Code No: R1622042 **R16** SET - 1

II B. Tech II Semester Regular/ Supplementary Examinations, April/May - 2019
CONTROL SYSTEMS
(Com to ECE, EIE, ECC)

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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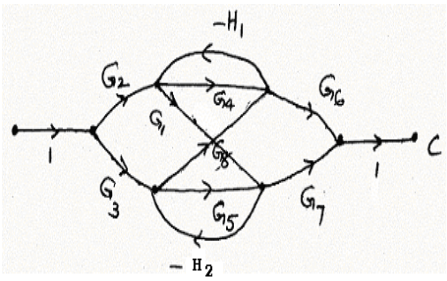
PART –A

1. a) Discuss why it is necessary to employ feedback in control systems. (3M)
   b) What is the significance of standard test signals? (3M)
   c) What is breakaway and breakin point? How to determine them? (2M)
   d) What are the advantages of Bode plot? (2M)
   e) What is lead lag compensator? (2M)
   f) Define state and state variables. (2M)

PART -B

2. a) Discuss Mason's gain formula. Obtain the overall transfer function C/R from the signal flow graph shown. (7M)



   b) Write the important differences between open loop and closed loop systems with suitable examples. (7M)

3. a) A unity feedback control system has the forward transfer function, $G(s) = 25/S^2+8S+25$. Find the response, rise time, peak time and the maximum peak over shoot for unit step input. (7M)
   b) Explain the field controlled DC servomotor and obtain its transfer function. (7M)

4. a) Choose the value of 'K' for the open loop transfer function $G(s) = \frac{K}{(S+2)(S^2+4S+5)}$, H(s)=1 for the system to be stable by using R-H criteria. (7M)
   b) Construct Routh array and determine the stability of the system whose characteristic equation is $s^6+2s^5+8s^4+12s^3+20s^2+16s+16=0$. (7M)

5. a) What is phase and gain cross over frequency? (4M)
   b) Sketch the Bode plot for a system $G(s) = 15(s+5)/(s^2+16s+100)$ and determine the stability of the system. (10M)

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6. a) What are the characteristics of Lead compensation? When lead compensation is employed? (7M)
   b) Obtain the transfer function of lag compensator. (7M)

7. a) Investigative the controllability and observability of the following system (7M)

$$\dot{x}(t) = \begin{bmatrix} 1 & 0 \\ 0 & 2t \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

y(t)=[0 1] x(t)

   b) State and prove the properties of state transition matrix? (7M)

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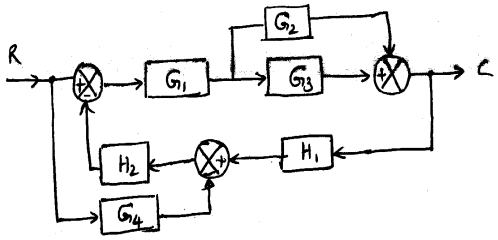
PART –A

1. a) Write the various types of control systems with examples? (3M)
   b) What is synchro? What is electrical zero of a synchro? (2M)
   c) List the demerits of Routh Stability Criterion. (2M)
   d) What are frequency domain Specifications? (3M)
   e) Draw the pole zero location of lag compensator. (2M)
   f) List the advantages of state space analysis. (2M)

PART -B

2. a) Draw a signal flow graph and evaluate the closed-loop transfer function of a system whose block diagram is given as follows (7M)



   b) Differentiate between the open loop and closed loop systems.. (7M)

3. a) Assess the time response of second order under damped system due to unit step unit. (7M)
   b) Explain how the potentiometers are used as error sensing devices. Give a typical application of it with single line diagram (7M)

4. The open loop transfer function of a unity gain feedback is given by (14M)
   $G(s) = k(s+2)/(s^4+3s^3+4s^2+2s)$, $k>=0$
   (a) Determine all the poles and zeros of G(s).
   (b) Draw the root locus.
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5. a) Explain how polar plots are useful in finding the stability of a system? (7M)

   b) Using Nyquist stability criterion, investigate the stability of a closed loop system whose open loop transfer function is given by, $G(S)H(S)=\frac{(S+2)}{(S+3)(S+4)}$ (7M)

6. a) What are the characteristics of Lead compensation? When lead compensation is employed? (7M)

   b) Design a lead compensator for unity feedback system whose open loop transfer function G(S) = K/(S(S+1)(S+5)) to satisfy the following specifications. (7M)

   (i) velocity error constant $K_V >= 50$

   (ii) Phase margin $>=20^0$

7. A feedback system is characterized by the closed loop transfer function. (14M)

$$\frac{C(s)}{U(s)}=\frac{10(s+4)}{s(s+1)(s+3)}$$

Construct state model for this system and give block diagram representation of state model.

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

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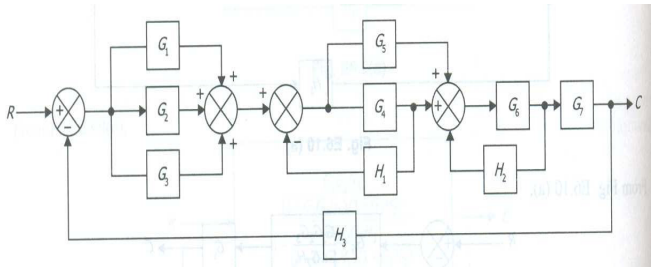
PART –A

1. a) List the disadvantages of open loop control systems. (3M)
   b) What is a potentiometer? What are the applications of potentiometess? (2M)
   c) Define the following terms (2M)
   i). absolute stability ii). marginal stability
   d) Explain the correlation between the time and frequency response? (3M)
   e) Draw the pole zero location of lag compensator. (2M)
   f) What are the advantages of state variable method over conventional methods? (2M)

PART -B

2. a) Determine the transfer function C(s) / R(s) by reducing the given block diagram (7M)



   b) Explain in detail the effect of feedback on sensitivity and stability (7M)

3. a) Explain the important time response specifications of a standard second ordered system to a unit step input. (7M)
   b) A unity feedback system has $G(s) = \frac{9}{s(s+1)}$. Determine the value of damping ratio, Un damped natural frequency, %Max Peak, peak time, settling time and delay time for unit step input. (7M)

4. Sketch the root locus diagram for a feedback system. The characteristic equation of which is given by, G(s)H(s) = K/s(s + 2)(s^2 + 2s + 2). Show clearly the steps involved. (14M)

5. a) What are the advantages of polar plot? Explain the effect of addition of a pole at the origin on the polar plot of a given system. (7M)
   b) Construct Bode magnitude and phase diagrams for GH(S)=100(0.1S+1)/S^2 (S+1). Comment on the closed loop stability of the system (7M)

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6. a) Discuss the advantages and disadvantages of proportional derivative, proportional integral and proportional integral derivative control system. (7M)

   b) The open loop transfer function of the given system is (7M)

   $G(s) = \frac{K}{s(2s+1)(0.5s+1)}$. It is desired to design a compensator to obtain a phase margin of 35^0 and velocity error constant of $10sec^{-1}$

7. a) Given the system (7M)

$$\dot{x}(t) = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 0 & 1 \\ 2 & 0 \\ 0 & 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 0 & 1 & 2 \\ 0 & 1 & 0 \end{bmatrix} x(t)$$

   Is this system controllable.

   b) Derive the state models for the system described by the differential equation in phase variable form (7M)

$$\dddot{y} + 4\ddot{y} + 5\dot{y} + 2y = 2\ddot{u}(t) + 5\dot{u}(t) + 5u.$$

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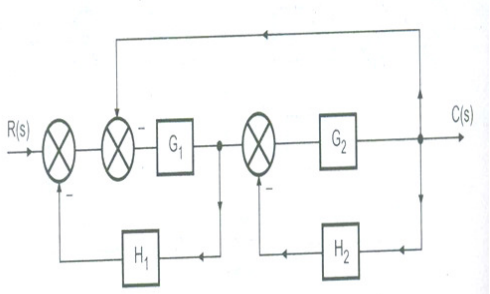
PART –A

1. a) Define transfer function. What are its limitations? (3M)
   b) Explain in brief about AC Tachometer. (3M)
   c) Discuss about relative stability of a system. (2M)
   d) Define phase margin and gain margin. (2M)
   e) What is the need of compensation? (2M)
   f) What are the drawbacks of state space analysis? (2M)

PART -B

2. a) Determine the overall transfer function by converting the block diagram to signal flow graph. (7M)



   b) Write the important differences between open loop and closed loop systems with suitable examples. (7M)

3. a) Drive the transfer function of DC servo motor. Explain about torque-speed characteristics. (7M)
   b) The open loop transfer function of a control system with unity feedback is given by $G(s) = \frac{100}{s(s+0.1s)}$. Determine the steady state error of the system when the input is $10+10t+4t^2$ (7M)

4. Sketch the root locus plot of a unity feedback system whose open loop T.F is $G(s) = K(s+9)/s(s^2+4s+11)$ (14M)
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5. a) Explain the procedure to draw a polar plot? (7M)

   b) The open loop transfer function of certain unity feedback system is given below. Sketch the Nyquist plot and determine the stability of the system (7M)

   $G(S) = \frac{K(S+3)}{S(S-1)}$.

6. The open loop transfer function of certain unity feedback control system is given by G(S)= K/(S+4)(S+8) It is desired to have the phase margin to be at least 33^0 and velocity error constant K_V = 30 Sec^{-1}. Design a lag compensator using root locus. (14M)

7. a) Explain the concept of controllability and observability? (7M)

   b) The state equation of a linear time invariant systems is given by (7M)

   $\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ t \end{bmatrix} u(t)$ Find the state transition matrix $\phi(t)$.