Code No: R1622024 **R16** SET - 1

II B. Tech II Semester Regular/ Supplementary Examinations, April/May - 2019
CONTROL SYSTEMS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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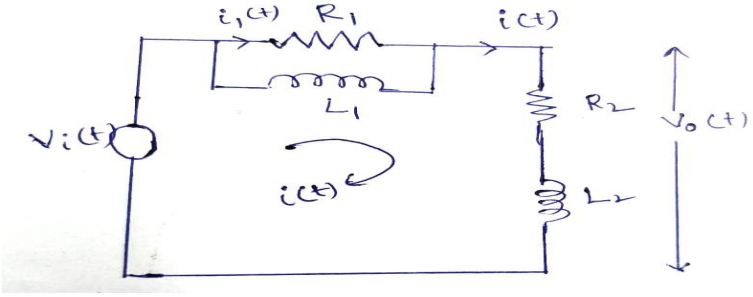
PART –A

1. a) Define electrical zero position of synchro transmitter. (2M)
   b) What are the various standard test signals? (2M)
   c) How to find the crossing points of imaginary axis in root locus? (3M)
   d) What is polar plot? (2M)
   e) What is compensation? What are the different types of compensators? (3M)
   f) Define concept of observability? (2M)

PART -B

2. a) Determine the transfer function of the electrical network shown below (7M)



   b) Compare different characteristics of A.C servo motor and D.C servo motor. (7M)

3. a) Derive expressions for peak time and setting time of second order system for unit step input. (7M)
   b) What are generalized error constants? State the advantages of generalized error coefficients. (7M)

4. The open loop transfer function of a unit feedback system is given by $G(S)=\frac{K}{S(S^2+4S+11)}$, sketch root locus of system. (14M)

5. a) Explain procedure of Bode plot and determination of gain margin and phase margin from Bode plot. (7M)
   b) Draw Bode plot for transfer function $G(S)=\frac{5(1+2S)}{(1+4S)(1+0.25S)}$. (7M)

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6. a) Procedure for design of lead compensator using Bode plot. (7M)

   b) Consider unit feedback system whose open loop transfer function is $G(S) = \frac{K}{S(S+3)(S+6)}$ design a lag-lead compensator to meet following specifications (7M)
   (i) velocity error constant, K_V =80
   (ii) Phase margin is $\geq 35^0$

7. a) What is state transition matrix? Write its properties. (7M)

   b) Consider the system descried by (7M)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -4 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

   Is this system controllable and observable?

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Code No: R1622024 **R16** SET - 2

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PART –A

1. a) What are the advantages of closed loop system? (2M)
   b) Why derivative controller is not used in control systems? (2M)
   c) What are the difficulties faced while applying R-H criteria? (2M)
   d) What are the advantages of frequency response analysis? (3M)
   e) What are the different types of compensators? (3M)
   f) Define state transition matrix? (2M)

PART -B

2. a) Explain about feedback characteristics? (7M)
   b) For mechanical translation system shown figure 2(b) below, obtain (7M)
      (i) Differential equation and
      (ii) Transfer function of system

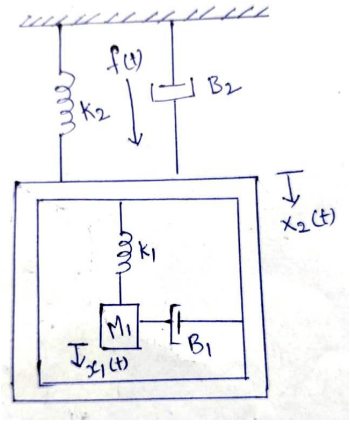

Figure. 2(b)

3. a) A control system with PD controller is shown figure 3(a), If the velocity error constant $K_r = 1000$ and damping ratio $\xi = 0.5$, find the values of K_p and K_D. (7M)

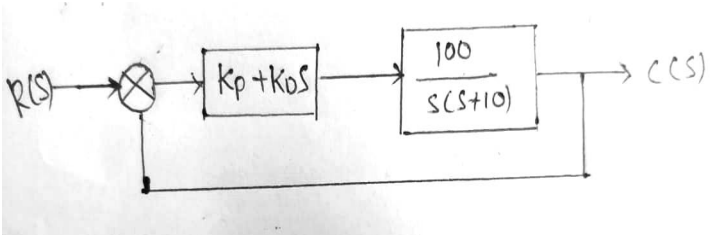

Figure. 3(a)

   b) Derive the response of under damped second order system for unit step input? (7M)

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4. a) The characteristic polynomial of a system is (7M)
$S^7+5S^6+9S^5+9S^4+4S^3+20S^2+36S+36=0$
Determine the location of roots on the S-plane and hence the stability of the system.
b) Explain the procedure for construction of root locus. (7M)

5. a) Define about frequency domain specifications. (7M)
b) The open loop transfer function of unit feedback system is given by $G(S)=\frac{(1+0.2S)(1+0.25S)}{S^3(1+0.005S)(1+0.001S)}$ sketch polar plot and determine phase margin. (7M)

6. a) Explain procedure for design of lag compensator using Bode plot. (7M)
b) Design a lead compensator for unit feedback system with open loop transfer function $G(S)=\frac{K}{S(S+1)(S+5)}$ to satisfy the following specifications (7M)
(i) Velocity error constant, $K_V \geq 50$
(ii) Phase margin is $\geq 20^0$

7. a) Determine the state representation of a continuous time linear time invariant system with system function $G(S)=\frac{3S+7}{(S+1)(S+2)(S+5)}$. (7M)
b) Find state transition matrix for a system described by, $\dot{X}(t)=Ax(t)+Bu(t)$, (7M)
where $A=\begin{bmatrix}2 & 0\\ -1 & -1\end{bmatrix}$ $B=\begin{bmatrix}1\\ 1\end{bmatrix}$.

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Code No: R1622024 **R16** SET - 3

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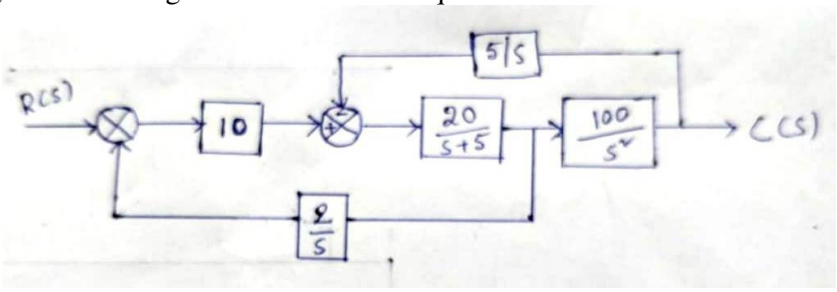
PART –A

1. a) What is the effect of positive feedback K on stability? (2M)
   b) List time domain specifications? (2M)
   c) Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system. (3M)
   d) What is Nyquist stability criterion? (2M)
   e) What is a lag compensation? (2M)
   f) Define (i) state variables (ii) state vector (iii) state space (3M)

PART -B

2. a) Derive an expression for the transfer function of an AC servo motor. (7M)
   b) For the block diagram of the system shown, determine the transfer function using the block diagram reduction technique (7M)



3. a) A unity feedback control system is characterized by the following open loop transfer function G(s)= $\frac{(0.4s+1)}{s(s+0.6)}$ determine its transient response for unit step input and sketch the response? (7M)
   b) For a system having $G(s)=\frac{25}{S(S+10)}$ and units negative feedback, find its time response specifications. (7M)

4. a) Determine range of K for stability of unit feedback system whose open loop transfer function is $G(S)=\frac{K}{S(S+1)(S+2)}$. (7M)
   b) Calculate the angle of asymptotes and the centroid for the system having $G(S)\ \ H(S)=\frac{K(S+3)}{S(S+2)(S+4)(S+5)}$ (7M)

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5. a) Sketch the Bode plot for a system $G(S)=\frac{15(S+5)}{S(S^2+16S+100)}$. Hence determine the stability of the system. (10M)
   b) Explain gain margin and phase margin. (4M)

6. a) The open loop transfer function of certain unity feedback control system is given by $G(S)=\frac{K}{S(S+4)(S+80)}$. If is desired to have phase margin 33^0 and the velocity error constant K_v=30 sec^{-1}. Design a phase lag series compensator. (7M)
   b) Explain procedure for design of lag-lead compensator using Bode plot. (7M)

7. a) What is diagonalization? Investigate the controllabity of the following (7M)
   $\dot{x}(t)=\begin{bmatrix}1 & 0\\ 0 & 2t\end{bmatrix}\mathrm{x(t)}+\begin{bmatrix}0\\ 1\end{bmatrix}\mathrm{u(t)}$.
   b) State equation of a control system is given by. (7M)
   $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -6 & 5\end{bmatrix}\begin{bmatrix}\mathrm{x}_1\\ \mathrm{x}_2\end{bmatrix}$
   Obtain the state transition matrix.

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Code No: R1622024 **R16** SET - 4

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2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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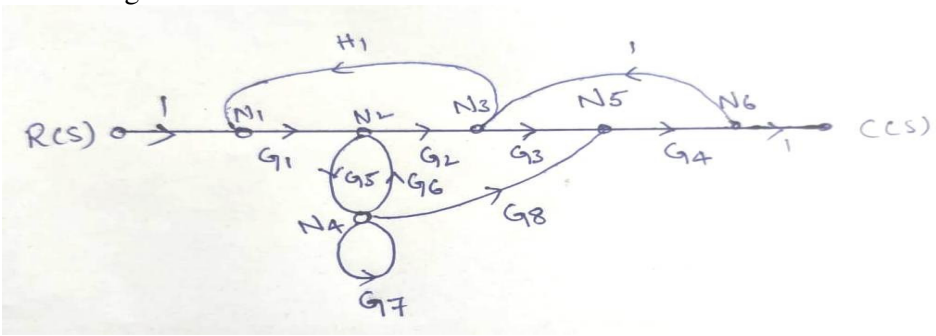
PART –A

1. a) Enumerate advantages and disadvantages of open loop control system. (2M)
   b) What are the types of static error constants? (2M)
   c) How will you find root locus on real axis? (3M)
   d) What are the advantages of Bode Plot? (2M)
   e) What is lead compensation? Draw pole zero diagram of lead compensator. (3M)
   f) Explain the concept of controllability. (2M)

PART -B

2. a) Explain about the synchro error detector with neat sketch. (7M)
   b) The signal flow graph for a system is shown; obtain the transfer function using Manson's gain formula. (7M)



3. a) Explain effect of PI controller on a unity feedback control system with a forward gain of G(s)? (7M)
   b) Derive the expression for % Mp of a second order system subjected to unit step input. (7M)

4. a) Determine the breakaway points of the systems which have the open loop transfer function $G(S)\ H(S) = \frac{K(S+4)}{(S^2+2S+4)}$ (7M)
   b) The characteristic polynomial of a system is (7M)
   $S^7 + 4S^6 + 9S^5 + 7S^4 + 4S^3 + 20S^2 + 32S + 36 = 0$,
   Determine the location of roots on the S-plane and hence the stability of the system.

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5. a) Explain how polar plots are useful in finding the stability of a system. (7M)

   b) Construct Nyquist plot for a feedback control system whose open loop transfer function is given by $G(S)H(S)=\frac{S}{S(1-S)}$, comment on stability of open loop and closed loop system. (7M)

6. a) Explain procedure for design of lag-lead compensator using Bode plot. (7M)

   b) Design a lead compensator for unit feedback system with open loop transfer function $G(S)=\frac{K}{S(S+1)(S+5)}$ to satisfy the following specifications (7M)

   (i) velocity error constant, $K_V \geq 50$
   (ii) phase margin is $\geq 20^0$

7. a) Obtain the state model of the system whose transfer function is given as $\frac{Y(S)}{U(S)}=\frac{10}{S^3+4S^2+2S+1}$ (8M)

   b) Explain the following (6M)

   i) Diagonalization
   ii) Significance of state transition matrix
   iii) Observability

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