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# DEPARTMENT OF EEE

# QUESTION BANK

**(As Per AUC 2008 REGULATION)**

## SUB CODE: EE2253

## SUB NAME: CONTROL SYSTEM

## YEAR : II

## SEM : IV

**PREPARED BY**

**K. KALAI SELVI AP/EEE**

# UNIT - I

# SYSTEMS AND THEIR REPRESENTATION

## PART - A (2 MARKS)

**1.What is control system?**

A system consists of a number of components connected together to perform a specific function. In a system when the output quantity is controlled by varying the input quantity then the system is called control system.

**2.What are the two major types of control system?**

The two major types of control system are open loop and closed loop.

**3.Define open loop control system.**

The control system in which the output quantity has no effect upon the input quantity are called open loop control system. This means that the output is not feedback to the input for correction.

**4.Define closed loop control system.**

The control system in which the output has an effect upon the input quantity so as to maintain the desired output value are called closed loop control system.

**5.What are the components of feedback control system?**

The components of feedback control system are plant, feedback path elements, error detector and controller.

**6.Define transfer function.**

The T.F of a system is defined as the ratio of the laplace transform of output to laplace transform of input with zero initial conditions.

**7.What are the basic elements used for modeling mechanical translational system?**

Mass, spring and dashpot

**8.What are the basic elements used for modeling mechanical rotational system?**

Moment of inertia J, dashpot with rotational frictional coefficient B and torsional spring with stiffness K.

**9.Name two types of electrical analogous for mechanical system.**

The two types of analogies for the mechanical system are Force voltage and force current analogy.

**10.What is block diagram?**

A block diagram of a system is a pictorial representation of the functions performed by each component of the system and shows the flow of signals. The basic elements of block diagram are block, branch point and summing point.

**11.What is the basis for framing the rules of block diagram reduction technique?**

The rules for block diagram reduction technique are framed such that any modification made on the diagram does not alter the input output relation.

**12.What is a signal flow graph?**

A signal flow graph is a diagram that represents a set of simultaneous algebraic equations .By taking L.T the time domain differential equations governing a control system can be transferred to a set of algebraic equations in s-domain.

**13. What is transmittance?**

The transmittance is the gain acquired by the signal when it travels from one node to another node in signal flow graph.

**14.What is sink and source?**

Source is the input node in the signal flow graph and it has only outgoing branches. Sink is a output node in the signal flow graph and it has only incoming branches.

**15.Define non-touching loop.**

The loops are said to be non touching if they do not have common nodes.

**16.Write Masons Gain formula.**

Masons Gain formula states that the overall gain of the system is

$$T = 1/\ \Delta \Sigma k\ Pk\ \ \Delta k$$

k-No.of forward paths in the signal flow graph. Pk-
Forward path gain of kth forward path
Δ = 1-[sum of individual loop gains ] +[sum of gain products of all possible combinations of two non touching loops]-[sum of gain products of all possible combinations of three non touching loops]+…
Δk = Δ for that part of the graph which is not touching kth forward path.

**17.Write the analogous electrical elements in force voltage analogy for the elements of mechanical translational system.**

Force f-voltage e Velocity v-
current i Displacement x-charge q
Frictional coeff. B-Resistance R
Mass M- Inductance L
Stiffness K-Inverse of capacitance 1/C

**18.Write the analogous electrical elements in force current analogy for the elements of mechanical translational system.**

Force-current i
Velocity v-voltage v
Displacement x-flux_
Frictional coeff B-conductance 1/R
Mass M- capacitance C
Stiffness K-Inverse of inductance 1/L

**19.Write the force balance equation of M ideal mass element.**

$F = M\ d^2x\ /dt^2$

**20. Write the force balance equation of ideal dashpot element.**

$F = B\ dx\ /dt$

**21. Write the force balance equation of ideal spring element.**

$F = Kx$

**22.Distinguish between open loop and closed loop system.**

| S.NO | OPEN LOOP SYSTEM | CLOSED LOOP SYSTEM |
|---|---|---|
| 1 | Inaccurate | Accurate |
| 2 | Simple and economical | Complex and costlier |
| 3 | The Changes in output due to external disturbance are not corrected | The Changes in output due to external disturbance are corrected automatically |
| 4 | They are generally stable | Great efforts are needed to design a stable system |

**23.What is servomechanism?**

The servomechanism is a feedback control system in which the output is mechanical position (or time derivatives of position velocity and acceleration,)

**24.Why is negative feedback invariably preferred in closed loop system?**

The negative feedback results in better stability in steady state and rejects any disturbance signals.

**25.What is synchro?**

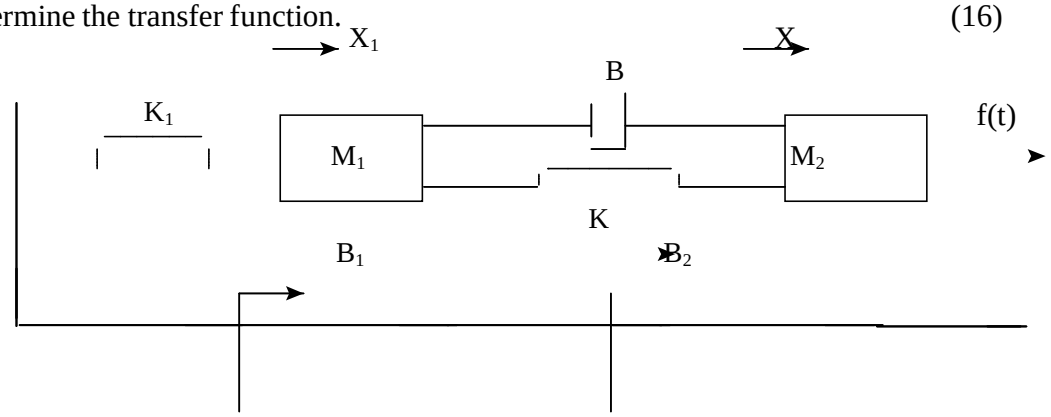
A synchro is a device used to convert an angular motion to an electrical signal or vice-versa.

**26.What is servomotor?**

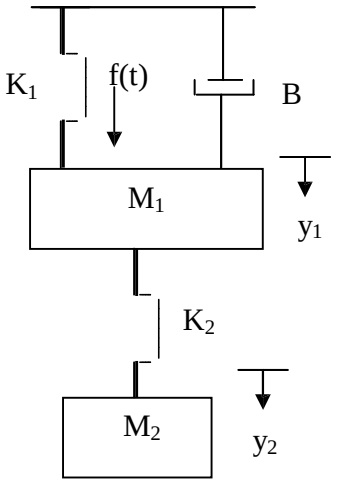
The motors used in automatic control systems or in servomechanism are called servomotors. They are used to convert electrical signal into angular motion.

## PART-B

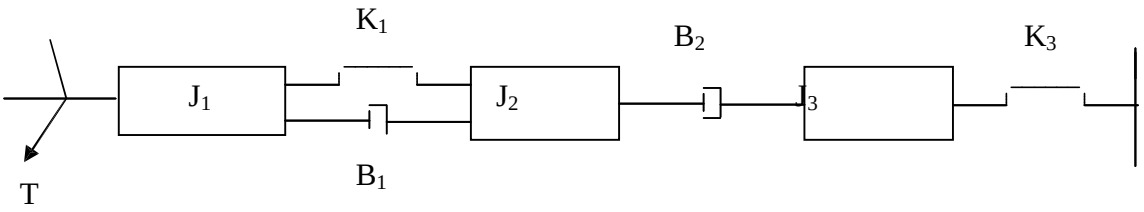
1.Write the differential equations governing the Mechanical system shown in fig 1.1.and determine the transfer function. (16)



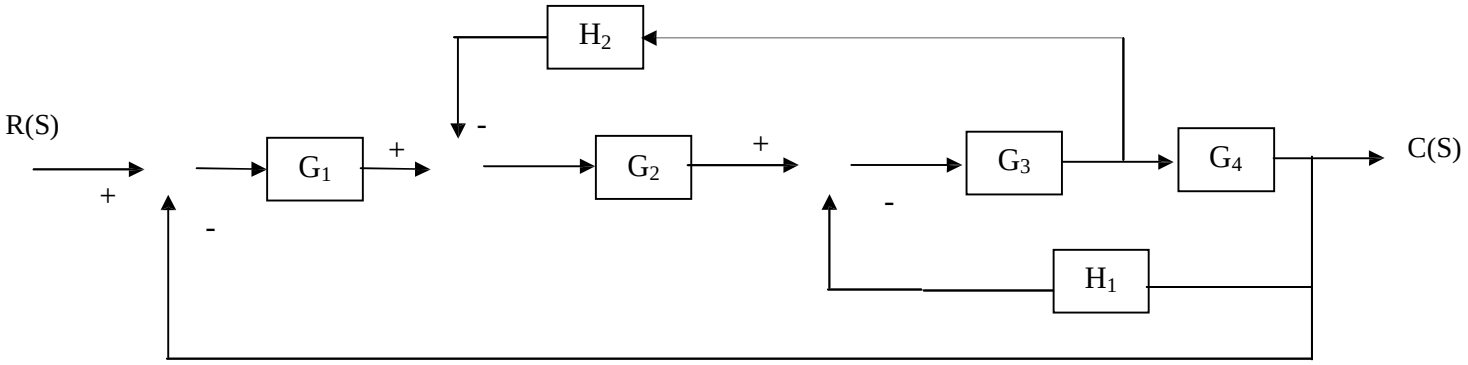
2. Determine the transfer function $Y_2(S)/F(S)$ of the system shown in fig. (16)



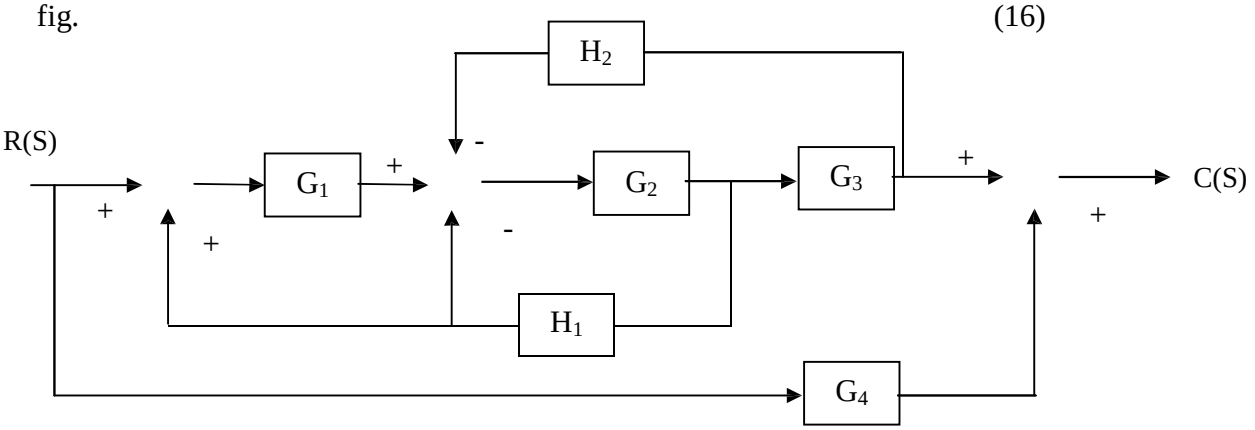

3. Write the differential equations governing the Mechanical rotational system shown in fig. Draw the Torque-voltage and Torque-current electrical analogous circuits. (16)



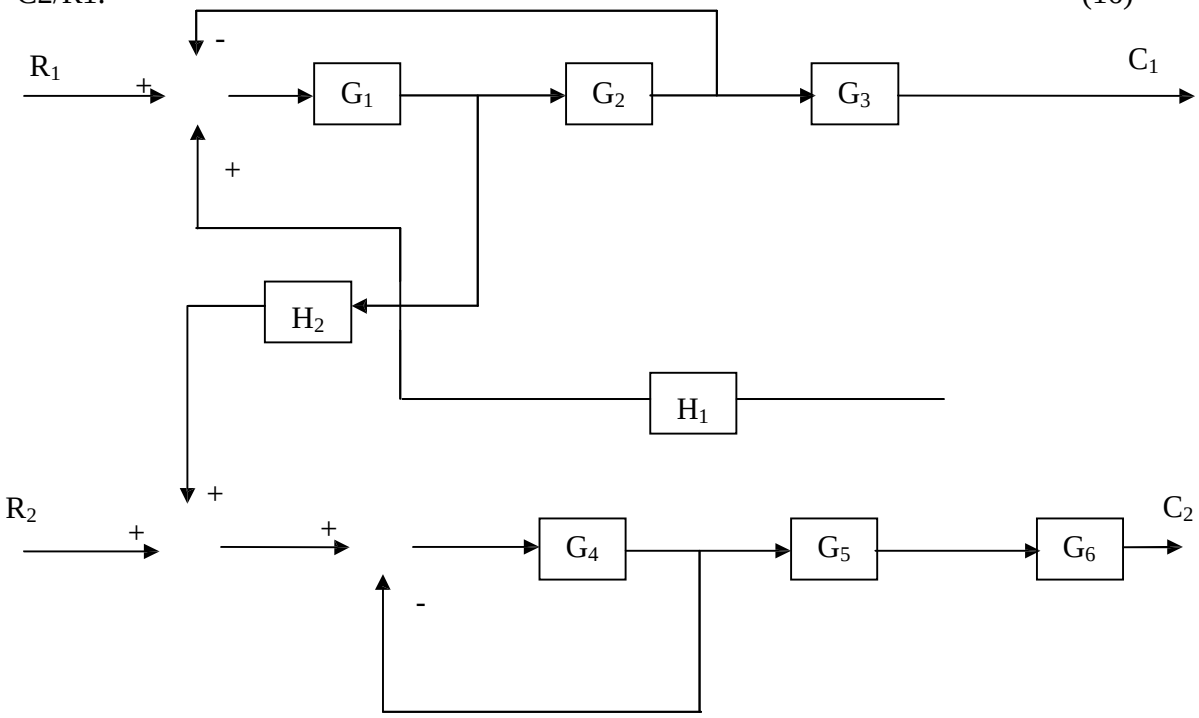

4. Determine the overall transfer function C(S)/R(S) for the system shown in fig. (16)



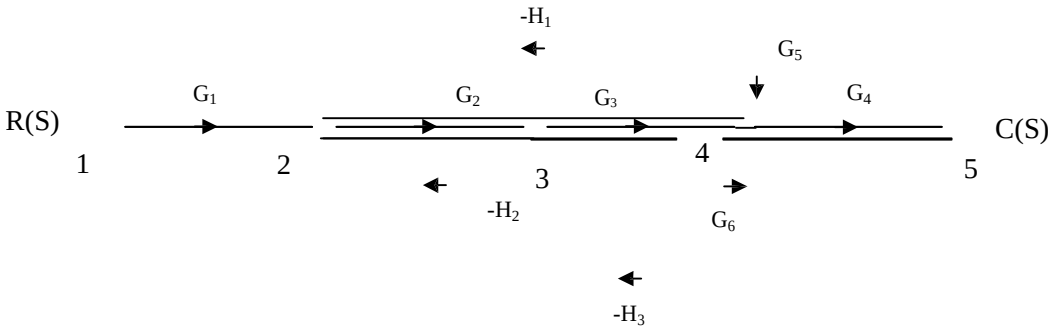
5. Obtain the closed loop transfer function C(S)/R(S) of the system whose block diagram is shown in fig. (16)



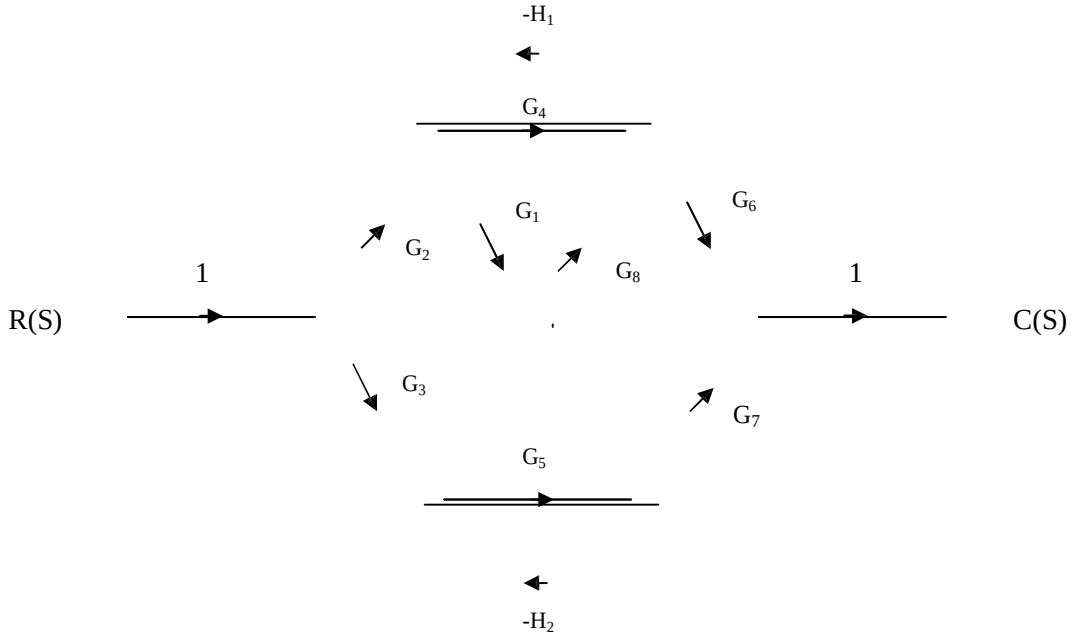

6 . For the system represented by the block diagram shown in fig. Determine C1/R1 and C2/R1. (16)



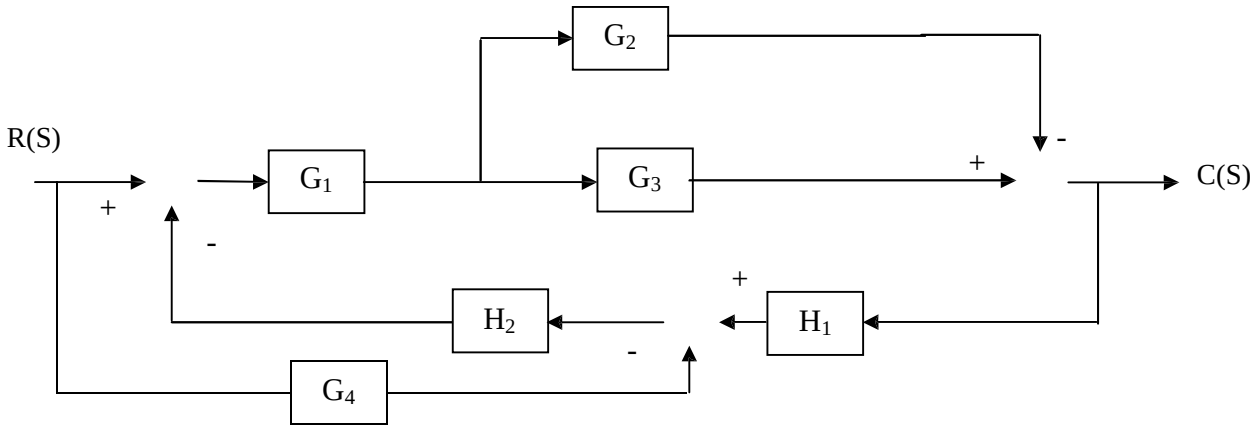

7. Find the overall gain C(s) / R(s) for the signal flow graph shown below. (16)



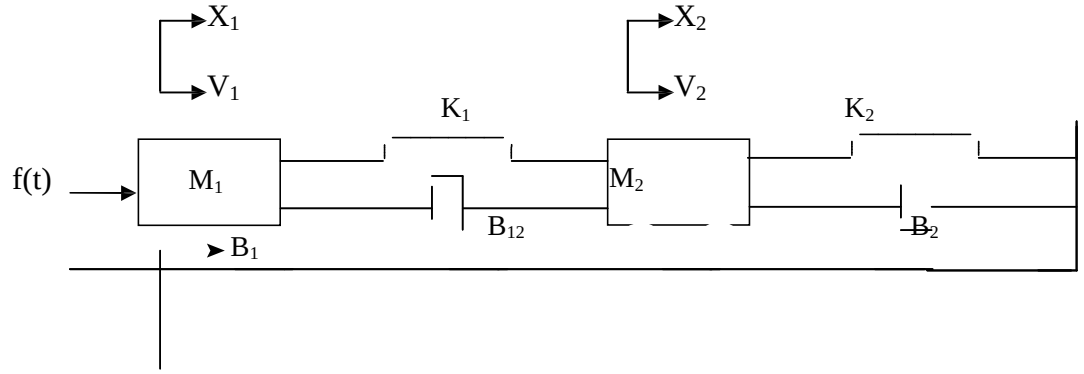
8.Find the overall gain of the system whose signal flow graph is shown in fig. (16)




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)




11. (i) Derive the transfer function for Armature controlled DC motor. (8)

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

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

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

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

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

# UNIT –II

## PART- A (2 MARKS)

**1.What is transient response?**

The transient response is the response of the system when the system changes from one state to another.

**2.What is steady state response?**

The steady state response is the response of the system when it approaches infinity.

**3.What is an order of a system.**

The order of a system is the order of the differential equation governing the system. The order of the system can be obtained from the transfer function of the given system.

**4.Define Damping ratio.**

Damping ratio is defined as the ratio of actual damping to critical damping.

**5.List the time domain specifications**. The

time domain specifications are
i.Delay time
ii.Rise time
iii.Peak time
iv.Peak overshoot

**6.Define Delay time.**

The time taken for response to reach 50% of final value for the very first time is delay time.

**7.Define Rise time.**

The time taken for response to raise from 0% to 100% for the very first time is rise time.

**8.Define peak time.**

The time taken for the response to reach the peak value for the first time is peak time.

**9.Define peak overshoot.**

Peak overshoot is defined as the ratio of maximum peak value measured from the Maximum value to final value.

**10.Define Settling time.**

Settling time is defined as the time taken by the response to reach and stay within specified error.

**11.What is the need for a controller?**

The controller is provided to modify the error signal for better control action

**12.What are the different types of controllers?**

Proportional controller
PI controller
PD controller
PID controller

**13.What is proportional controller?**

It is device that produces a control signal which is proportional to the input error signal.

**14.What is PI controller?**

It is device that produces a control signal consisting of two terms – one proportional to error signal and the other proportional to the integral of error signal.

**15. What is PD controller?**

PD controller is a proportional plus derivative controller which produces an output signal consisting of two time -one proportional to error signal and other proportional to the derivative of the signal.

**16. What is the significance of integral controller and derivative controller in a PID controller?**

The proportional controller stabilizes the gain but produces a steady state error. The integral control reduces or eliminates the steady state error.

**17.Why derivative controller is not used in control systems?**

The derivative controller produces a control action based on the rate of change of error signal and it does not produce corrective measures for any constant error.

**18.Define Steady state error.**

The steady state error is defined as the value of error as time tends to infinity.

**19.What is the drawback of static coefficients?**

The main draw back of static coefficient is that it does not show the variation of error with time and input should be standard input.

**20. What is step signal?**

The step signal is a signal whose value changes from zero to A at t= 0 and remains constant at A for t>0.

**21. What is ramp signal?**

The ramp signal is a signal whose value increases linearly with time from an initial value of zero at t=0.the ramp signal resembles a constant velocity.

**22.What is a parabolic signal?**

The parabolic signal is a signal whose value varies as a square of time from an initial value of zero at t=0.This parabolic signal represents constant acceleration input to the signal.

**23.What are the three constants associated with a steady state error?**

Positional error constant
Velocity error constant
Acceleration error constant

**24.What are the main advantages of generalized error co-efficients?**

i) Steady state is function of time.
ii) Steady state can be determined from any type of input

**25.What is the disadvantage in proportional controller?**

The disadvantage in proportional controller is that it produces a constant steady state error.

**26.What is the effect of PD controller on system performance?**

The effect of PD controller is to increase the damping ratio of the system and so the peak overshoot is reduced.

**27.What is the effect of PI controller on the system performance?**

The PI controller increases the order of the system by one, which results in reducing the steady state error .But the system becomes less stable than the original system.

**28.Name the test signals used in control system**

the commonly used test input signals in control system are impulse step ramp acceleration and sinusoidal signals.

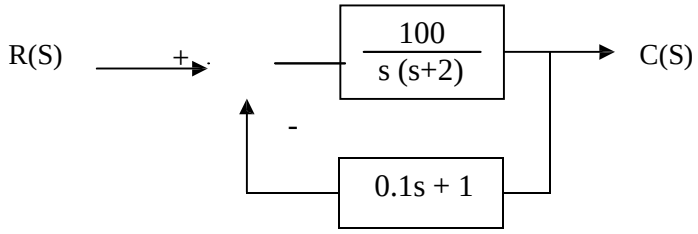
## PART B

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)

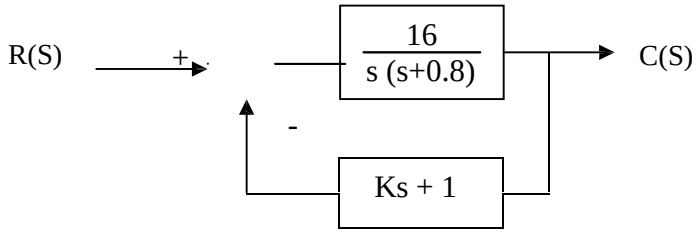
2. Derive the expressions for Rise time, Peak time, Peak overshoot, delay time (16)

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 $\varsigma$ =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 $r(t) = a_0 + a_1 t + a_2 /2\, t^2$ (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

## PART- A (2 MARKS)

**1.What is frequency response?**

A frequency responses the steady state response of a system when the input to the system is a sinusoidal signal.

**2.List out the different frequency domain specifications?**

The frequency domain specification are i)Resonant peak. ii)Resonant frequency.

**3.Define –resonant Peak?**

The maximum value of the magnitude of closed loop transfer function is called resonant peak.

**4.Define –Resonant frequency?**

The frequency at which resonant peak occurs is called resonant frequency.

**5.What is bandwidth?**

The bandwidth is the range of frequencies for which the system gain is more than 3 dbB. The bandwidth is a measure of the ability of a feedback system to reproduce the input signal ,noise rejection characteristics and rise time.

**6.Define Cut-off rate?**

The slope of the log-magnitude curve near the cut-off is called cut-off rate. The cut-off rate indicates the ability to distinguish the signal from noise.

**7.Define –Gain Margin?**

The gain margin, kg is defined as the reciprocal of the magnitude of the open loop transfer function at phase cross over frequency. Gain margin $kg = 1 / | G(j\omega pc) |$.

**8.Define Phase cross over?**

The frequency at which, the phase of open loop transfer functions is called phase cross over frequency $\omega pc$.

**9. What is phase margin?**

The phase margin ,γ is the amount of phase lag at the gain cross over frequency required to bring system to the verge of instability.

**11.Define Gain cross over?**

The gain cross over frequency $\omega_{gc}$ is the frequency at which the magnitude of the open loop transfer function is unity.

**12.What is Bode plot?**

The Bode plot is the frequency response plot of the transfer function of a system. A Bode plot consists of two graphs. One is the plot of magnitude of sinusoidal transfer function versus log ω.The other is a plot of the phase angle of a sinusoidal function versus log ω.

**13.What are the main advantages of Bode plot?**

The main advantages are:

i) Multiplication of magnitude can be in to addition.
ii) A simple method for sketching an approximate log curve is available.
iii) It is based on asymptotic approximation. Such approximation is sufficient if rough information on the frequency response characteristic is needed.
iv) The phase angle curves can be easily drawn if a template for the phase angle curve of 1+ jω is available.

**14.Define Corner frequency?**

The frequency at which the two asymptotic meet in a magnitude plot is called corner frequency.

**15.What is Polar plot?**

The Polar plot of a Sinusoidal transfer function G(jω) is a plot of the magnitude of G(jω) versus the phase angle/argument of G(jω) on polar or rectangular co-ordinates as ω is varied from zero to infinity.

**16.What is minimum phase system?**

The minimum phase systems are systems with minimum phase transfer functions. In minimum phase transfer functions, all poles and zeros will lie on the left half of s-plane.

**17.What is non-minimum phase transfer function?**

A transfer function which has one or more zeros in the right half of s-plane is known as non-minimum phase transfer function.

**18.What are M circles?**

The magnitude of closed loop transfer function with unit feed back can be shown to be in the for every value if M.These circles are called M circles.

**19.What is Nichols chart?**

The chart consisting if M & N loci in the log magnitude versus phase diagram is called Nichols chart.

**20.What are two contours of Nichols chart?**

Nichols chart of M and N contours, superimposed on ordinary graph. The M contours are the magnitude of closed loop system in decibels and the N contours are the phase angle locus of closed loop system.

**21.How is the Resonant Peak, resonant frequency, and bandwidth determined from Nichols chart?**

i) The resonant peak is given by the value of .contour which is tangent to G(jω ) locus. ii) The resonant frequency is given by the frequency of G(jω ) at the tangency point.
iii) The bandwidth is given by frequency corresponding to the intersection point of G(jω ) and –3dB M-contour.

**22.What are the advantages of Nichols chart?**

The advantages are:
i) It is used to find the closed loop frequency response from open loop frequency response. ii) Frequency domain specifications can be determined from Nichols chart.
iii) The gain of the system can be adjusted to satisfy the given specification

**23.What are N circles?**

If the phase of closed loop transfer function with unity feedback is α, then tan α will be in the form of circles for every value of α. These circles are called N circles.

## 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.

$G(S) = 400/ S (S+2)(S+10)$ (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.Explain in detail about M and N Circles with necessary equations. (16)

# UNIT-IV
# STABILITY OF CONTROL SYSTEM

## PART- A (2 MARKS)

**1.What is Nyquist contour?**

The contour that encloses entire right half of S plane is called nyquist contour.

**2.State Nyquist stability criterion.**

If the Nyquist plot of the open loop transfer function G(s) corresponding to the nyquist control in the S-plane encircles the critical point –1+j0 in the counter clockwise direction as many times as the number of right half S-plane poles of G(s),the closed loop system is stable.

**3.Define Relative stability.**

Relative stability is the degree of closeness of the system, it is an indication of strength or degree of stability.

**4.What are the two segments of Nyquist contour.**

i. An finite line segment C1 along the imaginary axis. ii.
An arc C2 of infinite radius.

**5.What are root loci?**

The path taken by the roots of the open loop transfer function when the loop gain is varied from 0 to α are called root loci.

**6.What is a dominant pole?**

The dominant pole is a air of complex conjugate pair which decides the transient response of the system.

**7.What are the main significances of root locus?**

i. The main root locus technique is used for stability analysis.
ii. Using root locus technique the range of values of K, for as table system can be determined.

**8. What are the effects of adding a zero to a system?**

Adding a zero to a system results in pronounced early peak to system response thereby the peak overshoot increases appreciably.

**9. State-Magnitude criterion.**

The magnitude criterion states that s=sa will be a point on root locus if for that value of s , | D(s) | = |G(s)H(s) | =1

**10.State – Angle criterion.**

The Angle criterion states that s=sa will be a point on root locus for that value of s, $\angle$ D(s) = $\angle$ G(s)H(s) =odd multiple of 180°

**11. What is a dominant pole?**

The dominant pole is a pair of complex conjugate pair which decides the transient response of the system.

**12.Define BIBO stability.**

A linear relaxed system is said to have BIBIO stability if every bounded input results in a bounded output.

**13.What is the necessary condition for stability.**

The necessary condition for stability is that all the coefficients of the characteristic polynomial be positive.

**14.What is the necessary and sufficient condition for stability.**

The necessary and sufficient condition for stability is that all of the elements in the first column of the routh array should be positive.

**15.What is quadrantal symmetry?**

The symmetry of roots with respect to both real and imaginary axis called quadrantal symmetry.

**16.What is limitedly stable system?**

For a bounded input signal if the output has constant amplitude oscillations Then the system may be stable or unstable under some limited constraints such a system is called limitedly stable system.

## 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. (i) Determine the range of K for stability of unity feedback system whose open loop transfer function is $G(s) = K / s (s+1)(s+2)$ (8) (ii) The open loop transfer function of a unity feed back system is given by $G(s) = K (s+1) / s3+as2+2s+1$. Determine the value of K and a so that the system oscillates at a frequency of 2 rad/sec. (8)

10.(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.Define Phase lag and phase lead?**

A negative phase angle is called phase lag. A positive phase angle is called phase lead.

**2.What are the two types of compensation?**

i. Cascade or series compensation
ii. Feedback compensation or parallel compensation

**3.What are the three types of compensators?**

i. Lag compensator
ii. Lead compensator
iii. Lag-Lead compensator

**4.What are the uses of lead compensator?**

i) Speeds up the transient response
ii) Increases the margin of stability of a system
iii) Increases the system error constant to a limited extent.

**5.What is the use of lag compensator?**

Improve the steady state behavior of a system, while nearly preserving its transient response.

**6.When is lag lead compensator is required?**

The lag lead compensator is required when both the transient and steady state response of a system has to be improved.

**7.What is a compensator?**

A device inserted into the system for the purpose of satisfying the specifications is called as a compensator.

**8.What is Compensation?**

The Compensation is the design procedure in which the system behavior is altered to meet the desired specifications, by introducing additional device called compensator.

**9.Why Compensation is necessary in feedback control system?**

In feedback control systems compensation is required in the following situations.

i) When the system is absolutely unstable, then compensation is required to stabilize the system and also to meet the desired performance.

ii) When the system is stable, compensation is provided to obtain the desired performance.

**10.When lag/lead/lag-lead compensation is employed?**

Lag compensation is employed for a stable system for improvement in steady state performance.
Lead compensation is employed for stable/unstable system for improvement in transient- state performance.
Lag-Lead compensation is employed for stable/unstable system for improvement in both steady-state and transient state performance.

## 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 $\geq 45^{o}$, (ii) Steady state error for a unit ramp input $\leq 1/15$, (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 $Kv > 5$sec 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 $\geq$ 50 (ii) Phase Margin is $\geq$ 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 $\geq$33 º. And Kv $\geq$30. (16)

14. 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 $\leq$ 0.04 rad. (16)

Reg. No. : | | | | | | | | | | | |

**V 4560**

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2008.

Fifth Semester

Electronics and Communication Engineering

EC 1304 — CONTROL SYSTEMS

(Regulation 2004)

Time : Three hours Maximum : 100 marks

(Provide Polar graph, semilog)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the mathematical model of the given mass-spring-dashpot system in Fig. 1.

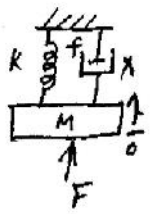



Fig. 1.

2. Define the transfer function of a system.

3. Define the type and order of a system.

4. Determine the stability of the following system using Routh criterion.

   (a) $G(s)H(s)=\dfrac{1}{(S-2)(S+4)}$.

   (b) $G(s)H(s)=\dfrac{9}{S^2(S+2)}$.

5. Define Nyquist stability Criterion.

6. The specification given on a certain 2nd order feedback control system is that the overshoot of the step response should not exceed 25%. What are the corresponding limiting values of the damping ratio $\delta$ and peak resonance $M_r$?

7. Mention the need for lead compensation and lag compensation.

8. Mention the characteristics of PI controller.

9. Draw a closed loop control system.

10. What is a synchro?

PART B — (5 × 16 = 80 marks)

11. (a) A dynamic vibration absorber is shown in Fig. 2. This system is representative of many situations involving the vibration of machines containing unbalanced components. The parameters $M_2$ and $K_{12}$ may be chosen so that the main mass $M_1$ does not vibrate when $F(t)=a\sin w_0 t$

(i) sketch the analogous electrical circuit based on force current analogy

(ii) obtain differential equation describing the system.

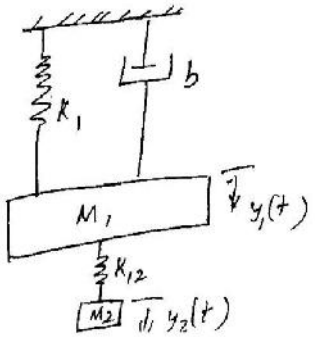



Fig. 2.

Or

(b) Obtain the output of the system shown in Fig. 3. (16)

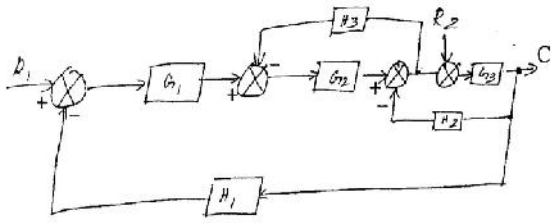



Fig. 3.

12. (a) (i) Certain measurements were conducted on a servo mechanism which show the system response as $c(t)=1+0.2e^{-60t}-1.2e^{-10t}$ when subjected to a unit step input.

(1) Find the expression for closed-loop transfer function.

(2) Obtain the undamped natural frequency and damping ratio. (8)

(ii) Determine the value of '$K$' and '$\alpha$' such that the system has a damping ratio of 0.7 and an undamped natural frequency of 4 rad/sec for the system shown in Fig. 4. (8)

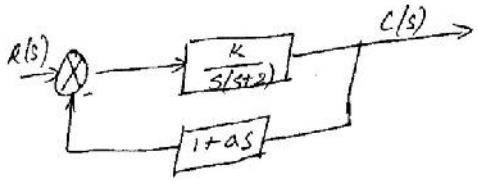



Fig. 4.

Or

(b) A system is described by

$$\frac{d^2y}{dt^2}+8\frac{dy}{dt}+25y(t)=50x(t).$$

Evaluate the response and maximum output for a step of 2.5 units. (16)

13. (a) Draw the Bode plot for a unity feedback system with $G(s)=\frac{K(S+0.3)}{(S+4)(S^2+30S+20)}$ where $K=2000$. Determine the gain margin, phase margin, $w_{gc}$ and $w_{pc}$. Comment on stability. Determine the value of $K$ to obtain phase margin of 30°. (16)

Or

(b) Apply Nyquist stability criterion to the system with loop transfer function $G(s)H(s)=\frac{4S+1}{S^2(1+s)(1+2s)}$ and ascertain its stability. (16)

14. (a) Design a compensating network for $G(s)=\frac{K}{S(1+0.2S)(1+0.01S)}$ so that its phase margin at least will be 40° and steady state error will be in the final position will not exceed 2% of the final velocity of 50 m/sec. (16)

Or

(b) Write short notes on :

(i) PD controller. (8)

(ii) PI controller. (8)

15. (a) What are servometer? Explain in detail their application in control system. (16)

Or

(b) Describe the electromechanical-hydraulic control system with derivation of its transfer function. (16)