8 a) Discuss the calculation of gain crossover frequency and phase crossover frequency with respective to the polar plots. [7M]

b) Derive the correlation between time domain and frequency domain specifications. [7M]

UNIT-V

9 a) State and prove the properties of State Transition Matrix. [7M]

b) Explain the concepts of state, state model, state variable, state space. [7M]

Or

10 a) State and explain the concepts of Controllability and Observability. [7M]

b) Given, $G(s) = \frac{K}{s^2+5S+6}$ obtain the state space model of the system in the diagonal canonical form. [7M]

|''|''|||''|'''|||'|
~~~~~~~~~~~~~~~~~~~~~~~~~