KINGS

COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

SUBJECT CODE & NAME: CONTROL SYSTEMS

YEAR / SEM: II / IV

UNIT I

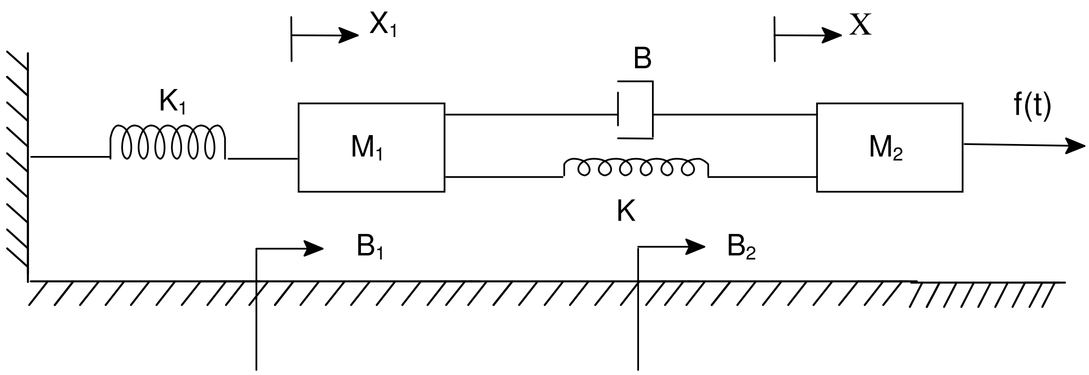
SYSTEMS AND THEIR REPRESENTATION

PART-A [2 MARKS]

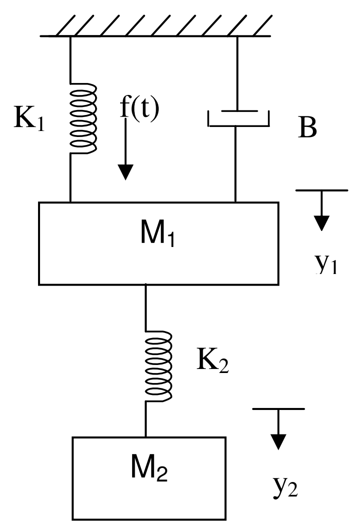
1. What is signal flow graph.
2. What is a block diagram
3. What is system?
4. What is control system?
5. Define open loop and closed loop systems.
6. Define closed loop systems.
7. State principle of superposition theorem.
8. What is time variant and Time invariant?
9. Define transfer function.
10. What is signal flow graph.
11. Define non-touching loop.

PART-B

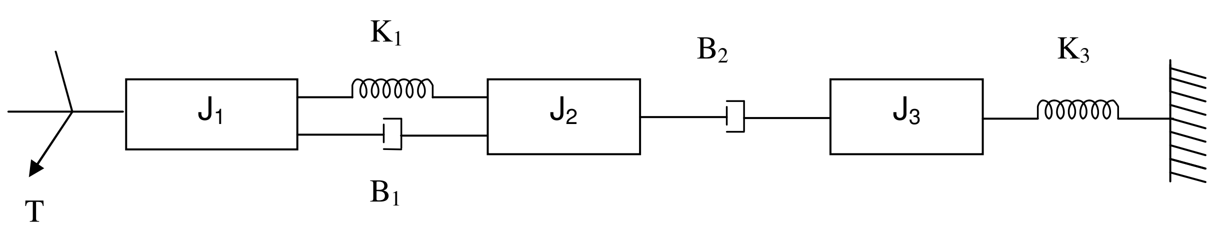
1.Write the differential equations governing the Mechanical system shown in fig 1.1.and determine the transfer function. (16)



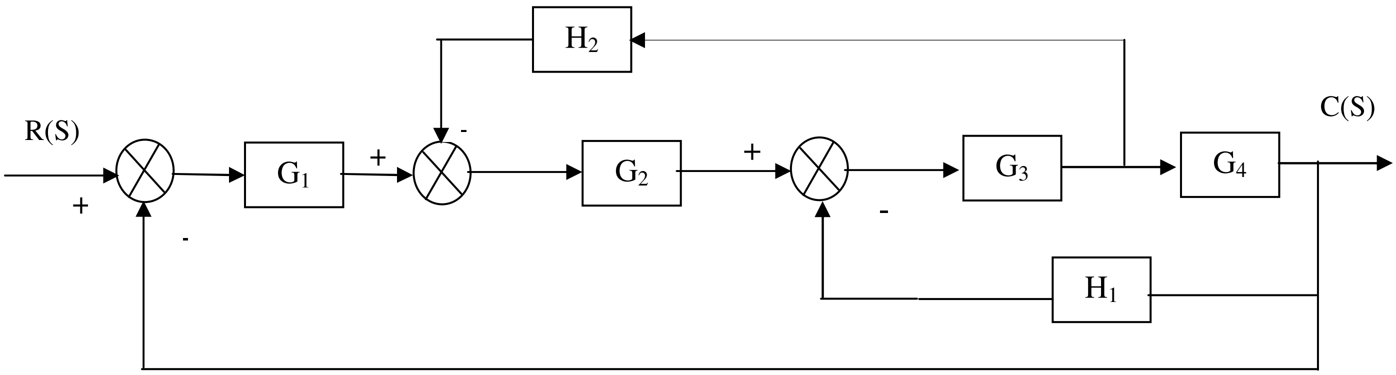
2. Determine the transfer function $Y_2(S)/F(S)$ of the system shown in fig. (16)



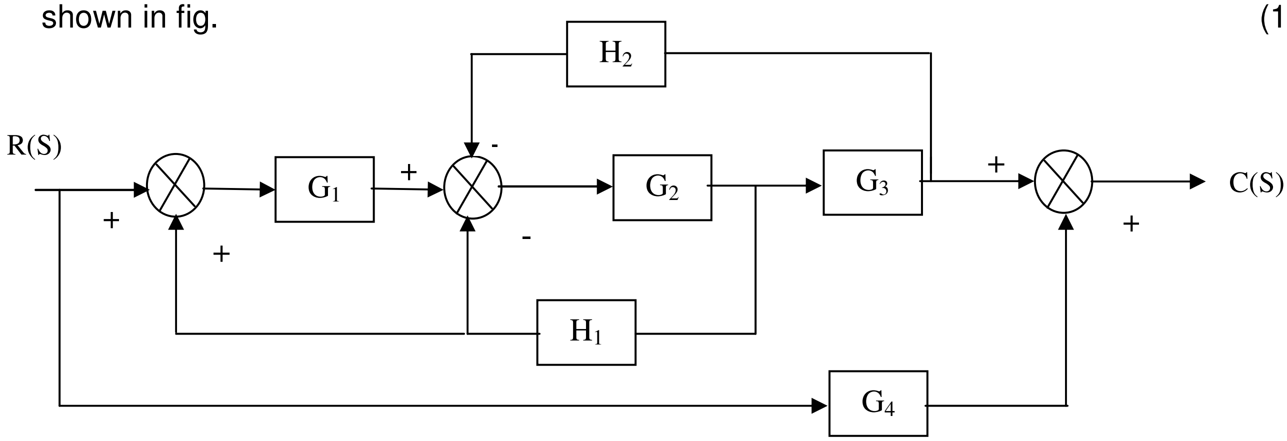
3. Write the differential equations governing the Mechanical rotational system shown in fig. Draw the Torque-voltage and Torque-current electrical analogous circuits. (16)



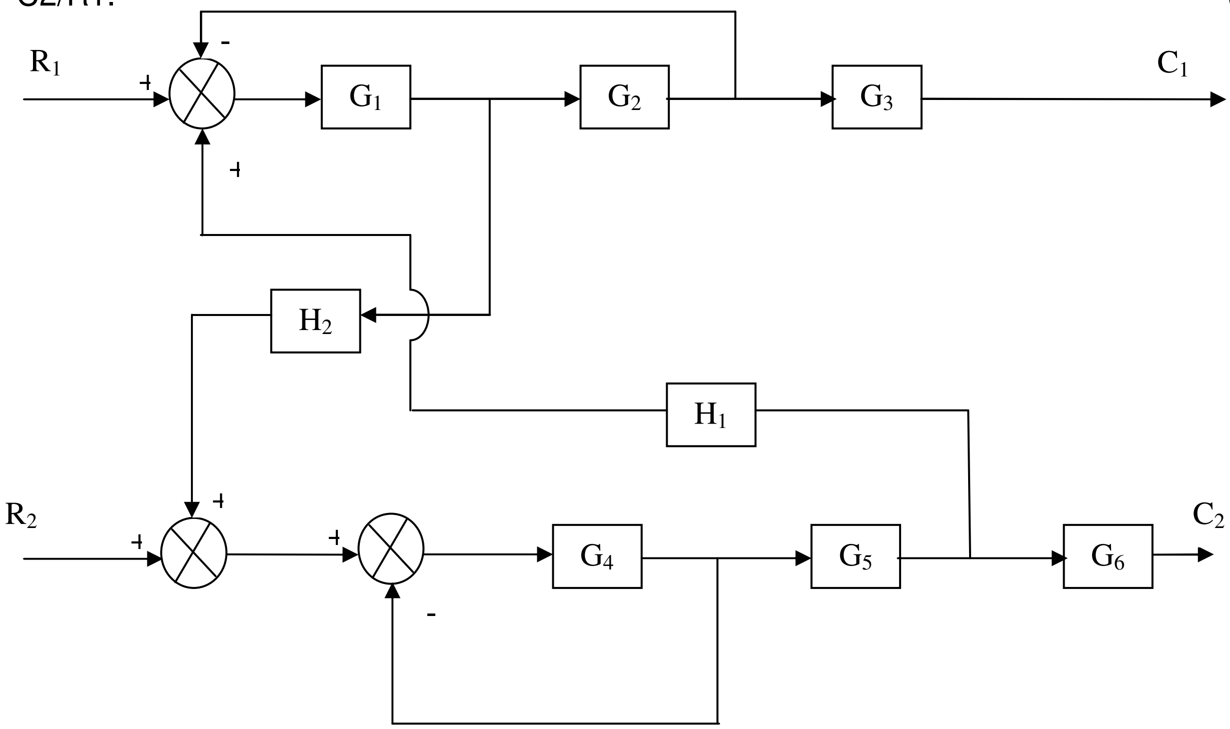
4. Determine the overall transfer function C(S)/R(S) for the system shown in fig. (16)



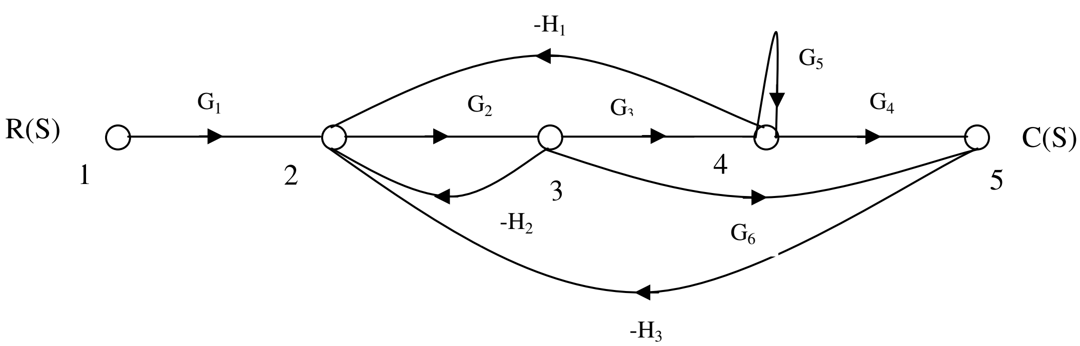
5. Obtain the closed loop transfer function C(S)/R(S) of the system whose block diagram is shown in fig. (16)



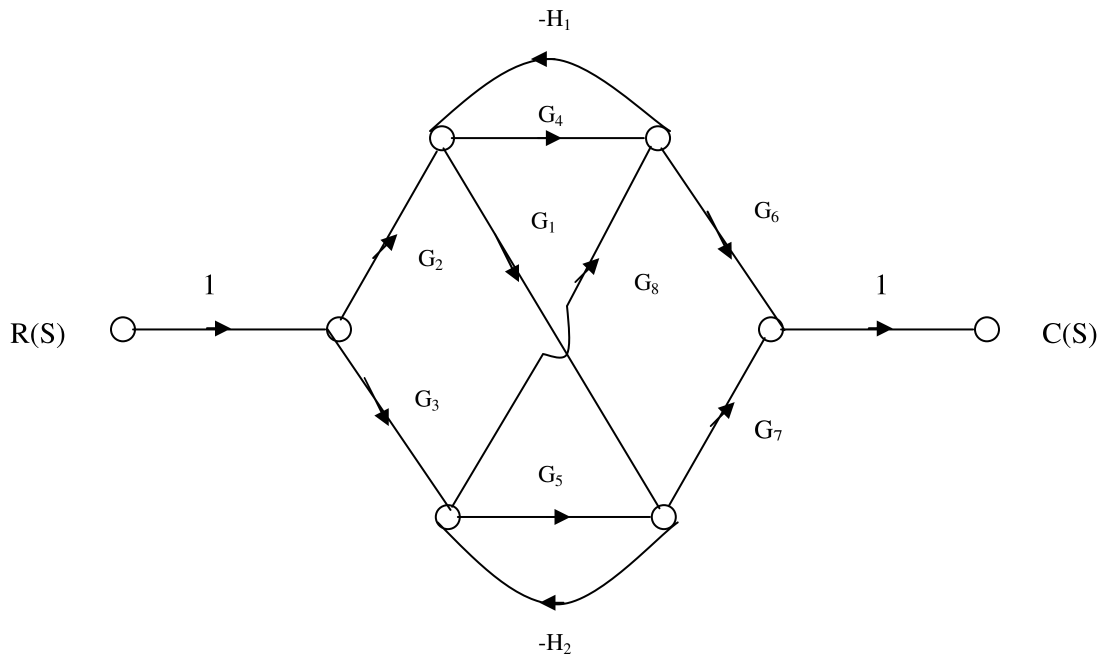
6 . For the system represented by the block diagram shown in fig. Determine C1/R1 and C2/R1. (16)



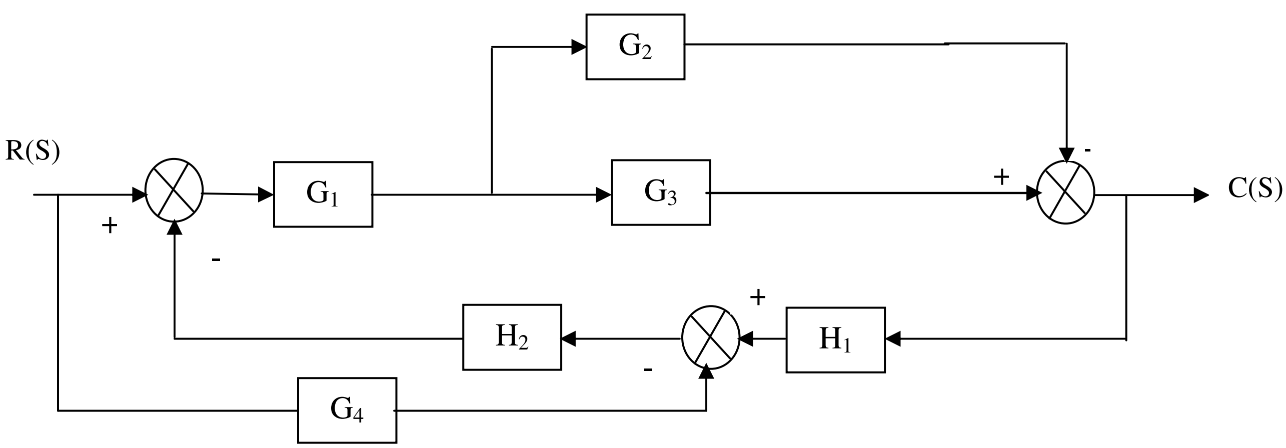
7. Find the overall gain C(s) / R(s) for the signal flow graph shown below. (16)



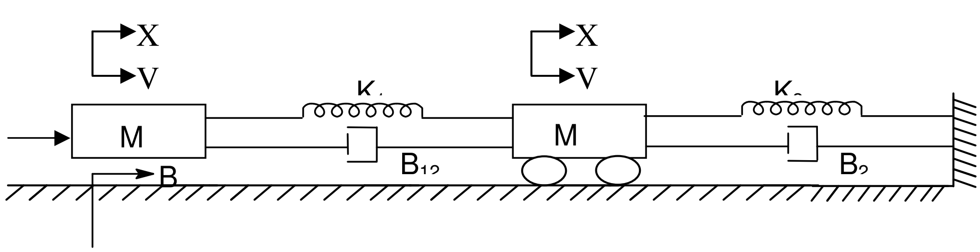
8.Find the overall gain of the system whose signal flow graph is shown in fig. (16)



9. Draw a signal flow graph and evaluate the closed loop transfer function of a system whose block is shown in fig. (16)



10. Write the differential equations governing the mechanical systems shown below. Draw the force-voltage and force-current electrical analogous circuits and verify by writing mesh and node equations. (16)



10. (I) Derive the transfer function for Armature controlled DC motor. (8)

(II)Derive the transfer function for Field controlled DC motor. (8)

11. (i)Explain DC servo motor. (6)

(ii)Explain the working of AC servomotor in control systems. (10)

12. (i)Explain Synchros and its types. (10)

(ii)Write the rules for block diagram reduction techniques. (6)

UNIT –II

TIME RESPONSE

PART-A [2 MARKS]

1. What is time response?
2. What is transient response
3. What is steady state response
4. Name the test signals used in time response analysis.
5. What is damped frequency of oscillation?
6. List the time domain specifications.
7. Define rise time, delay time.
8. What are static error constants.?
9. Define position ,velocity error constants.
10. Define velocity error constants.
11. Define damping ratio.

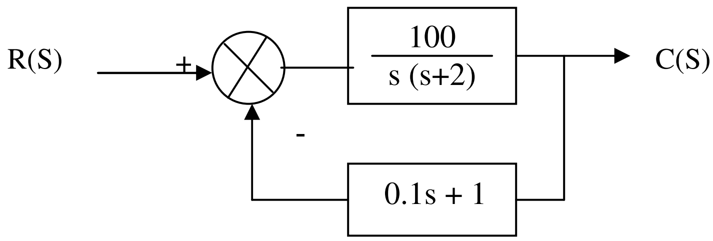
PART B

1.(a) Derive the expressions and draw the response of first order system for unit step input. (8)

(b) Draw the response of second order system for critically damped case and when input is unit step. (8)

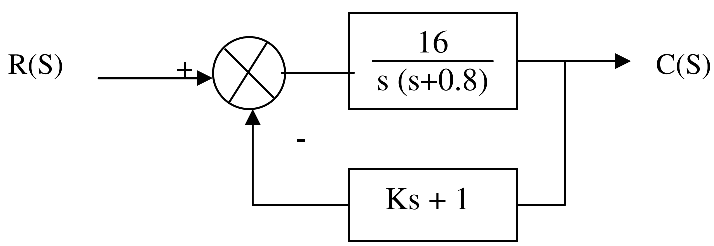
2. Derive the expressions for Rise time, Peak time, Peak overshoot, delay time (16)

3. A positional control system with velocity feedback is shown in fig. What is the response of the system for unit step input. (16)



4. (i) Measurements conducted on a Servomechanism show the system response to be c(t)=1+0.2 $\hat{e}^{-60t}$ -1.2 $\hat{e}^{-10t}$. when subjected to a unit step. Obtain an expression for closed loop transfer function. (8)

(ii). A positional control system with velocity feedback is shown in fig. What is the response c(t) to the unit step input. Given that ς =0.5.and also calculate rise time, peak time, Maximum overshoot and settling time. (8)



5. (i) A unity feedback control system has an open loop transfer function G(S)= 10/S(S+2).Find the rise time, percentage over shoot, peak time and settling time. (8)

(ii) A closed loop servo is represented by the differential equation d^2c/dt^2 +8 dc/dt = 64 e Where c is the displacement of the output shaft r is the displacement of the input shaft and e= r-c.Determine undamped natural frequency, damping ratio and percentage maximum overshoot for unit step input. (8)

6. For a unity feedback control system the open loop transfer function G(S) = 10(S+2)/ S^2 (S+1).Find (a) position, velocity and acceleration error constants. (b)the steady state error when the input is R(S) where R(S) =3/S –2/S^2 +1/3S^3 (16)

7. The open loop transfer function of a servo system with unity feed back system is G(S) = 10/ S(0.1S+1).Evaluate the static error constants of the system. Obtain the steady state error of the system when subjected to an input given Polynomial r(t) = a_0 +a_1t +a_2 /2 t^2 (16)

8. The unity feedback system is characterized by an open loop transfer function is G(S)= K / S(S+10).Determine the gain K ,so that the system will have a damping ratio of 0.5.For this value of K, determine settling time,Peak overshoot and time to Peak overshoot for a unit-step input. (16)

9.(i) For a servomechanisms with open loop transfer function(S)=10/(S+2)(S+3).What type of input signal gives constant steady state error and calculate its value. (8)

(ii) Find the static error coefficients for a system whose G(S)H(S)=10/ S(1+S)(1+2S)and also find the steady state error for $r(t)=1+ t + t^2/2$. (8)

10.(i) Obtain the response of unity feedback system whose open loop transfer function is G(S) = 4 / S (S+5) and When the input is unit step. (8)

(ii) A unity feedback system has an amplifier with gain K_A=10 and gain ratio G(S) = 1 / S (S+2) in the feed forward Path .A derivative feedback ,H(S)=S K_O is introduced as a minor loop around G(S).Determine the derivative feed back constant ,K_O ,so that the system damping factor is 0.6 (8)

11.(i) Explain P,PI,PID,PD controllers (8)

(ii) Derive the expressions for second order system for under damped case and when the input is unit step. (8)

UNIT III

FREQUENCY RESPONSE

PART-A [2 MARKS]

1. What is frequency response analysis?
2. What is Nichol's chart?
3. Define gain cross over frequency?
4. Define Phase cross over frequency?
5. Define Phase Margin?
6. Define Gain Margin?
7. List the Frequency domain specifications?
8. What is corner frequency?
9. What is Band width?

PART B

1. Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies. G(S) = 10/ S(1+0.4S) (1+0.1S) (16)

2. The open loop transfer function of a unity feed back system is G(S) = 1/ S(1+S) (1+2S). Sketch the Polar plot and determine the Gain margin and Phase margin. (16)

3. Sketch the Bode plot and hence find Gain cross over frequency ,Phase cross over

frequency, Gain margin and Phase margin.

$G(S) = 0.75(1+0.2S)/ S(1+0.5S) (1+0.1S)$ (16)

4. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin.

$G(S) = 10(S+3)/ S(S+2) (S^2+4S+100)$ (16)

5. Sketch the polar plot for the following transfer function .and find Gain cross over frequency ,Phase cross over frequency, Gain margin and Phase margin.

$G(S) = 10(S+2)(S+4)/ S (S^2 -3S+10)$ (16)

6. Construct the polar plot for the function $GH(S) =2(S+1)/ S^2$. find Gain cross over frequency ,Phase cross over frequency, Gain margin and Phase margin. (16)

7. Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies $G(S) =KS^2 / (1+0.2S) (1+0.02S)$.Determine the value of K for a gain cross over frequency of 20 rad/sec. (16)

8. Sketch the polar plot for the following transfer function .and find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin.

G(S) = 400/ S (S+2)(S+!0) (16)

9. A unity feed back system has open loop transfer function $G(S) = 20/ S (S+2)(S+5)$.Using Nichol's chart. Determine the closed loop frequency response and estimate all the frequency domain specifications. (16)

10. Sketch the Bode plot and hence find Gain cross over frequency, Phase cross over frequency, Gain margin and Phase margin.

$G(S) = 10(1+0.1S)/ S(1+0.01S) (1+S)$. (16)

11. Draw the Nyquist plot for the system whose open loop transfer function is $G(S)H(S) =K/S (S+2) (S+10)$.Determine the the range of K for which closed loop system is stable. (16)

12. Construct Nyquist plot for a feedback control system whose open loop transfer function is given by $G(S)H(S) =5/ S(1-S)$.Comment on the stability of open loop and closed loop transfer function. (16)

13. Sketch the Nyquist plot for a system with the open loop transfer function $G(S)H(S) =K(1+0.5S) (1+S) / (1+10S) (S-1)$.determine the range of values of K for which the system is stable. (16)

UNIT-IV

STABILITY OF CONTROL SYSTEM

PART-A [2 MARKS]

1. What is root locus?
2. What is an asymptote
3. What is the necessary condition for stability?
4. What is characteristic equation?
5. What is centroid
6. Define stability.
7. What do you mean by dominant pole.
8. What is an impulse response
9. What is routh stability criterion
10. What is breakin point

PART B

1. (i) Using Routh criterion determine the stability of the system whose characteristics equation is $S^4+8S^3+18S^2+16S+5=0$. (8)

   (ii). $F(S) = S^6+S^5-2S^4-3S^3-7S^2-4S-4=0$. Find the number of roots falling in the RHS plane and LHS plane. (8)

2. A unity feedback control system has an open loop transfer function $G(S)= K / S(S^2+4S+13)$. Sketch the root locus. (16)

3. Sketch the root locus of the system whose open loop transfer function is $G(S)= K / S(S+2)(S+4)$. Find the value of K so that the damping ratio of the closed loop system is 0.5 (16)

4. A unity feedback control system has an open loop transfer function $G(S)= K(S+9) / S(S^2+4S+11)$. Sketch the root locus. (16)

5. Sketch the root locus of the system whose open loop transfer function is $G(S)= K / S(S+4)(S^2+4S+20)$. (16)

6. A Unity feedback control system has an open loop transfer function $G(S)= K(S+1.5) / S(S+1)(S+5)$. Sketch the root locus. (16)

7. Draw the Nyquist plot for the system whose open loop transfer function is $G(S)= K / S(S+2)(S+10)$. Determine the range of k for which closed loop system is stable. (16)

8. Sketch the Nyquist Plot for a system with the open loop transfer function G(S) H(S)= K (1+0.5S)(1+S) / (1+10S)(S-1). Determine the range of k for which closed loop system is stable. (16)

9. Construct Nyquist Plot for a system with the open loop transfer function G(S) H(S)= 5 / S(1-S).Comment on the stability of open loop and closed loop system. (16)

10. By Nyquist stability criterion determine the stability of closed loop system, whose open loop transfer function is given by, G(S) H(S)= (s+2)/(s+1)(s-1). (16)

11. (i) Construct Routh array and determine the stability of the system represented by the characteristics equation $S^5+S^4+2S^3+2S^2+3S+5=0$.Comment on the location of the roots of characteristic equation. (8)

(ii) Construct Routh array and determine the stability of the system represented by the characteristics equation $S^7+9S^6+24S^4+24S^3+24S^2+23S+15=0$comment on the location of the roots of characteristic equation. (8)

UNIT V

COMPENSATOR DESIGN

PART-A [2 MARKS]

1. What are the two methods of designing a control system?
2. What are the time domain specifications needed to design a control system?
3. What are the frequency domain specifications needed to design a control system?
4. What is compensation?
5. What is compensator?
6. What are the different types of compensator available?
7. What are the two types of compensation schemes?
8. What is feedback compensation?
9. Why compensation is necessary in feedback control system?
10. What is lag compensation?

PART B

1. What is compensation? Why it is need for control system? Explain the types of compensation? What is an importance of compensation? (16)

2. Realise the basic compensators using electrical network and obtain the transfer function. (16)

3. Design suitable lead compensators for a system unity feedback and having open loop transfer function G(S)= K/ S(S+1) to meet the specifications.(i) The phase margin of the system ≥ 45º, (ii) Steady state error for a unit ramp input ≤1/15, (iii) The gain cross over frequency of the system must be less than 7.5 rad/sec. (16)

4. A unity feed back system has an open loop transfer function G(S)= K/ S(S+1) (0.2S+1). Design a suitable phase lag compensators to achieve following specifications Kv= 8 and Phase margin 40 deg with usual notation. (16)

5. Explain the procedure for lead compensation and lag compensation? (16)

6. Explain the design procedure for lag- lead compensation (16)

7. Consider a type 1 unity feed back system with an OLTF G(S) =K/S (S+1) (S+4). The system is to be compensated to meet the following specifications Kv > 5sec and PM > 43 deg. Design suitable lag compensators. (16)

8. Using Electrical lead network derive the transfer function. (16)

9. Using Electrical lag network derive the transfer function (16)

10. Using Electrical lag-lead network derive the transfer function (16)

11. Design a lead compensator for a unity feedback system with open loop transfer function G(S) = K/ S(S+1) (S+5) to satisfy the following specifications (i) Kv ≥ 50 (ii) Phase Margin is ≥ 20 . (16)

12. Design a lead compensator for G(S) =K / S^2 (0.2S+1) to meet the following Specifications (i)Acceleration k_a=10; (ii) P.M=35. (16)

13. Design a Lag compensator for the unity feedback system whose closed loop transfer function C(s) / R(s) = K / (s (s+4) (s+80) + K) is to meet the following specifications P.M ≥33 º. And Kv ≥30. (16)

14. Consider the unity feed back system whose OLTF is G(s) = K / s (s+3)(s+6). Design a lag-lead compensator to meet the following specifications.
    (i) Velocity error constant, Kv = 80, (ii) P.M ≥ 35º (16)

15. A unity feedback system has an OLTF G(s) = K / s(s+2)(s+60). Design a Lead-Lag compensator is to meet the following specifications.
    (i) P.M is atleast 40º , (ii) Steady state error for ramp input ≤ 0.04 rad. (16)

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