7. SUBJECT DETAILS

7.6. LINEAR CONTROL SYSTEMS

7.6.1 OBJECTIVE AND RELEVANCE

In this course it is aimed to introduce to the students the principles and applications of control systems in everyday life. The basic concepts of block diagram reduction, time domain analysis solutions to time invariant systems and also deals with the different aspects of stability analysis of systems in frequency domain and time domain.

The main objective of this course is to give the student a complete understanding of control systems that play a vital role in the advances in engineering and science. In addition to its extreme importance in space vehicle systems, missile guidance systems, robotic systems and the like, automated control has become an important and integral part of modern manufacturing and industrial processes. The advances in theory and practice of automatic control provide the means for attaining optimal performance of dynamic systems, improving productivity, relieving the drudgery of many routine repetitive manual operations and the time saving of various operations of the systems. This course is introduced to enable the student to understand the process of simulation and modeling of the control systems.

7.6.2 OUTCOME

After going through this course the student gets a thorough knowledge on open loop and closed loop control systems, concept of feedback in control systems, mathematical modeling and transfer function derivations of translational and rotational systems, Transfer functions of synchros, AC and DC servo motors, Transfer function representation through block diagram algebra and signal flow graphs, time response analysis of different ordered systems through their characteristic equation and time domain specifications , stability analysis of control systems in S-domain through R-H criteria and root locus techniques, frequency response analysis through bode diagrams, with which he/she can able to apply the above conceptual things to real world electrical and electronics problems and applications.

7.6.3 PREREQUISITES

Basic knowledge on network theory, Fourier and Laplace transforms elementary matrix algebra and basic electrical machines theory.

7.6.4.1 JNTU SYLLABUS

UNIT-I
OBJECTIVE

The objective of this unit is to give an idea on various control systems, the importance of feedback in control systems and the methodology of obtaining mathematical model of any physical system.

SYLLABUS
INTRODUCTION:

Concepts of control systems, open loop and closed loop control systems and their differences, different examples of control systems, classification of control systems, feedback characteristics, and effects of feedback. Mathematical models, differential equations, impulse response and transfer functions, translational and rotational mechanical systems.

UNIT-II
OBJECTIVE

The objective of this unit is to deal with the constructional and operational features of control system components and the various tools available for the reduction of complex systems into simpler ones.

SYLLABUS
TRANSFER FUNCTION REPRESENTATION:

Transfer function of DC servo motor, AC servo motor, synchro transmitter and receiver, block diagram representation of systems considering electrical systems as examples, block diagram algebra, representation by signal flow graph, reduction using Mason's gain formula.

UNIT-III
OBJECTIVE

The objective of this unit is to deal with the transient and steady state analysis of various systems for different types of test signals and the study of proportional derivative and proportional integral systems.

SYLLABUS
TIME RESPONSE ANALYSIS:

Standard test signals, time response of first order systems, characteristic equation of feedback control systems, transient response of second order systems, time domain specifications, steady state response, steady state errors and error constants, effects of proportional derivative, proportional integral systems.

UNIT-IV

OBJECTIVE

The objective of this unit is to deal with the concept of stability, various stability criterions for determining the stability of a given system and the graphical technique available for the analysis and design of control systems.

SYLLABUS

STABILITY ANALYSIS IN S-DOMAIN:

The concept of stability, Routh's stability criterion, qualitative stability and conditional stability, limitations of Routh's stability

Root Locus Technique:

The root locus concept, construction of root loci-effects of adding poles and zeros to G(s)H(s) on the root loci.

UNIT-V

OBJECTIVE

The objective of this unit is to deal with the analysis of control systems using frequency response plots and determination of transfer function from Bode plots.

SYLLABUS

FREQUENCY RESPONSE ANALYSIS:

Introduction frequency domain specifications, Bode diagrams, determination of frequency domain specifications and transfer function from the Bode diagram phase margin and gain margin-stability analysis from Bode plots.

7.6.4.2 GATE SYLLABUS

UNIT –I

Principles of feedback

UNIT-II

Transfer function, block diagram

UNIT-III

Response for linear time invariant systems, steady state errors

UNIT-IV

Routh stability criterion, root locus

UNIT-V

Bode plots

7.6.4.3 IES SYLLABUS

UNIT -I
Mathematical modelling of physical system

UNIT -II
Control systems components: Electromechanical components block diagrams and signal flow graphs and the reduction.

UNIT-III
Time domain and frequency domain analysis of linear dynamical system. Errors for different type of inputs

UNIT-IV
Stability analysis using Routh-Hurwitz array, root locus

UNIT-V
Bode plot, estimation of gain and phase margin

7.6.5 SUGGESTED BOOKS

TEXT BOOKS

T1 Control Systems theory and applications, S.K Bhattacharya, Pearson.
T2 Control Systems,N.C.Jagan,BS Publications

REFERENCE BOOKS

R1 Control Systems, Anand Kumar, PHI, 2008.
R2 Control Systems Engineering,S.Palani,Tata-McGraw-Hill.
R3 Control Systems, Dhanesh N.Manik, Cengage Learning.
R4 Control Systems Engineering, I. J. Nagrath and M. Gopal, 2nd Edn.,New Age International (P) Ltd.
R5 Control Systems by N.K Sinha, 3rd Edn.,New Age International (P) Ltd, 1998.

7.4.6 WEB SITES

1. www.contro.eng.com.ac.uk
2. melot.ee.usyd.edu.au
3. ocw.mit.edu
4. regpro.mechatronic.uni
5. www.control.utoronto.ca
6. www.controlengg.com
7. www.insrumentation.com

8. www.ecpsystems.com
9. www.ieeecss.org

7.4.7 EXPERTS' DETAILS

INTERNATIONAL

1. Dr.Rodolphe Sepulehre,
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7.6.8 JOURNALS

INTERNATIONAL

1. IEEE Transactions on Automatic Control
2. IEEE Control Systems Magazine
3. Instrumentation and Control

NATIONAL

1. Journal of Institution of Engineers (Electrical Enggneering)
2. Journal of Systems Society of India
3. Journal of Instrument Society of India

7.2.9 FINDINGS AND DEVELOPMENTS

1. Sufficient Conditions for Closed Loop Asymptotic Controllability and Stabilization by Smooth Time-varying Feedback Integrator, J. Tsinias, IEEE Transactions on Automatic Control System, Vol. 53, No 8, October 2008.
2. Robust Adaptive Control of Feedback Linearizable MIMO Non-linear Systems with Prescribed Performance, C.P. Bechliou Lis and G A Rovithakis, IEEE Transactions on Automatic Control System, Vol. 53, No 8, October 2008.
3. Input to State Stability of Time Delay Systems: A Link with Exponential Stability, P. Pipe and M.Dambrise, Transactions on Automatic Control System, Vol 53, No. 6, July 2008.
4. A Scenario Approach to Robost Control Design, Giuseppe C.Cda fire and Marco. C. Campi, IEEE Transactions on Automatic Control System, Vol.51, No.5, May 2006.
5. Non Blocking Supervisory Control of State Tree Structures, Chuan. Ma and W.M.Wonham, IEEE Transactions on Automatic Control System, Vol.51, No.5, May 2006.

7.1.10 SESSION PLAN

i. THEORY

Sl. No.	Topics in JNTU syllabus	Modules and Sub modules	Lecture No.	Suggested Books	Remarks
		UNIT-I			
1	Concepts of control systems	Definition Examples of day to day application of control systems	L1	T1-Ch1, T2-Ch1 R1-Ch1, R2-Ch1 R3-Ch1	GATE
2	Open loop and closed loop control systems and their difference	Open and closed loop definition Comparison between open and closed loop	L2	T1-Ch1, T2-Ch1 R1-Ch1, R2-Ch1 R3-Ch1	GATE IES
		Examples of open loop and closed loop control systems	L3	T1-Ch1, T2-Ch1 R1-Ch1, R2-Ch1 R3-Ch1	GATE IES
3	Different examples of control systems Classification of control systems	Different examples of control systems Classification of control systems	L4	T1-Ch1, R1-Ch1 R2-Ch1, R3-Ch1	
4	Feedback characteristics Effects of feed back	Feedback definition and importance Effect of feedback on gain Effect of feedback on stability	L5	T1-Ch1, T2-Ch3 R1-Ch1, R2-Ch4	GATE IES
		Reduction of parametric variations by use of feedback Sensitivity definition Sensitivity of system to parametric changes for open loop and closed loop system Effect of feedback on external disturbances	L6	T1-Ch1, T2-Ch3 R2-Ch4, R3-Ch7	GATE IES
		Control over system dynamics by feedback Effect of feedback on system dynamics Effect of feedback on band width	L7	T2-Ch3,R1-Ch1 R2-Ch4	GATE IES
5	Mathematical models Differential equations Impulse response and transfer functions	Transfer function, definition Concept of poles and zeros Transfer function from differential equations of physical systems Impulse response model	L8	T1-Ch1, T2-Ch2 R1-Ch3, R2-Ch2 R3-Ch2	GATE IES
6	Translational and rotational mechanical systems	Significance of mathematical modelling Modelling of mechanical systems using translational and rotational elements	L9	T1-Ch1, T2-Ch2 R1-Ch3, R2-Ch2 R3-Ch2	GATE IES
		Modelling of electrical systems	L10	T1-Ch4, T2-Ch2 R2-Ch2, R3-Ch2	GATE IES
		Analogy between mechanical translational, rotational and electrical systems	L11	T2-Ch2, R2-Ch2 R3-Ch2	GATE IES
Sl.	**Topics in JNTU**	**Modules and Sub modules**	**Lecture**	**Suggested Books**	**Remarks**

No.	syllabus		No.		
UNIT-II					
7	Transfer functions of DC servomotor	Basic principle and operation Features of field and armature controlled DC servomotor Characteristics and applications of DC servomotor	L12	T1-Ch4, T2-Ch4 R1-Ch4, R2-Ch2	
8	AC servomotor	Construction principle and operation Torque-speed characteristics Features and application of AC servomotor	L13	T2-Ch4,R2-Ch2	
9	Synchro transmitter and receiver	Synchro control transformer Applications	L14	T2-Ch4	
10	Block diagram representation of systems considering electrical systems as examples	Block diagram representation of RC circuits, DC motor armature and field control	L15	T1-Ch4, T2-Ch2 R2-Ch2, R3-Ch2	GATE IES
11	Block diagram algebra	Block diagram of closed loop system Block diagram of SISO and MIMO systems	L16	T1-Ch4, T2-Ch2 R2-Ch2, R3-Ch2	GATE IES
		Rules of block diagram algebra Problems	L17	T1-Ch3, T2-Ch2 R2-Ch2	GATE IES
12	Representation of signal flow graph, reduction through Mason's gain formulae	Properties and terminology of signal flow graph Methods to obtain signal flow graph from system equations and block diagram and vice versa	L18	T1-Ch4, T2-Ch2 R2-Ch2, R3-Ch2	GATE IES
		Derivation of Mason's gain formulae Comparison of block diagram and SFG methods	L19	T1-Ch3, T2-Ch2 R2-Ch2	GATE IES
		Problems	L20	T1-Ch3, T2-Ch2 R2-Ch2, R3-Ch5	GATE IES
UNIT-III					
13	Standard test signals	Definition and classification Standard test signals Step Ramp Parabolic	L21	T1-Ch7, T2-Ch5 R1-Ch4, R2-Ch5	GATE IES
14	Time response of 1st order systems	Time response of 1st order systems with step, ramp, parabolic inputs	L22	T1-Ch7, T2-Ch5 R1-Ch4, R2-Ch5	GATE IES
15	Characteristic equation of feedback control system	Characteristic equation of feedback control system	L23	T1-Ch7, T2-Ch5 R1-Ch4, R2-Ch5	GATE IES
Sl. No.	**Topics in JNTU syllabus**	**Modules and Sub modules**	**Lecture No.**	**Suggested Books**	**Remarks**
16	Transient response of 2nd order systems	Derivation of unit step response of 2nd order systems	L24	T2-Ch4, T2-Ch5 R1-Ch7, R2-Ch5	GATE IES

		Effect of zeta on 2nd order system performance		R3-Ch4	
17	Time domain specifications	Derivation of peak time, peak overshoot, settling time and rise time	L25	T2-Ch4, T2-Ch5 R1-Ch7, R2-Ch5 R3-Ch4	GATE IES
18	Steady state response Steady state errors and error constants	Derivation of steady state error Effect of input (type and magnitude) on steady state error Analysis of type 0,1 & 2 systems Disadvantages of steady state error coefficients method	L26	T2-Ch5, R1-Ch7 R2-Ch5, R3-Ch7	GATE IES
		Problems	L27	T2-Ch5, R1-Ch7 R2-Ch5, R3-Ch7	GATE IES
19	Effects of proportional derivative and proportional integral systems	PD and PI controllers Transfer function Purpose Realization	L28	R1-Ch10, T2-Ch5 R3-Ch9	GATE IES
		UNIT-IV			
20	The concepts of stability	BIBO Stability Absolute and relative stability	L29	T2-Ch6, R1-Ch6 R2-Ch6, R3-Ch6	GATE IES
21	Routh stability criterion Qualitative stability, conditional stability and limitations of Routh's stability	Hurwitz criterion Necessary conditions Routh criterion Special cases Applications Advantages and limitations	L30	T2-Ch5, T2-Ch6 R1-Ch6, R2-Ch6 R3-Ch6	GATE IES
		Problems	L31	T2-Ch6, T2-Ch5 R1-Ch6, R2-Ch6 R3-Ch6	GATE IES
22	The root locus concept construction of root loci	Basic concept of root locus Angle and magnitude criterion	L32	T2-Ch6, T2-Ch7 R1-Ch8, R2-Ch7 R3-Ch6	GATE IES
		Rules for construction of root locus Advantages of root locus method Problems	L33	T2-Ch6, T2-Ch7 R1-Ch8, R2-Ch7 R3-Ch6	GATE IES
		Problems	L34	T2-Ch6, T2-Ch7 R1-Ch8, R2-Ch7 R3-Ch6	GATE IES
23	Effects of adding poles and zeros to G(s)H(s) on the root loci	Effects of adding open loop poles and zeros	L35	T2-Ch10, R1-Ch8 R3-Ch4	GATE IES
Sl. No.	**Topics in JNTU syllabus**	**Modules and Sub modules**	**Lecture No.**	**Suggested Books**	**Remarks**
		UNIT-V			
24	Introduction	Advantages and limitations of frequency response methods	L36	T2-Ch8, R1-Ch9 R2-Ch8	GATE IES
25	Frequency domain specifications	Co-relation between time domain and frequency domain for 2nd order systems Problems	L37	T1-Ch9, T2-Ch8 R1-Ch8	GATE IES
26	Bode diagrams	Bode plots of standard factors of G(jw) H(jw)	L38	T1-Ch9, T2-Ch8 R1-Ch8, R3-Ch10	GATE IES
		Steps to sketch Bode plot Advantages of Bode plot	L39	T1-Ch9, T2-Ch8 R1-Ch8, R2-Ch8	GATE IES

		Problems		R3-Ch10	
		Problems	L40	T1-Ch9, T2-Ch8 R1-Ch8, R2-Ch8 R3-Ch10	GATE IES
27	Determination of frequency domain specifications and transfer function from Bode diagrams Phase margin and gain margin Stability analysis from Bode plots	Concept of phase and gain margin Calculation and improvement of G.M and P.M.	L41	T1-Ch9, T2-Ch9 R1-Ch8, R3-Ch10	GATE IES
		Relative stability analysis from G.M and P.M Calculation of transfer function from magnitude	L42	T1-Ch9, T2-Ch9 R1-Ch8, R3-Ch10	GATE IES
		Problems	L43	T1-Ch9, T2-Ch9 R1-Ch8, R3-Ch10	GATE IES

ii. TUTORIAL

o	**Topics scheduled**	**Salient topics to be discussed**
1	Concepts of control systems Open loop and closed loop control system and their difference Different examples of control systems Classification of control systems	Discussion of various examples of control systems in day to day life Classification of control systems
2	Feedback characteristics of control systems Mathematical models Differential equations Impulse response and transfer functions	Transfer functions of various electrical networks
3	Translational and rotational mechanical systems Block diagram representation of systems considering electrical systems as examples	Determination of transfer function of translational and rotational mechanical systems Representation of complex systems by block diagram
4	Block diagram algebra Representation of signal flow graph Reduction through Mason’s gain formulae	Problems on block diagram algebra and Mason's gain formula
5	Transfer functions of DC servomotor and AC servomotor Synchro transmitter and receiver	Review on mathematical models of DC servomotor and AC servomotor
6	Standard test signals Time response of 1st order systems Characteristic equation of feedback control system Transient response of 2nd order systems	Transient response of 2nd order system for various standard test signals
7	Time domain specifications Steady state response Steady state errors and error constants Effects of proportional derivative and proportional integral systems	Problems on time domain specifications Steady state errors and error constants
8	The concepts of stability Routh stability criterion Qualitative and conditional stability	Problems on Routh stability criterion
9	Root locus concept Construction of root locii Effects of adding poles and Zeros to G(s)H(s) on root locii	Problems on construction of root locus for various systems

10	Frequency response analysis Introduction Frequency domain specifications Bode diagrams	Problems on frequency domain specifications Construction of Bode plot for various systems
11	Determination of frequency domain specifications and transfer function from Bode diagrams Phase margin and gain margin Stability analysis from Bode plot	Problems on determination of transfer function from Bode plots Problems on phase margin and gain margin

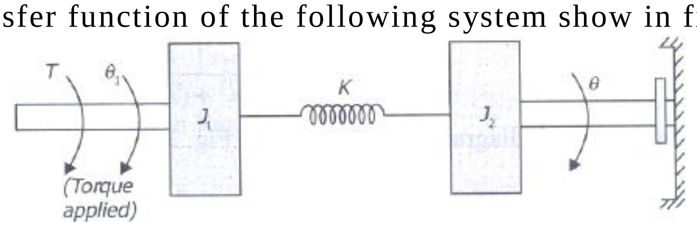
7.6.11 STUDENT SEMINAR TOPICS

1. Nano Positioning for Probe-based Data Storage, Abu Sebastian, Vol. 28, No. 4, IEEE Control Systems Magazine, August 08.
2. Sensing and Control in Optical Drives, Amir H. Chaghajerdi, Vol. 28, No. 3, IEEE Control Systems Magazine, June 08.
3. Functional Electrical Stimulation, Closed-loop Control of Induced Muscle Contractions, C.L. Lynch and M.R. Popovic, Vol. 98, No. 2, IEEE Control Systems Magazine, April 08.
4. Coordinating Control for an Agricultural Vehicle with Individual Wheel Speeds and Steering Angles, Robo Armwrestler, Chul-Goo Kang, Vol. 28, No. 5, IEEE Control Systems Magazine, October 08.
5. Control of Variable Speed Wind Turbines,K.E.Johnson,Lucy Y.Rao,Mark.J.Balas and Lee J.Fingersh,Vol.26,No.3,IEEE Control System Magzine,June 2006.
6. Robust Tuning of PI and PID Controllers, Birgitta Kristiansson and Bengt Lennartson,Vol.26, No.1, IEEE Control System Magzine, February 2006.

7.6.12 QUESTION BANK

UNIT-I

1. a) Explain the feedback effect on parameter variation.
   b) Find the transfer function of the following system show in figure.



(Dec 14,May/June 13,Sep 08)

1. a) Explain the various types of control systems with suitable examples.

2. a) Derive the relavent expressions to establish the effect of feedbackon sensitivity ,signal to noise ratio and rate of response

b) For the electrical systems shown in the figureP1(C)for the given input i_1,find v_3 in terms of i_1

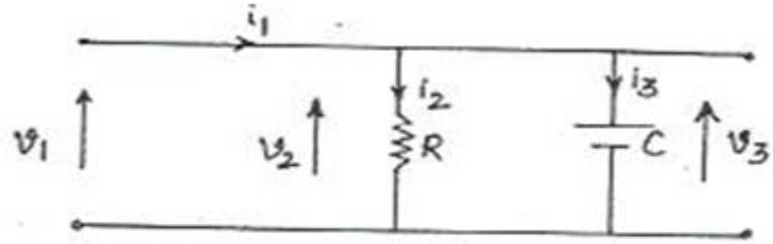
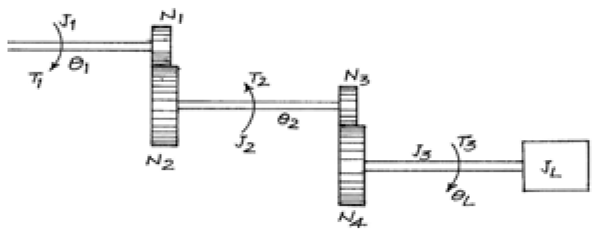


Fig. P1(c)

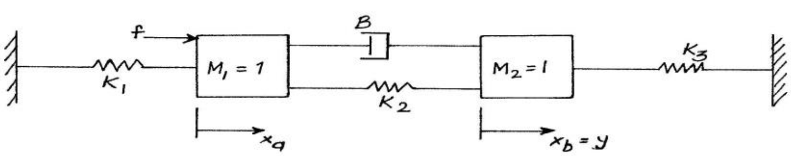
(Nov/Dec 12)

3. For the geared system shown below in Figure 3, find the transfer function relating the angular displacement θ_L to the input torque T1, where J1, J2, J3 refer to the inertia of the gears and corresponding shafts. N1, N2, N3, and N4 refer to the number of teeth on each gear wheel.



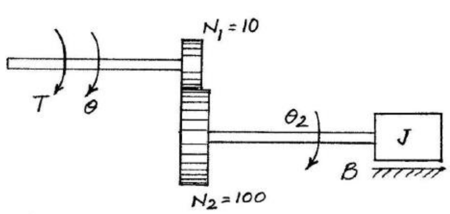
(May/June 2012)

4. Derive the differential equation relating the position y (t) and the force f (t) as shown in figure 5.Determine the transfer function y/f



(May/June 2012)

5. A load having moment of inertia J and frictional coefficient B is driven through a gear as shown in Figure 10, write the differential equations and find transfer function $\theta_2(s)/T(s)$



(May/June 2012)

6. (a) Distinguish between open loop and closed loop systems. Explain merits and demerits of open loop and closed loop systems.
   (b) With suitable example explain the classification of control systems.

(May/June 2012)

7. i. Explain the effect of feedback on stability.
   ii. Explain the temperature control system concepts using open loop as well as closed loop system.

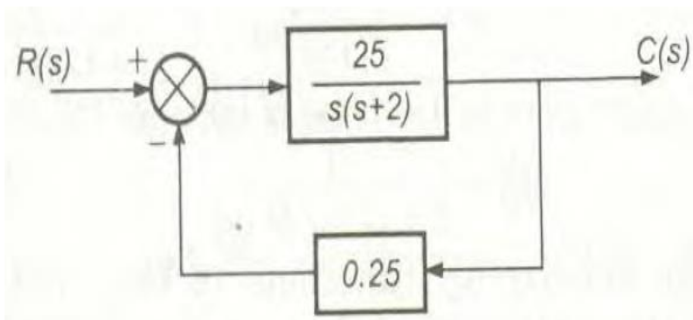
(Apr 11)

8. i. Explain temperature control system with neat block diagram.
   ii. Human being is an example of closed loop system. Justify your answer.

(Dec 10)

9. i. Explain sensitivity?
   ii. Determine the sensitivity of the closed loop system shown in figure (b) at w= 1 rad/sec w.r.t
   a. forward path transfer function
   b. feedback path transfer function.

(Dec 10)



10. Explain the following terms :
    i. Impulse response
    ii. Rotational mechanical systems
    iii. Translational systems
    iv. Sensitivity. **(Dec 10)**

11. i. How can you control the system dynamics by using feedback?
    ii. What is a mathematical model of a physical system? Explain briefly. **(Dec 10)**

12. i. Explain the traffic control system concepts using open loop as well as closed loop system.
    ii. Why is negative feedback invariably preferred in closed loop systems?

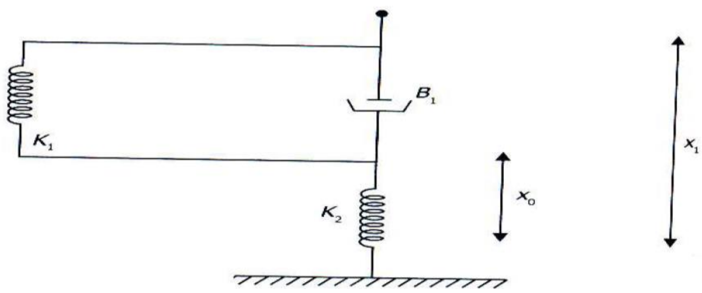
(May 10)

13 .Define and explain the following terms

i. Characteristic equation
ii. Order of a transfer function
iii. Type of a transfer function
iv. Poles and zeros of a transfer function. **(May 10, 09)**

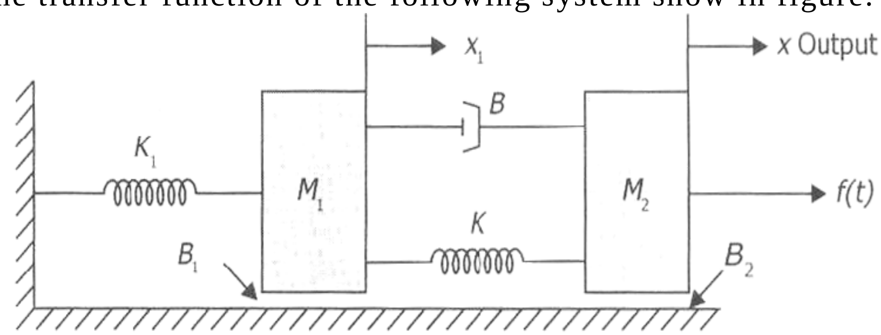
14. i. Illustrate at least three applications of feedback control systems?
ii. Explain translatory and rotary elements of mechanical systems? **(May 10)**

15. i. Write the important differences between open loop and closed loop systems with suitable examples.
ii. Obtain the transfer function $\frac{X_0(s)}{X_1(s)}$ of the following system. Shown in figure.

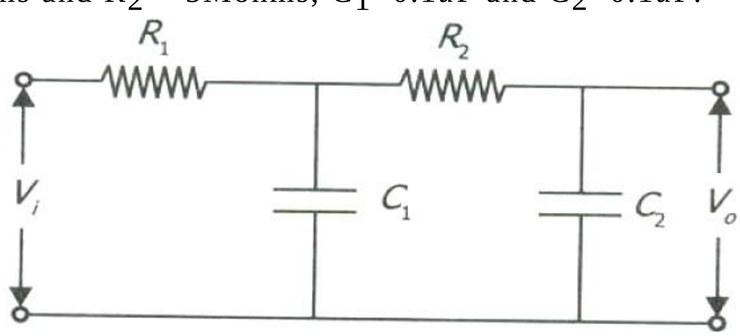


(May 10)

16. i. Find the transfer function of the following system show in figure.



ii. Derive the transfer function of the following network figure by assuming R_1=5Mohms and R_2 = 5Mohms, C_1=0.1uF and C_2=0.1uF.



(May 09, Sep 08)

17.i. Explain the difference between systems with feedback and without feedback.

ii. Explain the advantages of systems with feedback, with suitable examples. **(May 09)**

18.i. Explain and derive the relation between impulse response and transfer function.

ii. Find the transfer function $\frac{C(s)}{R(s)}$ of a system having differential equation.

$$9\frac{d^2c(t)}{dt^2} + 12\frac{dc(t)}{dt} + c(t) = r(t) + 2r(t-1)$$

(May 09)

19. Explain the following terms:

i. Linear systems and nonlinear systems

ii. Continuous systems and discrete systems

iii. Single input-single output systems (SISO) and multiple input-multiple output systems (MIMO)

iv. Static systems and dynamic systems. **(May 09)**

20. i Explain the linearizing effect of feedback.

ii. The dynamic behaviour of the system is described by the equation $\frac{dC}{dt} + 10C = 40e$, where 'e' is the input and 'C' is the output. Determine the transfer function of the system. **(May 09)**

21. i. Explain the effect of feedback on bandwidth?

ii. Explain reduction of parameter variations by use of feedback systems? **(May 09)**

22. Define and explain the following terms

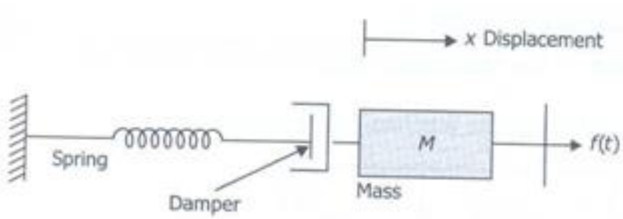
i. Characteristic equation

ii. Order of a transfer function

iii. Type of a transfer function

iv. Poles and zeros of a transfer function. **(May 09)**

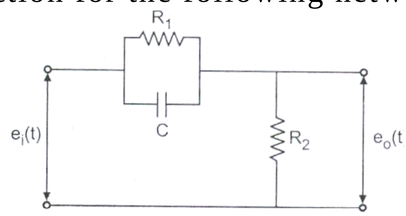
23.i. Find the transfer function for the following mechanical system: Shown in figure.



ii. Explain the limitations of closed loop system over open loop system.

(Sep 08)

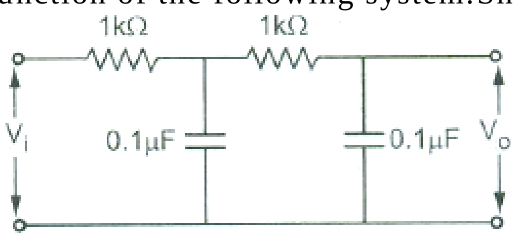
24. i.Obtain the transfer function for the following network Figure.



ii. Explain the effects of disturbance signals by use of feedback. **(Sep 08)**

26. i. Define transfer function and what are its limitations?

ii. Find the transfer function of the following system.Shown in figure.



(May 08)

27. i. Explain the traffic control system concepts using open loop as well as closed loop system.

ii. Why is negative feedback invariably preferred in closed loop systems?

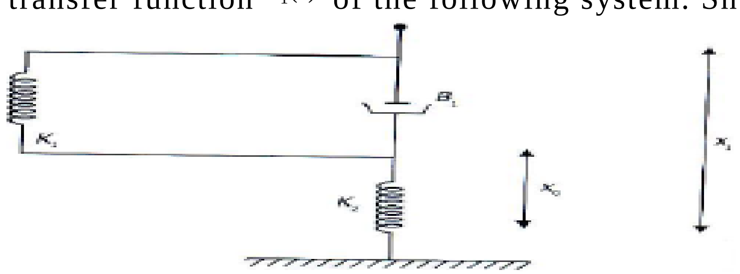
(May 08)

28. i. Explain the effect of feedback on stability.

ii. Explain the temperature control system concepts using open loop as well as closed loop system. **(Sep 08)**

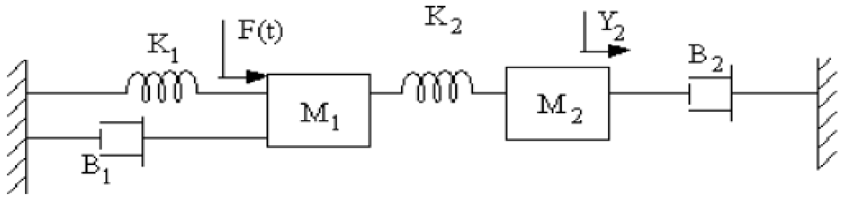
29. i. Write the important differences between open loop and closed loop systems with suitable examples.

ii. Obtain the transfer function $\frac{X_0(s)}{X_1(s)}$ of the following system. Shown in figure.



(May 08)

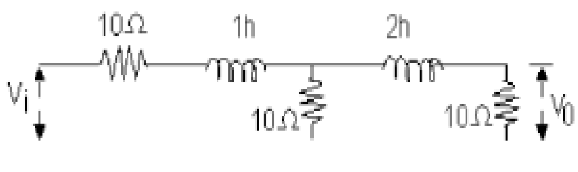
30. i. For the mechanical system Figure given, write down the differential equations of motion and hence determine the Y2(s)/F(s).



ii. Describe the analogy between electrical and mechanical systems. **(May 08)**

31. i. Explain, with example, the use of control system concepts to engineering and non engineering fields

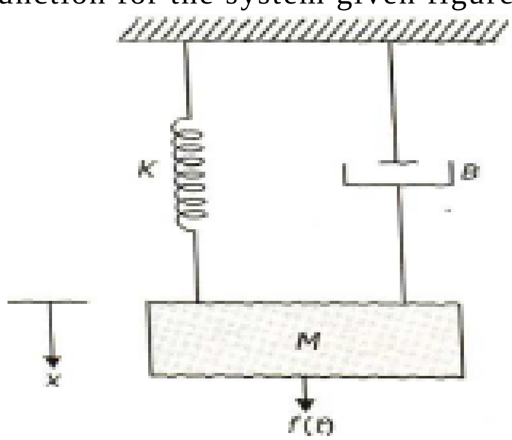
ii. For the electrical network given below, derive the transfer function



(May 08, 05)

32. i. Explain the basic components of control systems?

ii. Find the transfer function for the system given figure.

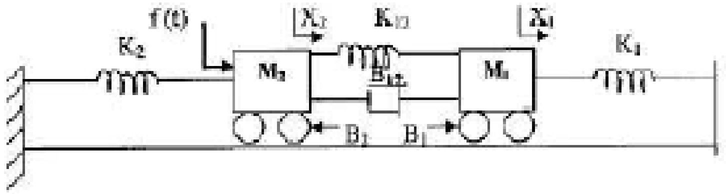


Where, M is the mass of the system.

K is the spring deflection

B is the coefficient of viscous damping. **(May 08)**

33. For the mechanical system given in Figure.



Obtain the following:

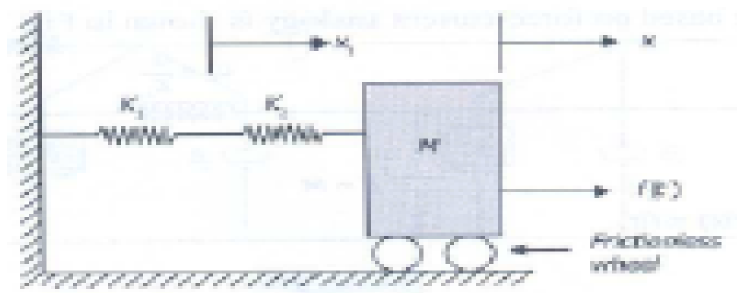
i. Mathematical model

ii. The transfer functions. $\frac{X_1(s)}{F(s)}$ and $\frac{X_2(s)}{F(s)}$ **(May 08, 06)**

34. i llustrate atleast three applications of feedback control systems?

ii. Explain translatory and rotary elements of mechanical systems? **(Sep 07)**

35. i. Obtain the transfer function of the following system and draw its analogous electrical circuit. Figure.



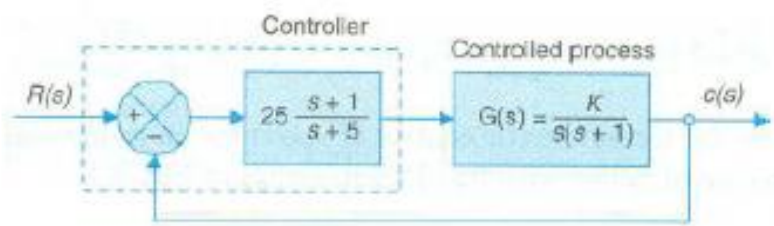
ii. Explain the advantages and features of transfer function. **(Sep, May 07)**

36. i. Explain the linearizing effect of feedback.

ii. The dynamic behaviour of the system is described by the equation, dC/ dt + 10C = 40e, where 'e' is the input and 'C' is the output. Determine the transfer function of the system. **(Sep 07)**

37 .i. Explain regenerative feedback?

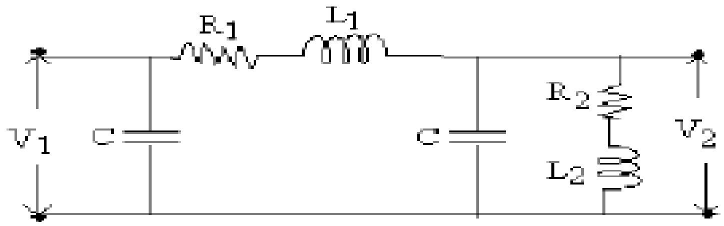
ii. Determine the sensitivity of the closed loop transfer function T(s) = C(s)/R(s) to variations in arameter K at *w* = 5 rad/sec. Assume the normal value of K is



(Sep 07)

38.i. Explain the differences between open-loop and closed-loop systems.

ii. Determine the Transfer Function of the electrical network. Figure



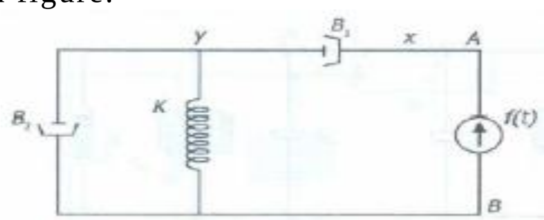
(May 07)

39. Explain the effect of feedback on noise to signal ratio. **(May 07)**

40.i. Explain the effect of feedback on the stability of a closed loop system?
ii. Explain the effect of feedback on the sensitivity of a closed loop system? **(May 07, 05)**

41. Define the following terms.
i. Concept of the system
ii. Control system. **(May 07)**

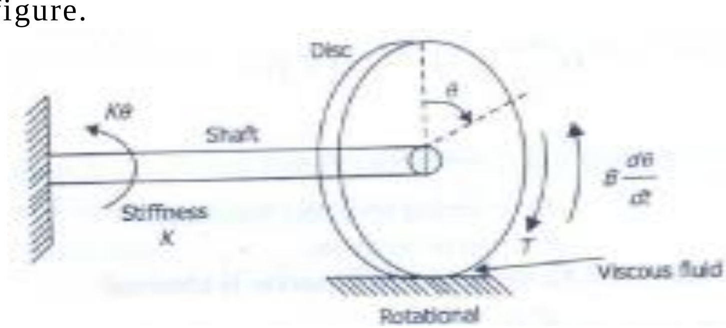
42.i. Explain the classification of control systems?
ii Find the transfer function relating displacement 'y' and 'x' for the following system. Shown in figure.



(May 07)

43.i. What is feedback? Explain the effects of feedback?
ii. What is the sensitivity function and explain it with respect to open loop and closed loop systems? **(May 07)**

44.i. Derive the transfer function for the following rotational mechanical systems. Shown in figure.



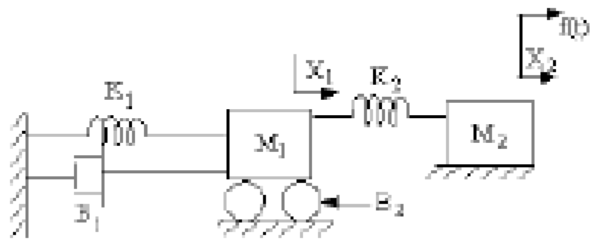
ii. List out the limitation of open loop systems over closed loop systems. **(May 07)**

45. Explain the operation of ordinary traffic signal, which control automobile traffic at roadway intersections. Why are they open loop control systems? How can traffic be controlled more effectively?

(Apr 06)

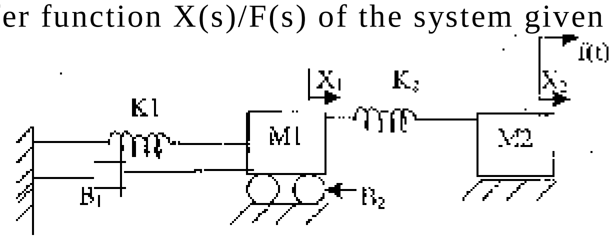
46. Explain the concept of multivariable control systems. **(Apr 06)**

47 Find the transfer function X(s)/F(s) of the system figure given below.



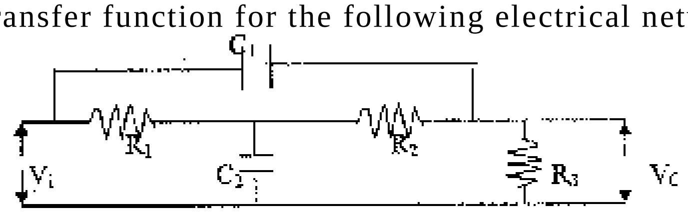
(Apr 06)

48. i. Find the transfer function X(s)/F(s) of the system given below:



ii. Define transfer function and determine the transfer function of RLC series circuit if voltage across the capacitor is output variable and input is voltage source V(s). **(Apr 06, 04)**

49. i. Define transfer function and what are its limitations.
ii. Obtain the transfer function for the following electrical network.



(Apr 06, 04)

50. By means of relevant diagrams explain the working principles of a practical closed loop system.

(Apr 06)

51. Distinguish between:
i. Linear and non linear system
ii. Single variable and multivariable control systems
iii. Regenerative and degenerative feeds back control systems.
Give an example for each of the above. **(Apr 05)**

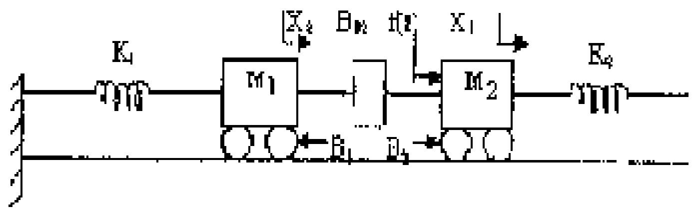
52. Define system and explain about various types of control systems with examples and their advantages.

(Apr 05)

53. i. Explain about various types of control systems with examples briefly.

ii. Explain the differences between open loop and closed loop system. **(Apr 05)**

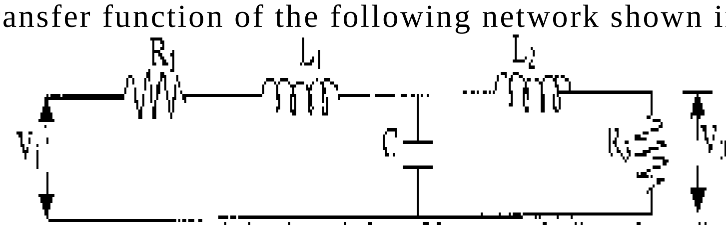
54. i. For the mechanical system given below, derive an expression for the transfer function



(Nov 03)

(Apr 04, 03)

55. Derive the transfer function of the following network shown in fig. :

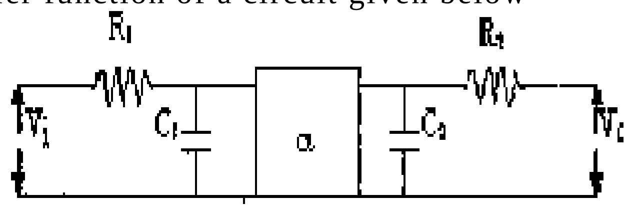


(Apr 04, Nov 03)

56. Discuss the effects of feedback on system dynamics by unit feedback and regenerative feedback. Give suitable examples **(Apr 04)**

57. Define system and explain about various types of control systems with examples and their advantages. **(Apr 04)**

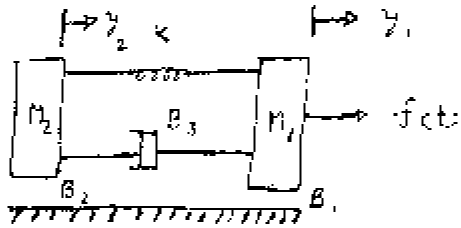
58. Find the transfer function of a circuit given below



(Nov 03)

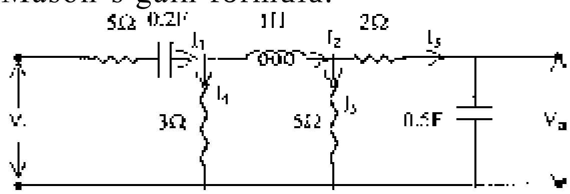
59. i. Discuss the advantages of providing feedback to an open-loop control system.

ii. Find the transfer functions $Y_1(S)/F(S)$ and $Y_2(S)/F(S)$ for the system shown in Fig.



(Nov 03)

60. For the electrical system shown below draw the signal flow graph and hence find the gain by Mason's gain formula.

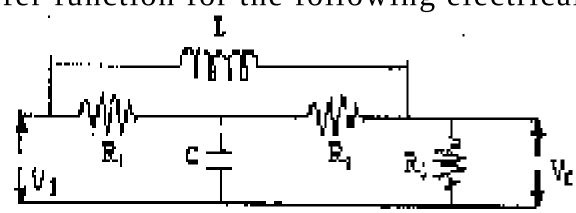


(Nov 03)

61. Explain the open loop control system with practical example **(Nov 03)**

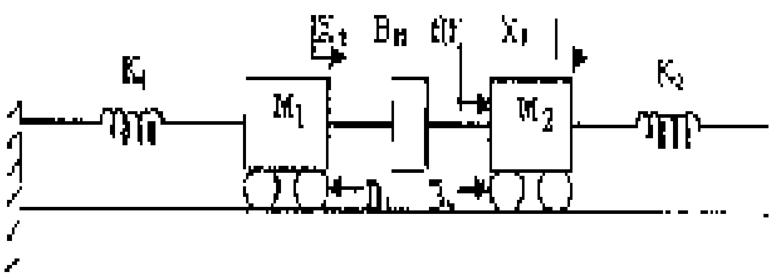
62.i. Explain the concepts of control systems.

ii. Obtain the transfer function for the following electrical network.



(Nov 03)

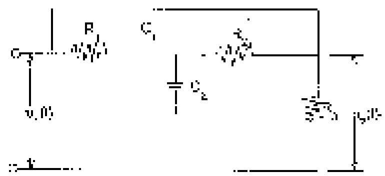
63. For the mechanical system given below, derive an expression for the transfer function



(Nov 03)

64. i. Explain the terms (a) time response (b) frequency response and (c) transfer function.

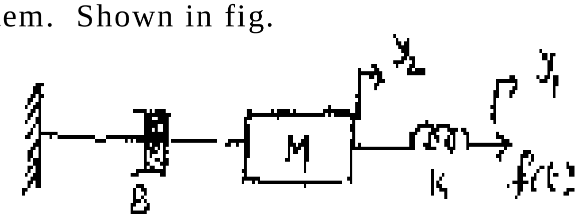
ii. Obtain the transfer function for the following electrical system.



iii. What are the different types of standard test input signals used in testing the response of a control system? Which type of input signal is widely used? Why? **(Apr 03)**

65. Derive the transfer function of a closed loop system **(Apr 03)**

66. Draw the analogous (use force-voltage analogy) electrical system for the mechanical system. Shown in fig.



(Apr 03)

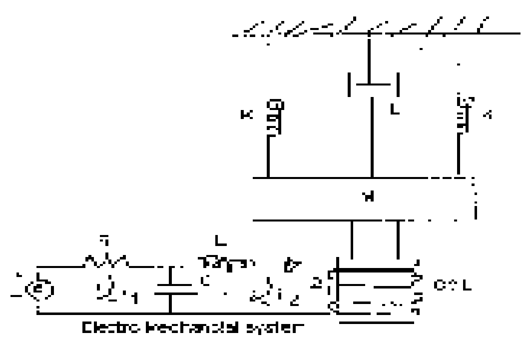
67. i. Explain the following terms with suitable examples. **(Jan 03)**

a. Open loop
b. Feed back
c. Signal flow graphs.

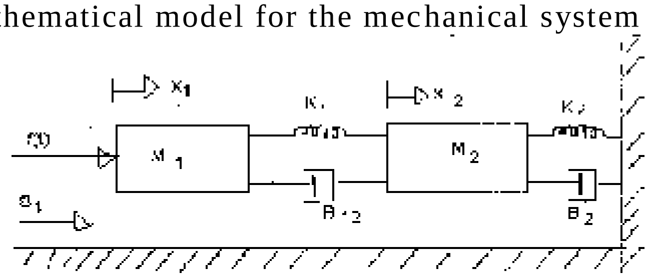
ii. Obtain the transfer function x(s)/Î(s) for the electromechanical system shown in figure.

Assuming that the coil has a back emf and the coil current i_2 produces a force

$Fc = k_2 i_2$ on the mass M.



68. i. Obtain the mathematical model for the mechanical system shown in figur



ii. Draw the force-voltage and force-current electrical analogous circuits for the system show in fig.

iii. Verify the result by writing mesh and node equations. **(Jan 03)**

69. What do you understand by the terms "Open-loop system", "closed loop-system", "Manually control system" and automatic control system? Give one practical example of each type with proper diagram and explanation.**(IES 93)**

UNIT-II

1. a) Derive the transfer function of field controlled dc servo motor.

b) The block diagram of a speed control system is shown below in figure2. Determine its transfer function.

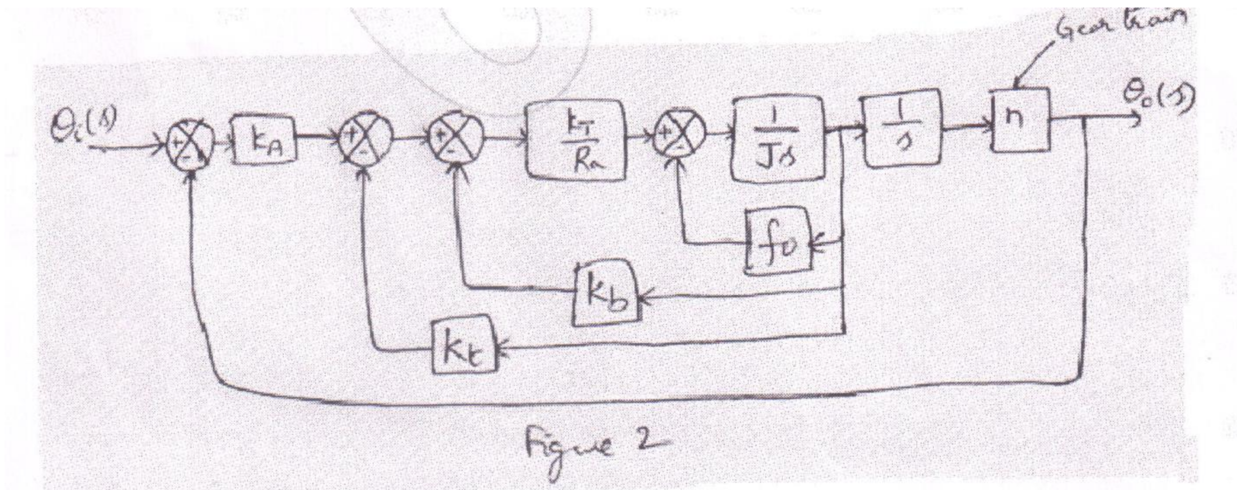
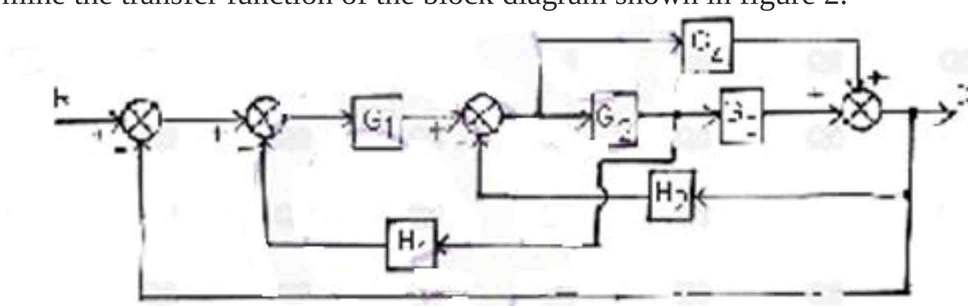


Figure 2

(Dec 14)

1. a) Determine the transfer function of the block diagram shown in figure 2.



b) Determine the closed loop transfer function for the signal flow graph shown in the figure 3.

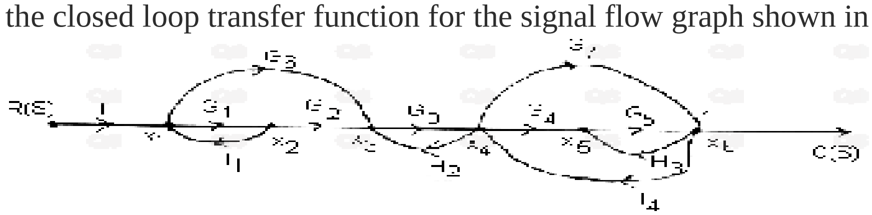


Figure.3

(May/June13)

2. Find the closed loop transfer function of the system whose block diagram is given in the fig.P2 using block diagram reduction techniques and verify the result using signal flow graph technique

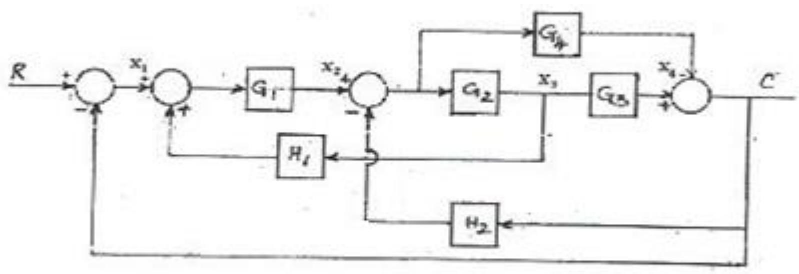
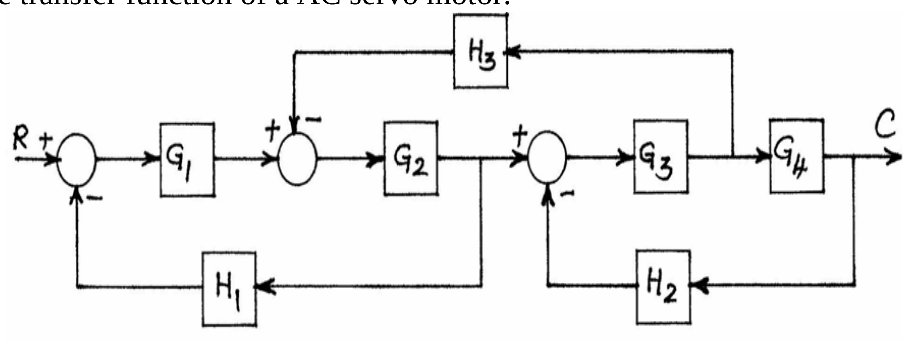


Fig P2.

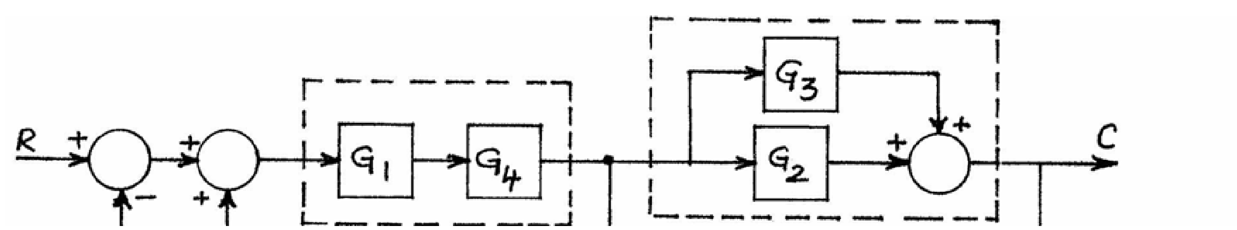
(Nov/Dec12)

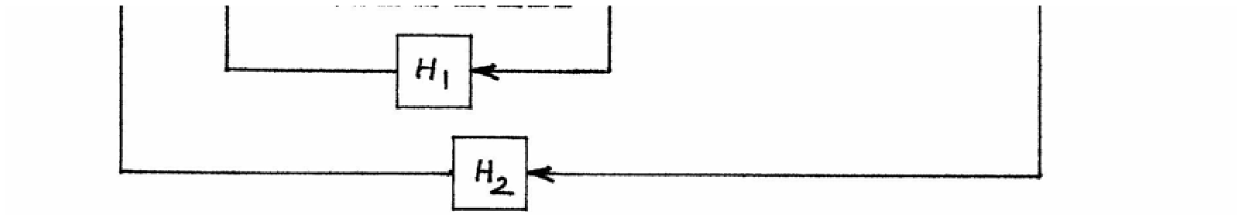
3. (a) Find the transfer function of the system shown in Figure 2.
   (b) Find the transfer function of a AC servo motor.



(May/June12)

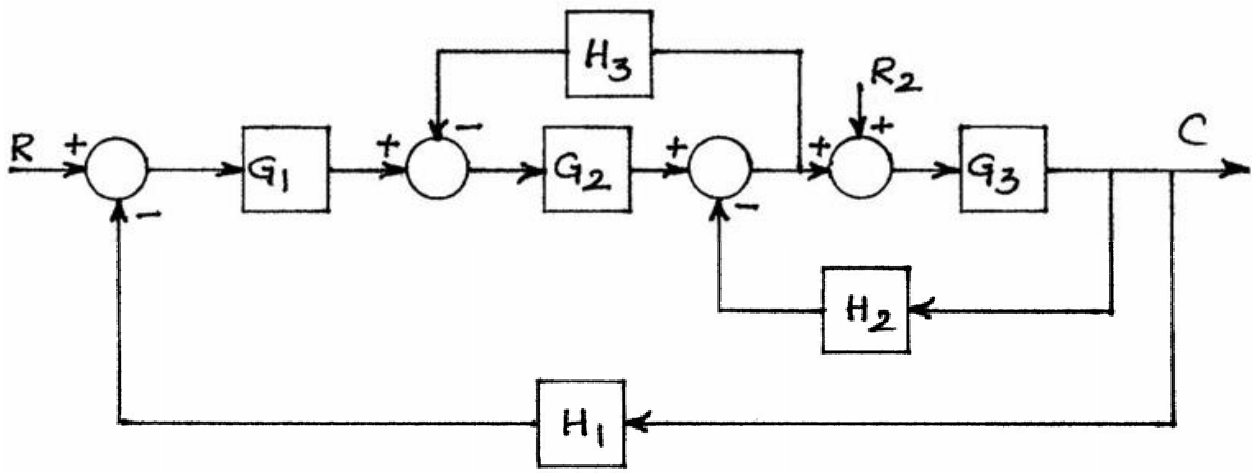
4. (a) Explain the Armature voltage controlled DC servomotor and obtain its transfer function.
   (b) Obtain the overall transfer function for the block diagram in Figure 4.





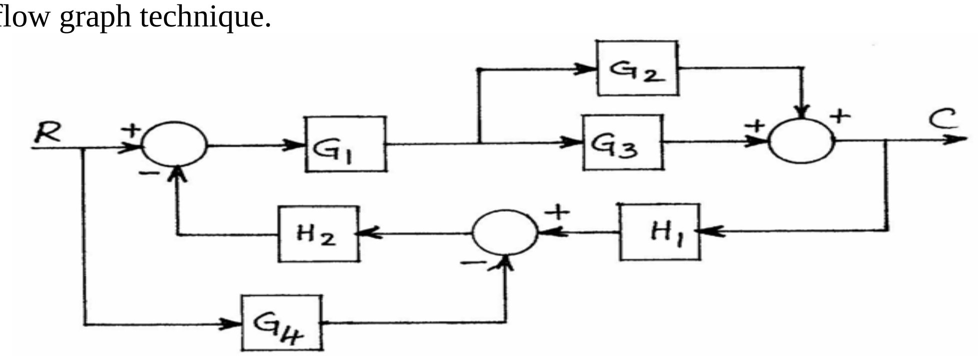
(May/June12)

5. Using block diagram reduction techniques, find the closed loop transfer function of the system whose block diagram is given in Figure 9 and verify the result using signal flow graph technique



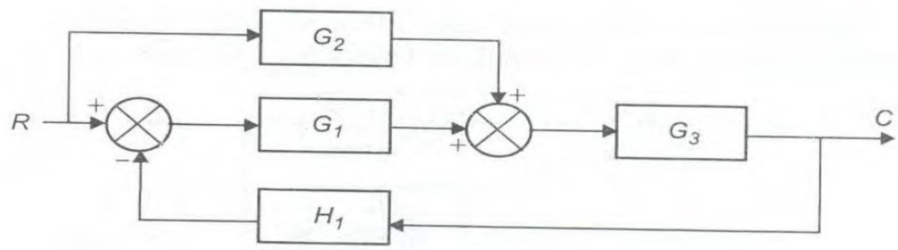
(May/June12)

6. Using block diagram reduction techniques, find the closed loop transfer function of the system whose block diagram is given in Figure 11 and verify the result using signal flow graph technique.



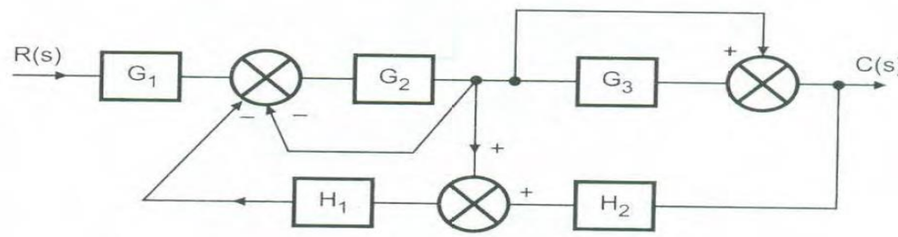
(May/June12)

7. i. Determine the transfer function C(s)/ R(s) for the following block diagram.



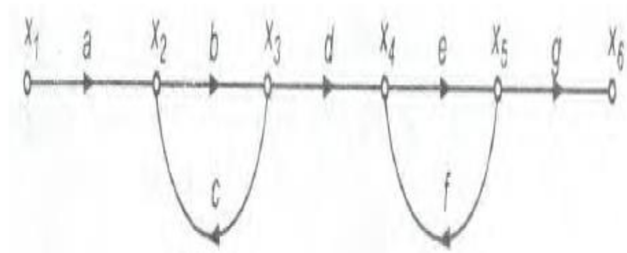
ii. Explain the properties of signal flow graphs. **(Apr 11)**

8. i. Reduce the given block diagram and hence obtain the transfer function C(s)/R(s).



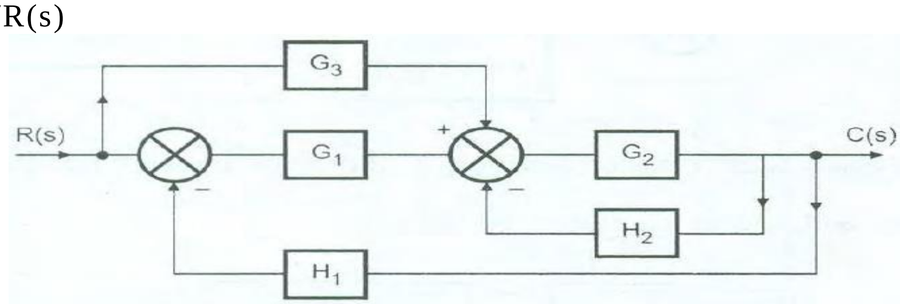
ii. Explain the need of Mason's gain formula for any system reduction. **(Dec 10)**

9. i. The signal flow graph shown in figure has one forward path and two isolated loops. Determine the overall transfer function relating x and x



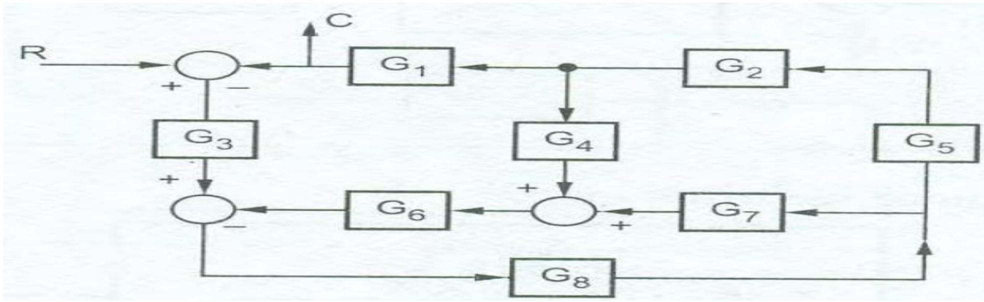
ii. Explain the differences between AC servomotor and DC servomotor. **(Dec 10)**

10. i. Reduce the given block diagram and hence obtain the transfer function C(s)/R(s)



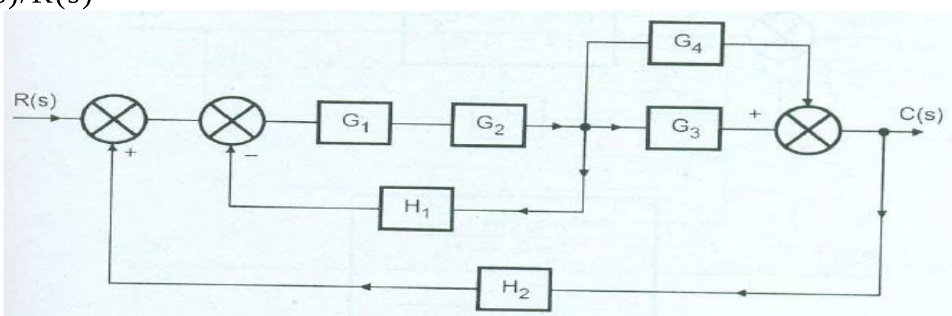
ii. Explain synchro with neat sketch. **(Dec 10)**

11. i. Reduce the given block diagram and hence obtain the transfer function C(s)/R(s)



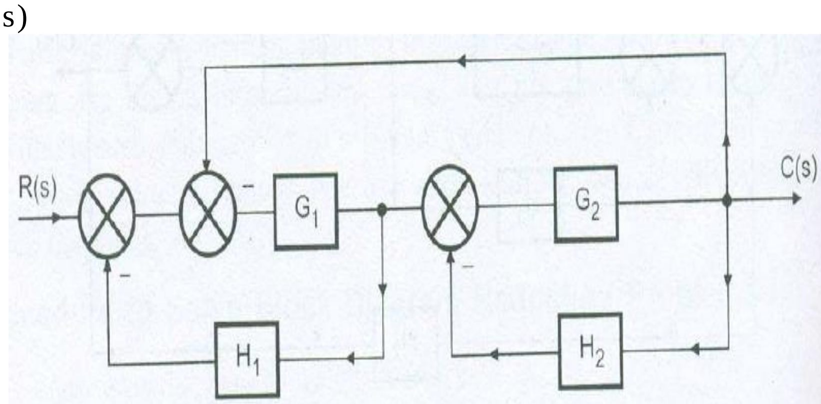
ii. Explain the practical applications of servomotors. **(Dec 10)**

12. i. Reduce the given block diagram and hence obtain the transfer function C(s)/R(s)



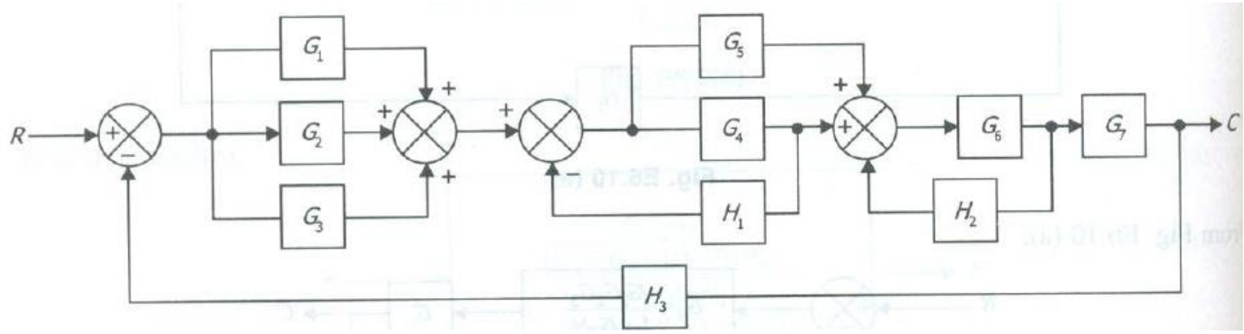
ii. Explain synchro transmitter. **(May 10)**

13. i. Reduce the given block diagram and hence obtain the transfer function C(s)/R(s)



ii. Explain synchro transmitter. **(May 10)**

14. i. Reduce the given block diagram and hence obtain the transfer function C(s)/R(s).



ii. Explain DC servomotor and its features.

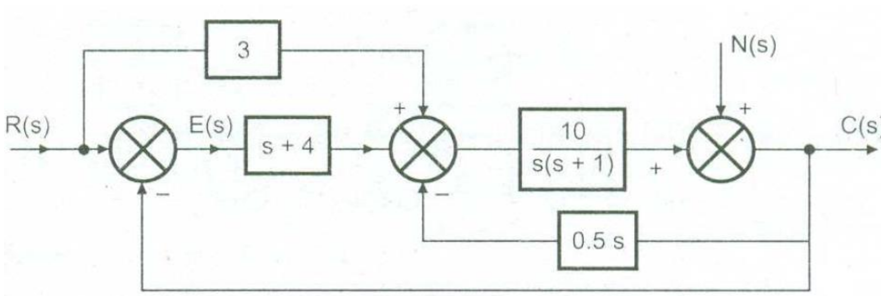
(May 10)

15. Reduce the given block diagram and hence obtain the transfer functions:

i. $\frac{C(s)}{E(s)}$ if $N(s) = 0$

ii. $\frac{C(s)}{R(s)}$ if $N(s) = 0$

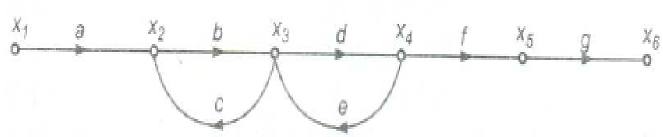
iii. $\frac{C(s)}{N(s)}$ if $R(s) = 0$



(May 10)

16. Derive the transfer function for the field controlled d.c. motor with neat sketch and explain the advantages of field controlled d.c. motor over armature controlled d.c. motor. **(May 09)**

17. i. The signal flow graph shown in figure has one forward path and two non-touching loops. Determine the overall transmittance relating x_6 and x_1.



ii. Explain the advantages of Mason's gain formula. **(May 09)**

18. Represent the following set of equation by a signal flow graph and determine the overall gain relating x_5 and x_1. **(May 09)**

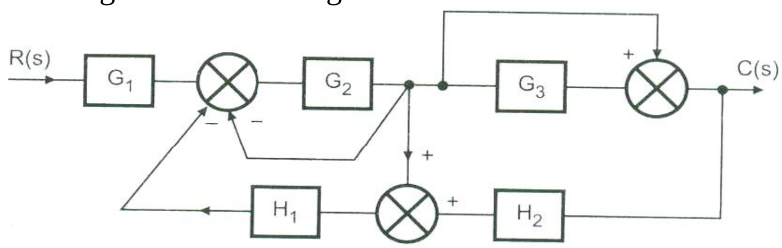
$x_2 = ax_1 + fx_2$

$x_3 = bx_2 + ex_4$

$x_4 = cx_3 + hx_5$

$x_5 = dx_4 + gx_2$

19. i. Reduce the given block diagram and hence obtain the transfer function



ii. Explain the need of Mason's gain formula for any system reduction. **(May 09, 08)**

20. i. Derive the transfer function of an a.c. servomotor and draw its characteristics.

ii. Explain the Synchro error detector with circuit diagram. **(May 09, 08, 07, 03)**

21. i. With a neat sketch explain the construction and principle of working of the synchro transmitter and receiver.

ii. Derive the transfer function for the synchro transmitter receiver. **(May 09, 04)**

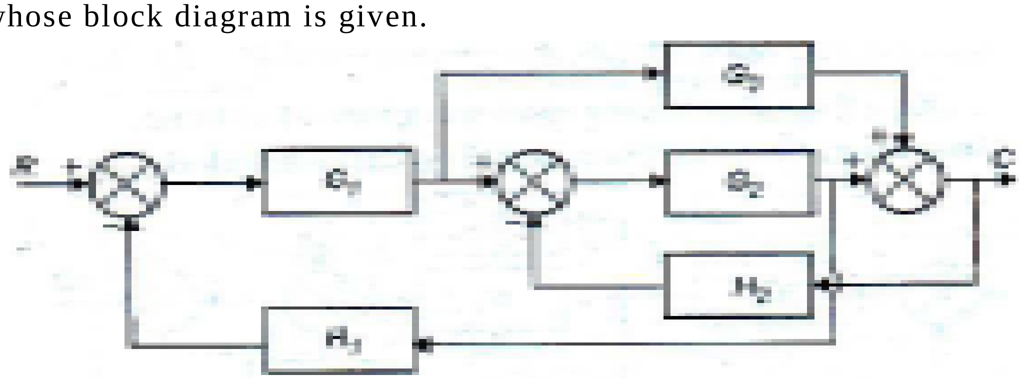
22. i. Explain the disadvantages and advantages of block diagram reduction process over signal flow graph.

ii. Explain the rules of block diagram reduction. **(May 09, 07)**

23. i. Derive the transfer function of a field controlled d.c. Servomotor and develop the block diagram. Clearly state the assumptions made in the derivation.

ii. What are the effects of feedback on the performance of a system? Briefly explain. **(Sep 08)**

24. i. Determine the overall transfer function relating C and R for the system whose block diagram is given.

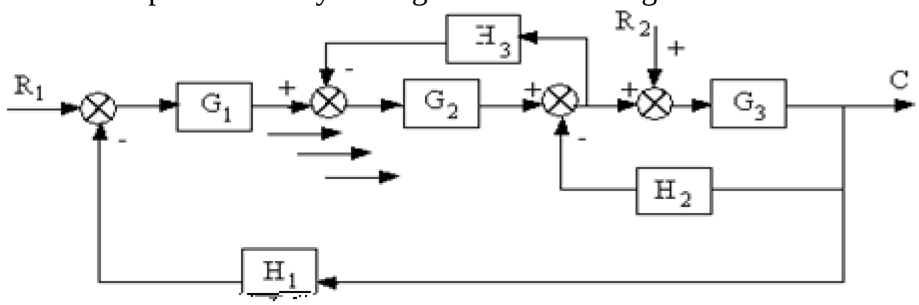


ii. Explain the properties of block diagrams. **(Sep 08, 07)**

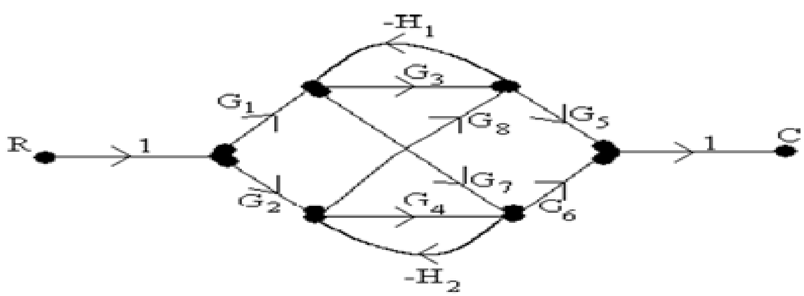
25. i. Explain the advantages of signal flow graph over block diagram reduction process?

ii. Expalin the following terms related to signal flow graph:
a. Node b. Branch c. Forward path gain d. Loop gain. **(Sep 08)**

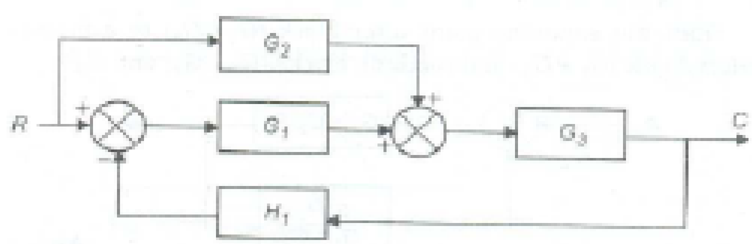
26. i. Obtain the output of the system given below. Figure. **(Sep 08)**



ii. Determine the overall transfer function from the signal flow graph given in figure.

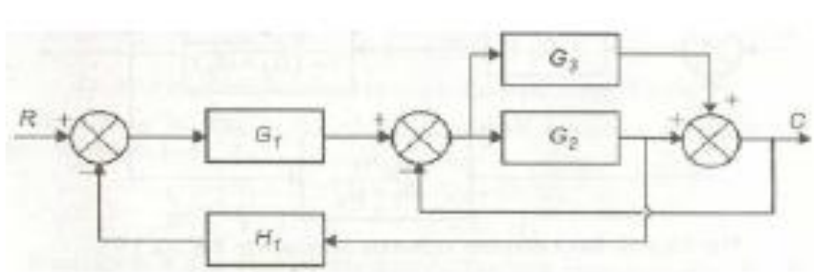


27. i. Determine the transfer function $\frac{C(s)}{R(s)}$ for the following block diagram



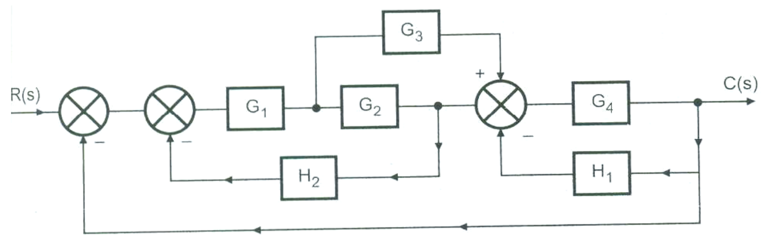
ii. Explain the properties of signal flow graphs. **(Sep 08, 07)**

28. i. Determine the transfer function $\frac{C(s)}{R(s)}$ for the following block diagram



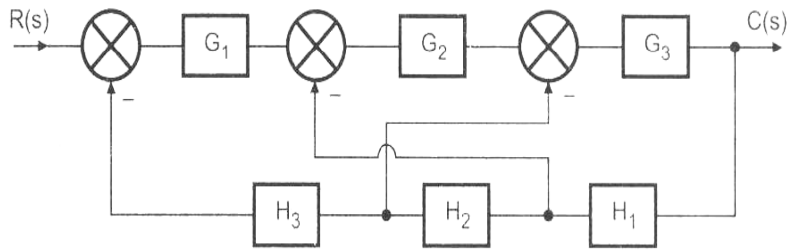
ii. Define various terms involved in signal flow graphs. **(Sep 08, May 07)**

29. i. Reduce the given block diagram and hence obtain the transfer function .



ii. Explain the need of signal flow graph representation for any system. **(May 08)**

30. i. Reduce the given block diagram and hence obtain the transfer function



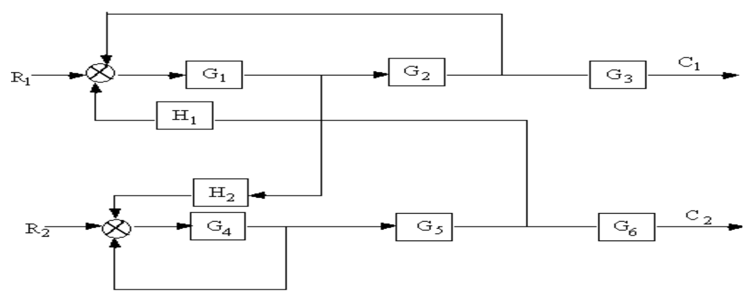
ii. Explain the working principle of synchro receiver with neat sketch. **(May 08)**

31. i. State and explain mason's gain formula for the signal flow graph.

ii. What are differences between block diagram reduction and signal flow graph reduction?

(May 08, Sep 07)

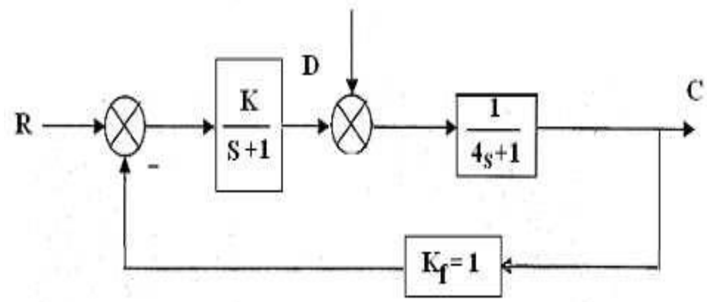
32. Find the transfer function matrix for the two input and output system shown in the given Figure.



(May 08)

33. i Explain how the potentiometers are used as error seensing devices . Give a typical application of it with single line diagram.

ii. Discuss the effect of disturbance signal of the speed control system for a gasolineengine as shown in Figure assuming K=10. **(May 08, 06, 04)**

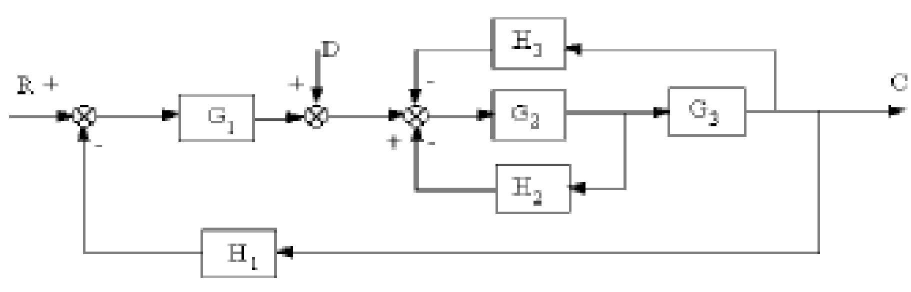


34. Explain the procedure for deriving the transfer function and derive the transfer function for servo.

(Sep 07)

35. Derive the Transfer Function for the field controlled d.c. servomotor with neat sketch. **(May 07)**

36. Derive the Transfer Function for a.c. servomotor. Explain about torque-speed characteristics of a.c. servomotor. **(May 07, 06, 04)**



37. i.

For the system in the above figure, obtain transfer function

a. C/R b. C/D

ii. Verify the above transfer function using signal flow graph. **(May 07)**

38. i. Draw the signal flow graph for the system of equations given below and obtain the overall transfer function using mason's rule

$X_2 = X_1 - X_6$

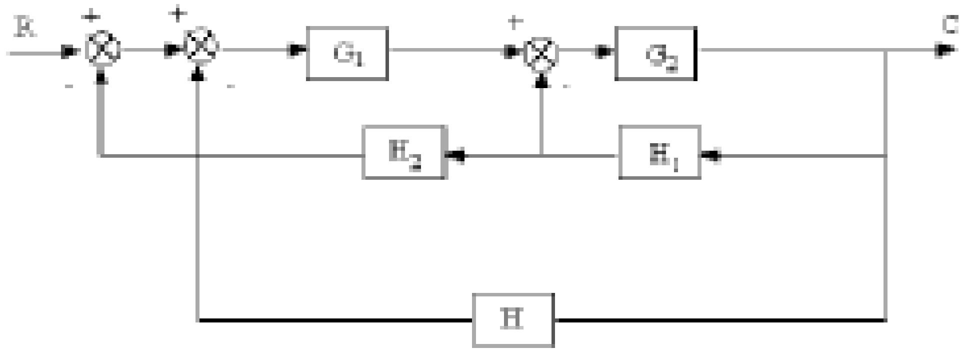
$X_3 = G_1X_2 - H_2X_4 - H_3X_5$

$X_4 = G_2X_3 - H_4G_6$

$X\backslash = G_5X_4$

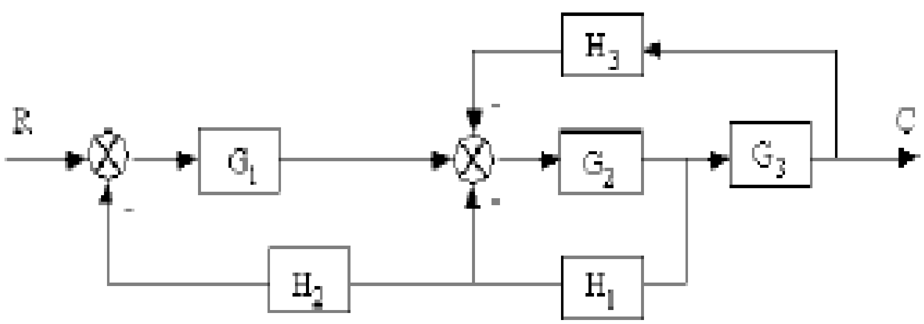
$X_6 = G_4X_5$

ii. Simplify the Figure 1 of the system given below by block diagram reduction technique and determine the transfer function of the system.



(May 07, Apr 04)

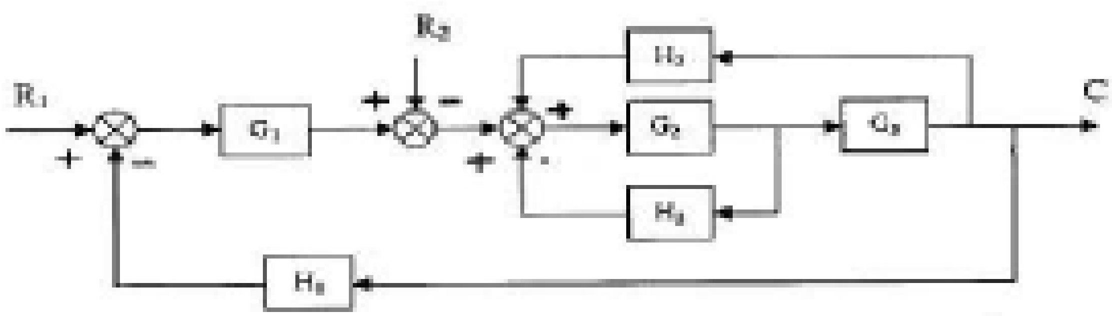
39. Reduce the following Figure using block diagram reduction technique find C/R and verify the transfer function by applying mason's gain formula.



(May 07)

40. i. For the system represented in the given Figure obtain transfer function **(Sep 06, Dec 04)**

a. C/R_1 b. C/R_2



ii. Write down the signal flow equations and draw the signal flow graph for the above system.

41. i. What is feedback and explain about the Reduction of parameter variation by use of feedback.

ii. Consider the feedback control system shown in figure and the normal value of process parameter K is 1. Evaluate the sensitivity of transfer function T(s) = C(s)/R(s) to variations in parameter K.

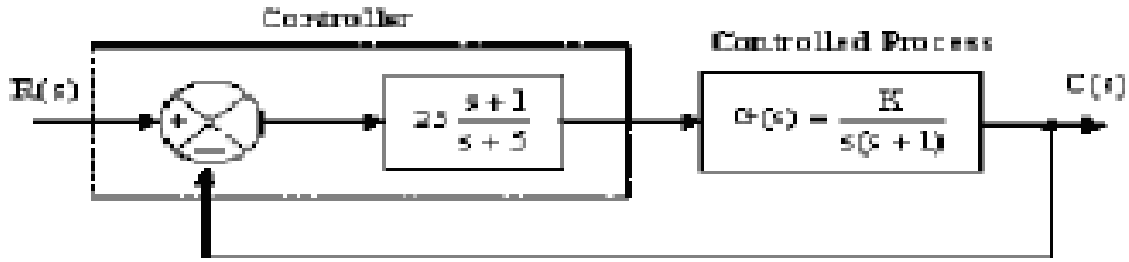


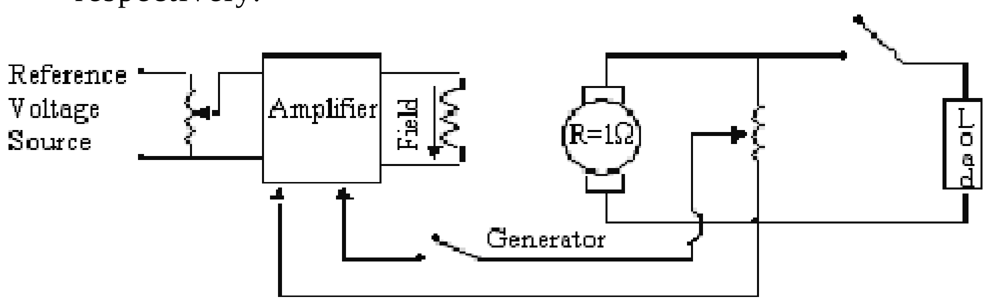
Figure 2:

(Sep 06)

42. Derive the transfer function of a field controlled dc Servomotor and develop the lock diagram. Clearly state the assumptions made in the derivation.

(Apr 06)

43. Following figure shows a voltage control device. The gain factors of the amplifier and generator are 1.5 amp/volt input and 80V/amp field current respectively.



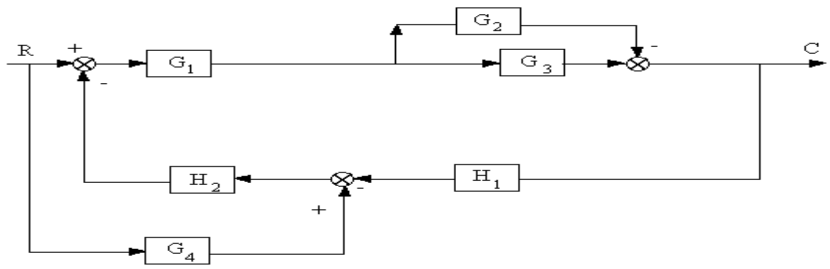
Voltage Control system

(Apr 06)

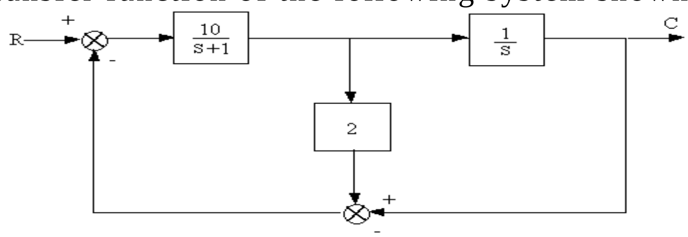
i. If the output voltage were to be 250 volts on no load how much should be the referece voltage with a feedback potentiometer setting at 0.2?
ii. If the feedback is open how much will be the input voltage for the same output voltage?
iii. What will be the improvement in the performance with feedback if a load current of 20A is supplied by the generator. Assume -ve feedback in the above cases
iv. What happens if the feedback point setting is increased?

44. i. Explain the effect of feedback on noise to signal ratio **(Apr 06)**
ii. With the help of sketches, explain the construction and working principle of a Synchro transmitter.

45. i. Deive the transfer function of the Figure given, using block diagram reduction technique

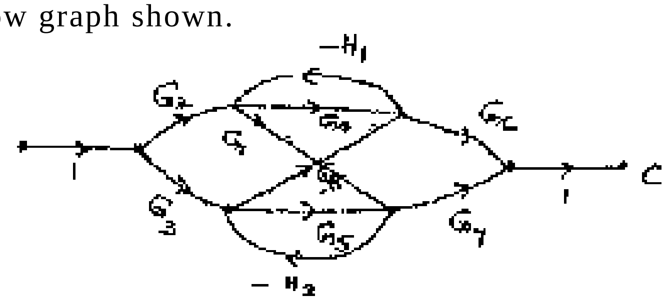


ii. Derive the transfer function of the following system shown in fig.



(Apr 06)

46 Discuss Mason’s gain formula. Obtain the overall transfer function C/R from the signal flow graph shown.

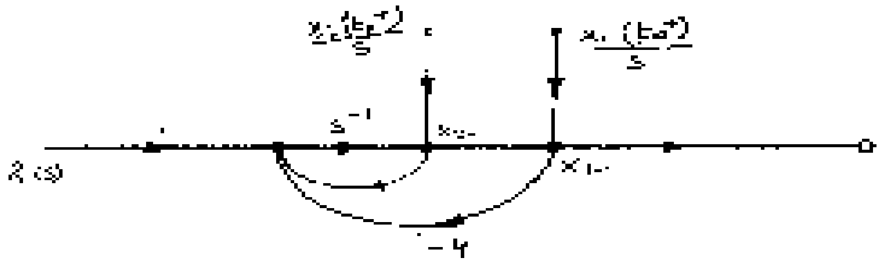


(Apr 06)

47. i.Derive the transfer function of an a.c. servomotor and draw its characteristics.
ii. Explain the Synchro error detector with circuit diagram. **(Dec 04)**
iii. Write down the signal flow equations and draw the signal flow graph for the above system.

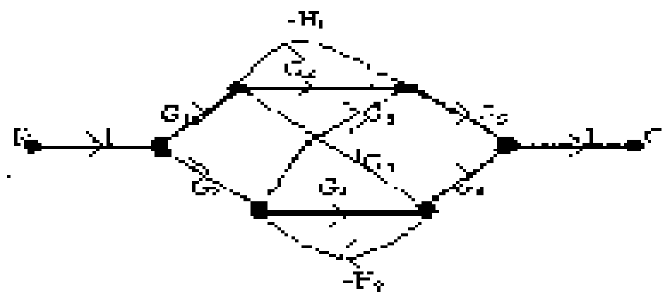
48. i. Derive the transfer function of an DC servomotor and draw its characteristics. **(Dec 04)**
ii. Explain the Synchro error detector with circuit diagram.

49. Simplify the block diagram of the system given below by block diagram reduction technique and determine the transfer function of the system.



(Dec 04)

50. i. Explain the traffic control system concepts using open loop as well as closed loop system.
    ii. Determine the overall transfer function from the signal flow graph given below:



(Apr 04)

51. Write notes on the following:
    i. Modems
    ii. Synchro transmitter and receiver. **(Apr 04)**

52. Write notes on the following:
    i. Field controlled d.c. servomotor
    ii. Armature controlled d.c. servomotor. **(Apr 04)**

53. i. Derive the transfer function of D.C.servomotor with armature voltage control.
    ii. Draw the connection diagram of a Synchro pair used as a position indicator? **(Apr 04)**

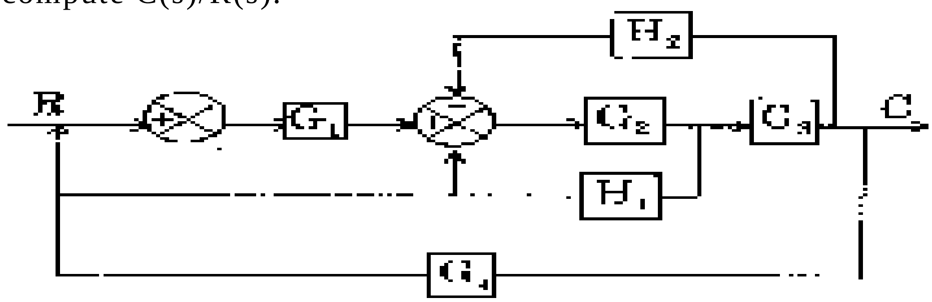
54. i.Derive the Transfer Function for the field controlled d.c. servomotor with neat sketch. **(Apr 04)**
    ii. Draw the connection diagram of a synchro pair used as a position indicator.

55. i. Why a conventional induction motor is not suitable for servo applications.
    ii. Derive the transfer function for the a.c. servomotor with neat diagram. **(Nov 03)**

56. The rotor of a a.c. servo motor is built with high resistance i.e. low X/R ratio why? What will happen if we use the rotor of an ordinary 3 phase induction motor having high X/R ratio as the rotor of an a.c. servo motor? Determine

the transfer function q(s)/V_C(s) for an a.c. servo motor where q is the angular position of shaft in radians and V_C(s) is the control phase voltage. **(Nov 03)**

57. Reduce the following block diagram using block diagram reduction technique and compute C(s)/R(s).



(Nov 03)

58. i. Define signal flow graph and how do you construct signal flow graph from equations. **(Nov 03)**

ii. Draw the signal flow graph for the system shown below and hence find gain from Mason’s gain formula.

59. Explain the principle of operation of a.c. and d.c. tachometer. Hence derive the transfer functions for the same. **(Apr 03)**

60. i. Describe the operation of synchro as an error detector. Derive the necessary Transfer function.

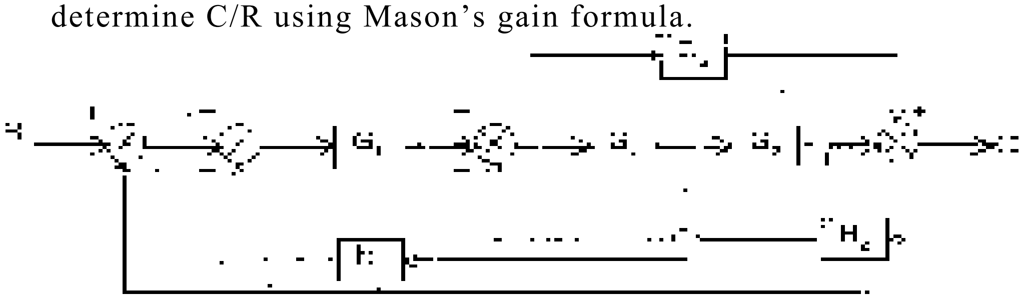
ii. Discuss the effects of negative feedback on the following

a. Gain of the system

b. Band width

c. Sensitiveness to parameter variation. **(Apr 03)**

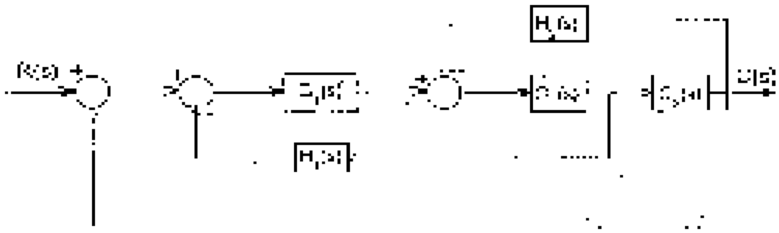
61. For the following block diagram draw the signal flow graph and hence determine C/R using Mason’s gain formula.



(Apr 03)

62. i. What are the advantages of signal blow graph over block diagram ?

ii. Simplify the block diagram shown below using block diagram reduction techniques. Obtain the closed loop transfer function C(s)/R(s). **(Apr 03)**



iii. Construct signal flow graph for the above system and verify the result obtained in part ii. Using Masons' gain formula.

63. i. What is servomotor?
   ii. What are the characteristic of servo motors?
   ii. Derive transfer function of a DC motor when it is operated in field control mode. Assume necessary data. **(Jan 03)**

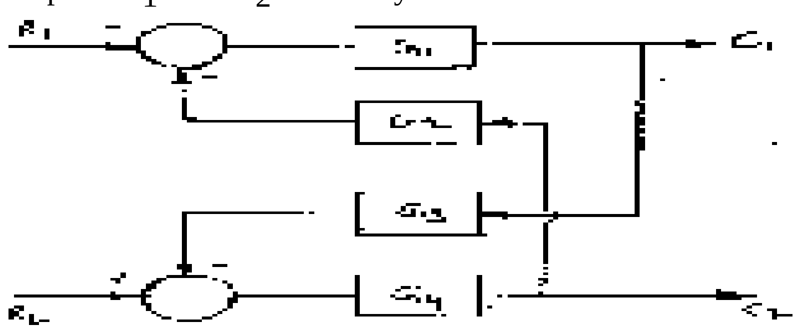
64. i. What is the difference between ac servomotor and two phase induction motor? **(Jan 03)**
   ii. What is tachogenerator?

65. An ac servo motor has both windings excited with 115 V a.c. It has a stall torque of 2 lb-ft. Its coefficient of viscous friction is 0.2 lb ft. sec.
   i. Find it's no load speed.
   ii. It is connected to a constant load of 0.9 lb ft and coefficient of viscous friction of 0.05 lb-ft.sec. through a gear pass with a ratio of 4. Find the speed at which the motor will run. **(Jan 03)**

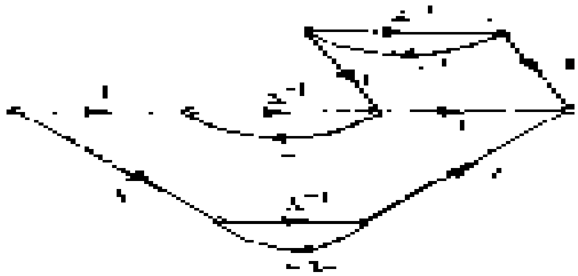
66. i. With aid of neat sketch, explain the working principle of synchro transmitter.
   ii. Derive the transfer function of synchro receiver. **(Jan 03)**

67. How does a two-phase servomotor differ from a Normal Induction motor? Find its transfer function and explain how the motor constants can be estimated. **(Jan 03)**

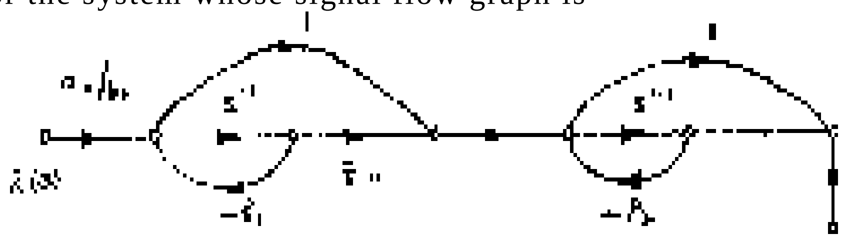
68. Find the outputs C_1 and C_2 of the system. **(IES 97)**



69. Give basic properties of SFG. Find the transfer function $\frac{C(S)}{R(S)}$ for a system whose signal flow graph is shown below: **(IES 96)**

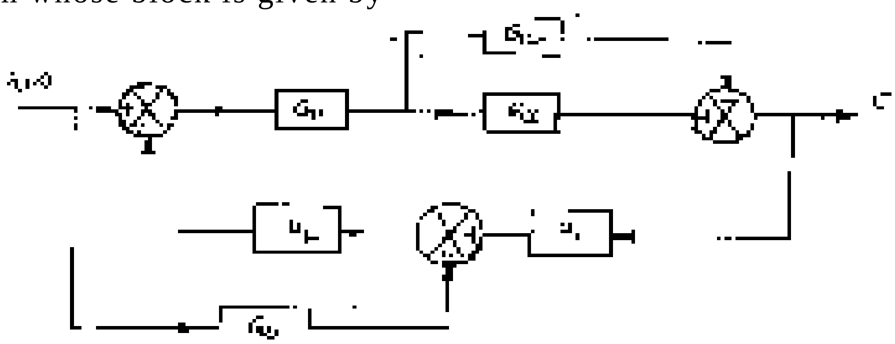


70. State and explain Mason's gain formulae. Hence find the transfer function $\frac{C(S)}{R(S)}$ for the system whose signal flow graph is



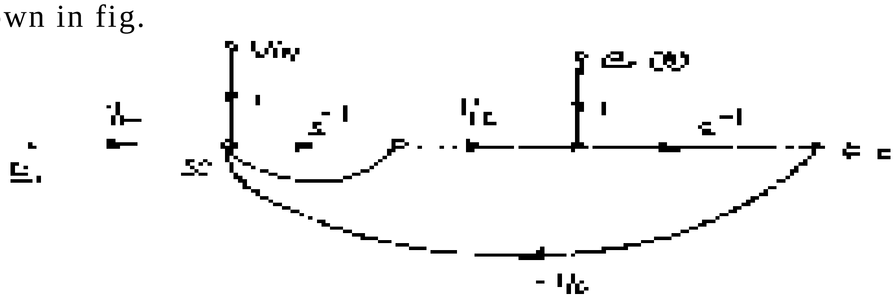
(IES 94)

71. Draw a signal flow graph and evaluate the closed loop transfer function of a system whose block is given by



(IES 94)

72. State Mason's Gain Formulae. Hence otherwise. Find I and E_C in terms of the input varaibles. E(0) $i_1(0)$ and $e_c(0)$ for the network whose signal flow graph is shown in fig.



(IES 94)

73. A servo mechanism is used to control the angular position q_0 of a mass through a command signal. The M.I.of moving parts referred to the load shaft is 200 Kg-m^2 and the motor torque at the load is 6.88 x $10^{\cdot 4}$N-m/rad of error.

The damping torque coefficient referred to the load shaft is 5 x 10^{-3}N-m/rad/sec.

i. Find the time response of the servo mechanism to a step input of 1 rad and determine the frequency of transient oscillation, the time to rise to the peak overshoot and the value of the peak overshoot.

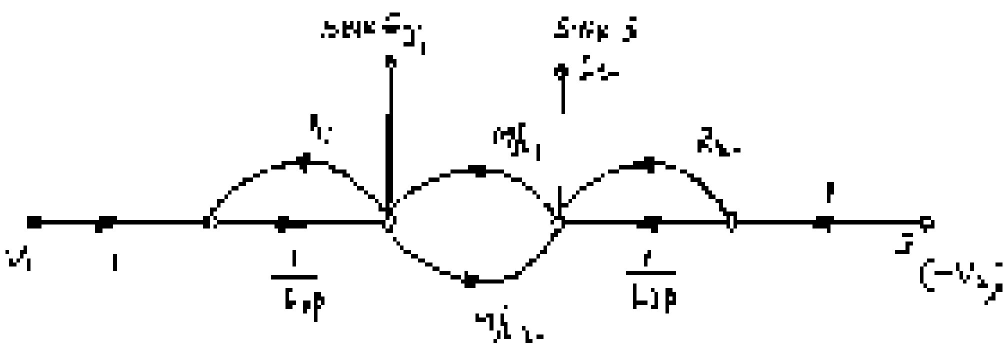
ii. Determine the steady-state error when the command signal is a constant angular velocity of 1 revolution/minute.

iii. Determine the steady-state error which exists when a steady torque of 1200 N-m is applied at load shaft **(IES 94)**

74. For a two winding transformer (mutually coupled circuit) equations relating the terminal voltages are given by

$V_1 = (R_1 + L_1P)\, i_1 - Mpi_2$

$-V_2 = (R_2 + L_2P)\, i_2 - Mpi_2$ Where P is a differential operator. Rearrange the above equations in appropriate cause-effect from to obtain the signal flow graph as shown in figure.

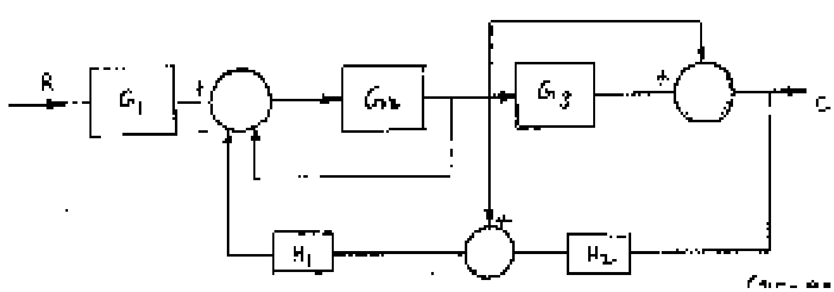


Using mason gain formulae, prove that i_1 is given by

$$\frac{(R_1 + L_2P)\ U_1 - Mpv_2}{P^2(L_1L_2 - M^2) + (R_1L_2 + R_2L_1)p + R_1R_2}$$

(IES 93)

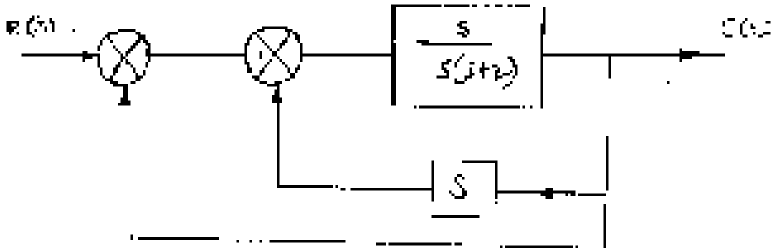
75. Use block diagram reduction methods to obtain the equivalent transfer function from R to C.



(IES 93)

76. What is a signal flow graph. Give its properties for the signal flow graph shown in the figure below. Find, using Mason's gain formulas, the transfer function c(s)/r(s). **(IES 92)**

77. Consider the system shown in figure : **(IES 92)**



i. In the absence of derivate feedback (a=0) determine the damping factor and natural frequency. Also determine the steady state error resulting from a unit ramp.

ii. Determine the derivative feedback. Constant a, which will increase the damping factor of system to 0.7. What is the steady state error to unit ramp with this setting of the derivative feed back constant?

UNIT-III

1. a) What is the beneficial effect of derivative error compensation on important performance indices of a type-1 control system? Elaborate.

b) A unity negative feedback control system has the plant $G(s) = \dfrac{k}{s\left(s + 1.5\sqrt{k}\right)}$.
Determine its peak overshoot and settling time due to unit step input. Determine the range of K for which the settling time is less than 1sec. **(Dec 14)**

1 . a) Explain the standard test signals that are used in the time-domain analysis.

b) A unity feedback control system has an open loop transfer function 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 the settling time, peak overshoot and time to peak overshoot for a unit-step unit.

(May/June 13)

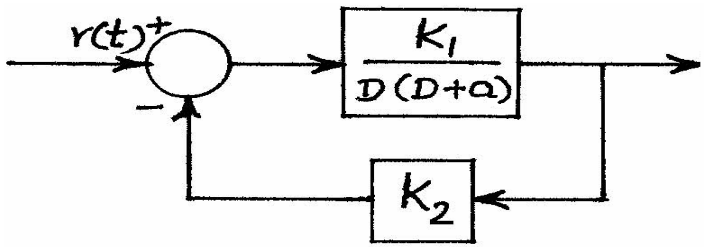
2. a) A unity feedback control system has the forward transfer function G(s)=25/s(s+6).find the rise time ,peak time and maximum over shoot for unit step input.

b) Find the error constants and steady state error for the velocity input r(t)=2t and step input of 2 units. The system is described by G(s) H(s) =10/s(s+5)

(Nov/Dec12)

3. a) For the system shown in Figure 1, determine K1, K2, and `a' such that the system will have a steady state gain of 1.0, a damping ratio & _ = 0 .6, !n = 5.0.

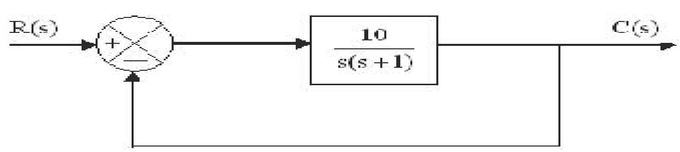
b) A unity feedback control system has the forward transfer function, G(s) =25/s(s+6). Find the rise time, peak time and the maximum over shoot for unit step input.



(May/June 12)

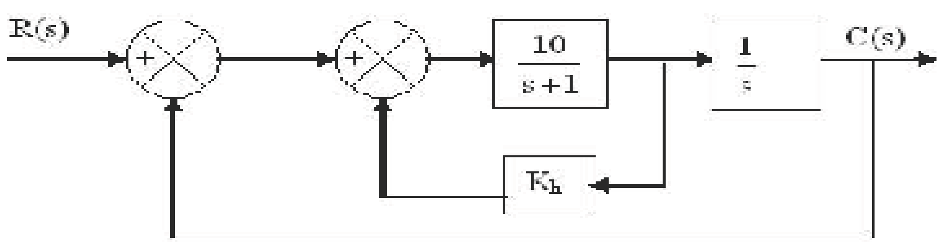
4. Consider the system shown in Figure 6.
   (a) The damping ratio of this system is 0.158 and the undamped natural frequency is 3.16rad/sec. To improve the relative stability, we employ tachometer feedback Figure 7.
   (b) Shows such a tachometer-feedback system. Determine the value of K_h so that the damping ratio of the system is 0.5. Draw unit-step response curves of both the original and tachometer-feedback systems. Also draw the error-versus-time curves for the unit-ramp response of both systems.

(May/June 12)



Control system

Figure 6:



Closed-loop System with tachometer feedback

Figure 7

5. (a) Consider the differential equation system given by $\ddot{Y} + 3\dot{y} + 2y = 0$; $y(0) = 0.1$ $\dot{y}(0) = 0.05$. Obtain the response y (t), subjected to the given initial condition.

(b) Consider a unity-feedback control system whose open-loop transfer function is G(s) = K/s(Js+B) . Discuss the effects of varying the values of K and B on the steady-state error in unit-ramp response.

(May/June 12)

6. (a) Explain error constants Kp , Kv, Ka for type 1 system.

(b) Given the open loop transfer function of a unity feedback system as G(s) =10/s(0.1s+1) , find Kp , Kv, Ka.

(May/June 12)

7. i. State how the type of a control system is determined? How it effect the steady-state error of the system?

ii. A unity feed-back system has $G(s) = \frac{40(s+2)}{s(s+1)(s+4)}$. Determine

a. Type of the system?

b. All the error coefficients?

c. Error for ramp input with magnitude. **(Apr 11, Dec 10)**

8. i. Define the following terms:

a. Steady-state error b. Settling time

c. Peak overshoot d. type and order of a control system.

ii. Sketch the transient response of a second order system and derive the expression for rise time and peak overshoot? **(Dec, May 10)**

9. i. Explain the significance of generalized error series?

ii. For a system $G(s)H(s) = \frac{K}{s^2(s+2)(s+3)}$, find the value of K to limit the steady state error to 10 when the input to the system is $r(t)=(1+10t+40)/2\ t^2$. **(Dec, May 10)**

10. i. Explain error constants K_p, K_v, K_a for type-1 system?

ii. A unity feed back system has an open loop transfer function $G(s) = \frac{25}{s(s+8)}$. Determine its damping ratio, peak overshoot and time required to reach the peak output. Now a derivative component having T.F. of s/10 is introduced in the system. Discuss its effect on the values obtained above?

(Dec 10)

11. i.Define type and order of a control system and hence find the type and order of the following systems?

a. $G(s)H(s) = \frac{100}{s(s^2+4s+200)}$

b. $G(s)H(s) = \frac{200}{s^2(s^2+10s+200)}$

c. $G(s)H(s) = \frac{4(s^2+10s+100)}{s(s+3)(s^2+2s+10)}$

d. $G(s)H(s) = \frac{200}{(1+01s)(1+0.5s)}$

ii. The unit step response of a second order linear system with zero initial state is given by c(t) = 1 + 1:25e^{-6t}Sin(8t – $\tan^{-1}$ 1:333). Determine the damping ratio, un damped natural frequency of oscillations and peak overshoot?

(May 10)

12. i. Derive the static error constants and list the disadvantages?

ii. Find step, ramp and parabolic error coefficients and their corresponding steady-state error for unity feed-back system having the T.F $G(s) = \frac{14(s+3)}{s(s+5)(s^2+3s+2)}$. **(May 10)**

13. i. Explain the significance of generalized error series?

ii. For a system G(s) H(s) = $\frac{K}{s^2(s+2)(s+3)}$. Find the value of K to limit the steady state error to 10 when the input to the system is r(t)=1+10t+40/2 t^2.

(May 09, 07, Sep 07)

14. i. Explain error constants K_p, K_v and K_a for type-1 system?

ii. A unity feed back system has an open loop transfer function $G(s) = \frac{25}{s(s+8)}$. Determine its damping ratio, peak overshoot and time required to reach the peak output. Now a derivative component having T.F. of s/10 is introduced in the system. Discuss its e”ect on the values obtained above?

(May 09, Sep 07)

15. i. Derive the static error constants and list the disadvantages?

ii. Find step, ramp and parabolic error coefficients and their corresponding steady-state error for unity feed-back system having the T.F $G(s) = \frac{14(s+3)}{s(s+5)(s^2+3s+2)}$.

(May 09)

16. For a unity feed back system having G(s) = K/s(2+sT) find the following

i. The factor by which the gain K should be multiplied to increase the damping ratio from 0.15 to 0.6

ii. The factor by which the time constant should be multiplied to reduce the damping ratio from 0.8 to 0.4. **(May 09)**

17. i. Establish the relation relation between ζ and M_p for a step response of a second order system?

ii. A system is given by differential equation $\frac{d^2y}{dt^2}+4\frac{dy}{dt}+8y=8x$, where y=output x= input. Determine all the time domain specifications and obtain output response for unit step input ? **(May 09)**

18. i. What are the types of controllers that are used in closed loop system? Explain them?

ii. The response of a system subjected to a unit step input is $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ Obtain the expression for the closed loop transfer function? Also determine the Undamped natural frequency and damping ratio of the system? **(May 09, Sep 08)**

19. i. Define the following systems and sketch their output wave forms for an unit step i/p

a. Under damped system
b. Undamped system
c. Over damped system
d. Critically damped system

ii. For a second order system $\zeta = 0.6$, $w_n = 5$rad/sec. Find the values of w_d, T_r, T_p, T_s and M_p. **(May 09)**

20. i. Define time constant and explain its importance.

ii. A unit feedback system is characterized by an open-loop transfer function G(s) = K/s(s+5). 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 times to peak overshoot for a unit-step input. **(Sep 08)**

21. i. What are the different time domain specifications of a dynamical system? Explain important specifications of a second ordered system to unit step input.

ii. The open loop transfer function of a unity feedback system is given by G(s) = K/s(Ts+1), where K and T are positive constants. By what factor should the amplifier gain be reduced so that the peak overshoot of unit-step response of the system is reduced from 75% to 25%? **(Sep 08)**

22. i. Explain the important time? response specification of a standard second ordered system to a unit step input.

ii. Derive expressions for time domain specifications of a standard second ordered system to a step input. **(Sep 08)**

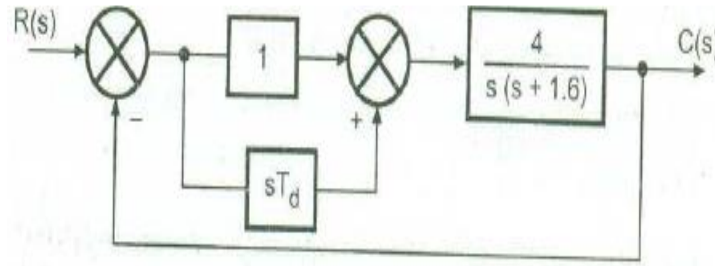
23. The overall T.F. is a unity feed back control system is given by $\frac{C(s)}{R(s)} = \frac{10}{s^2+6s+10}$

i. Find K_p, K_v, K_a

ii. Determine the steady state error if the input is $r(t)=1 + t + t^2$. **(Sep 08)**

24. i. What is the difference between type and order of a control system? Explain each with an example?

ii. The figure shows PD controller used for the system. Determine the value of T_d so that the system will be critically damped? Calculate it’s settling time?

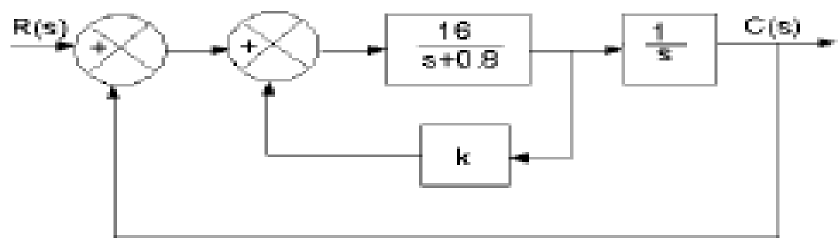


(Sep 08)

25. i. Explain about various test signals used in control system?

ii. Measurement conducted on a servomechanism shows the system response to be $C(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$, when subjected to a unit step input. Obtain the expression for closed loop T.F., the damping ratio and undamped natural frequency of oscillations? **(Sep 08, 07)**

26. Consider the system shown in Figure. Determine the value of k such that the damping ratio ζ is 0.5. Then obtain the rise time, t_r, peak time t_p, maximum overshoot M_p, and settling time ts in the unit-step response.



(Sep 08, May 07)

27. i. What is meant by time response? Explain about
a. Steady- state response b. Transient response

ii. A unity feed-back system is characterized by an open loop T.F 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 T_s, T_p and M_p for a unit step input. **(May 08)**

28. i. What are generalized error constants? State the advantages of generalized error coefficients?

ii. For a first order system, find out the output of the system when the input applied to the system is unit ramp input? Sketch the r(t) and c(t) and show the steady state error. **(May 08)**

29. i. How steady state error of a control system is determined? How it can be reduced?

ii. Determine the error coefficients and static error for G(s) =1/s(s+1)(s+10) , H(s) = s + 2. **(May 08)**

30. i. Derive the expression for rise time, peak time peak overshoot and settling time of second order system subjected to a step input.

ii. A unity feedback control system has a loop transfer function.

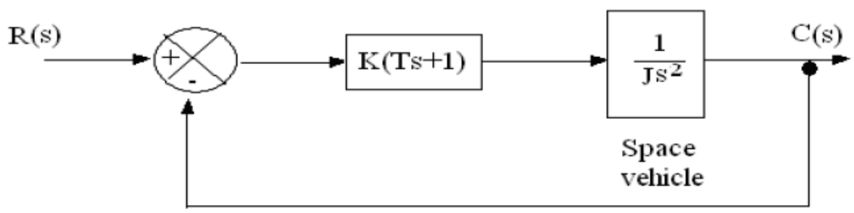
$$G(s) = \frac{10}{s(s+2)}$$

Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units.

(May 08)

31. i. Determine whether the largest time constant of the characteristic equation given below is greater than, less than, or equal to 1.0 sec. $s^3 + 4s^2 + 6s + 4 = 0$

ii. Figure. is a block diagram of a space-vehicle attitude-control system. Assuming the time constant T of the controller to be 3 sec., and the ratio K/J to be 2/9 rad^2/sec^2, find the damping ratio and natural frequency of the system.



Space-vehicle attitude- control systems

(May 08)

32. i. Define type and order of a control system and hence find the type and order of the following systems?

a. G(s) H(s) = $\dfrac{100}{s(s^2+4s+200)}$ b. G(s) H(s) = $\dfrac{200}{s^2(s^2+10s+200)}$

c. G(s) H(s) = $\dfrac{4(s^2+10s+100)}{s(s+3)s^2+2s+10)}$ d. G(s) H(s) = $\dfrac{200}{(1+01s)(1+0.5s)}$

ii. The unit step response of a second order linear system with zero initial state is given by $c(t) = 1 + 1.25e^{-6t}\text{Sin}(8t - \tan^{-1} 1.333)$. Determine the damping ratio, undamped natural frequency of oscillations and peak overshoot?

(May 08)

33. i. For an under damped second order system, define various time domain specifications?

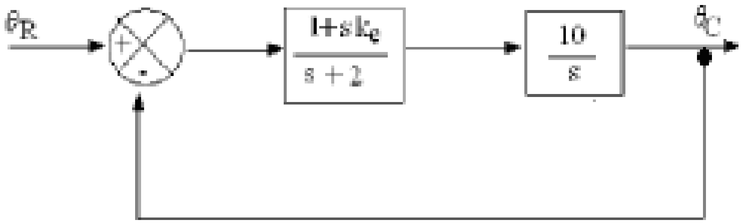
ii. The forward path T.F. of a unity feed back control system is given by G(s) =2/s(s+3). Obtain the expression for unit step response of the system?

(Sep, May 07)

34. The open-loop transfer function of a servo system with unity feedback isG(s) = 10/s(0.1s+1). Evaluate the static error constants (Kp, Ku, and Ka) for the system. Obtain the steady-state error of the system when subjected to an input given by the polynomial $r(t)=a_0+a_1t+\frac{a_2}{2}t^2$ **(May 07, 06, 05)**

35. Consider a system shown in Figure, employing proportional plus error-rate control. Determine the value of the error-rate factor Ke so that the damping

ratio is 0.5. Determine the values of settling time, maximum overshoot when subjected to with and without error-rate control a unit step input.

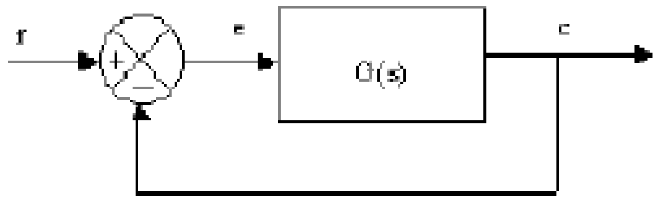


(May 07, 06)

36. For a unity feedback system G(s) = $\frac{36}{s(s+0.72)}$. Determine the characteristic equation of the system. Hence calculate the undamped frequency of oscillations, damped frequency of oscillations, damping ratio, peak overshoot, and time required to reach the peak output, settling time. A unit step input is applied to the system. **(May 07)**

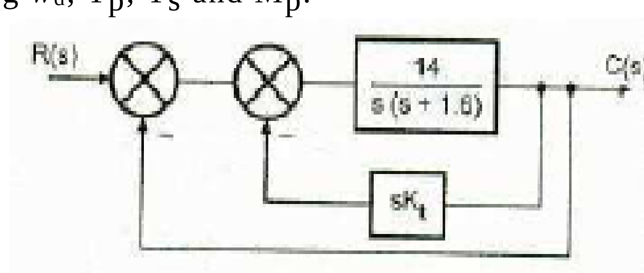
37. The open loop transfer function of a control system with unity feedback is given by G(s)= 100/s(s+01s) . Determine the steady state error of the system when the input is $10+10t+4t^2$. **(May 07)**

38. For the feedback control system shown in figure. It is required that:
   i. The steady-state error due to a unit-ramp function input is equal to 1.5.
   ii. The dominant roots of the characteristic equation of the third-order system are at?1+j1 and ?1-j1. Find the third-order open-loop transfer function G(s) so that the foregoing two conditions are satisfied.



(May 07)

39. i. Why derivative controller is not used in control systems? What is the effect of PI controller on the system performance?
   ii. The system shown in figure uses a rate feed back controller. Determine the tachometer constant K_t so as to obtain the damping ratio as 0.5. Calculate the corresponding w_d, T_p, T_S and M_p.



(May 07)

40. i. Define the following terms:
    a. Steady-state error
    b. Settling time
    c. Peak overshoot
    d. type and order of a control system.

    ii. Sketch the transient response of a second order system and derive the expression for rise time and peak overshoot? **(May 07)**

41. A second order servo has unity feedback G(s) = 500/s(s+5). Sketch the transient response for unity step input, and calculate peak overshoot, settling time, peak time. **(Sep 06)**

42. A feedback system employing output-rate damping is shown in Figure: **(Sep 06)**

    i. In the absence of derivative feedback (K_0=0), determine the damping factor and natural frequency of the system. What is the steady state error resulting from unit-ramp input?

    ii. Determine the derivate feedback constant K_0, which will increase the damping factor of the system to 0.6. What is the steady-state error to unit-ramp input with this setting of the derivative feedback constant?

    iii. Illustrate how the steady-state error of the system with derivative feedback to unit-ramp input can be reduced to same value as in part (a), while the damping factor is maintained at 0.6.

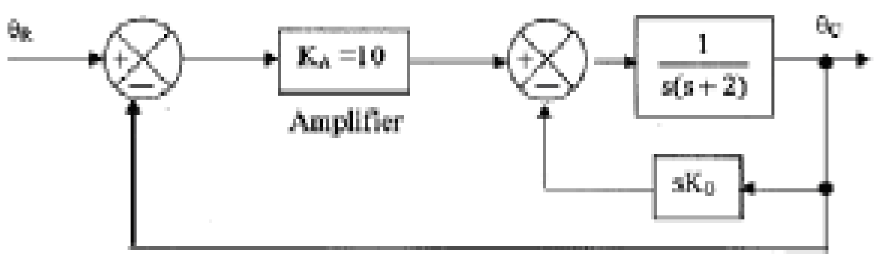


Figure 3:

43. The open loop transfer function of a unity feedback control system is $G(s) = \dfrac{K}{s(1+Ts)}$

    i By what factor should the amplifier gain "K" be multiplied in order to increase the damping ratio from 0.2 to 0.8?

    ii. By what factor should "K" be multiplid so that the maximum overshoot for a step input decreases from 60% and 10%. **(Apr 06)**

44. i. Explain error constants K_p, K_v and K_a for type I system.

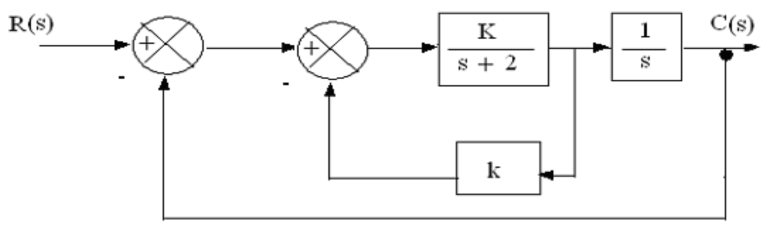
    ii. Given the open-loop transfer function of a unity feedback system as $G(s) = \dfrac{100}{S(0.1s+1)}$

    Find K_p, K_v and K_a. **(Apr 06, Jan 03)**

45. i. Consider the closed-loop system given by $\frac{C(S)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$
Determine the values of ζ and w_n so that the system responds to a step input with approximately 5% overshoot and with a settling time of 2 sec. (Use the 2% criterion)

ii. What are the time response specifications? Explain each of them. **(Apr 06)**

46. i. Consider the system shown in Figure. Determine the values of K and k such that the system has a damping ratio of 0.7 and an undamped natural frequency of 4 rad/sec.



ii. Consider the unit-step response of a unity-feedback control system whose open-loop transfer function is G(s) =1/s(s+1). Obtain the rise time, peak time, maximum overshoot, and setting time, peak time, maximum overshoot, and setting time. **(Apr 06, 05)**

47. A Unity feedback system has forward transfer function G(s)=20/(s+1). Determine and compare the response of the open and closed loop systems for unit step input.Suppose now that parameter variation occurring during operating conditions causes G(s) to modify toG(s) =20/(s+0.4). What will be the effect on unit-step response of open and closed loop systems? Comment upon the sensitivity of the two systems to parameter variations. **(Apr 06)**

48. i. Find the steady-state error to
a. a unit step input b. a unit ramp input and

ii. a unit parabolic input ($r = {}^{1}/2t^2$) for a unity feedback systems that have the following forward transfer functions. $G(s) = \frac{10}{s^2(s+4)(s^2+3s+12)}$

iii. The open loop transfer function of a servo system with unity feedback is given G(s)=500/s(1+0.1s) Evaluate the error series for the above system and determine the steady state error when the input is $r(t) = 1 + 2t + t^2$.**(Apr 05)**

49. i. What are the time response specifications? Explain each of them.

ii. For a negative feedback control system having forward path transfer function G(s)=k/s(s+6) and H(s) = 1. Determine the value of gain k for the system to have damping ratio of 0.8. For this value of gain k, determine the complete time response specifications. **(Nov 04)**

50. An open loop transfer function of unity feedback System is given by G(s)=25/s(s+5) Determine the damping factor, undamped natural frequency, damped natural frequency and time response for a unit step input. **(Apr 04)**

51. i. What are the different time domain specifications of a dynamical system? Explain important specifications of a second ordered system to unit step input.

ii. The open loop transfer function of a unity feedback system is given by G(s) = K/s(Ts+1), where K and T are positive constants. By what factor should the amplifier gain be reduced so that the peak overshoot of unit-step response of the system is reduced from 75% to 25%? **(Apr 04)**

52. i. Explain the Routh's criterion to determine the stability of a dynamical system and give its limitations.

ii. Find the step, ramp and parabolic error coefficients and their corresponding steady state errors for unit feedback control system having the transfer function $G(s) = \frac{14(s+3)}{s(s+5)\left(s^2+2s+5\right)}$ **(Apr 04)**

53. i. A unity feedback system has a forward path transfer function G(s) =9/s(s+1) Find the value of damping ratio, undamped natural frequency of the system, percentage overshoot, peak time and settling time.

ii. Measurements conducted on servomechanism show the system response to be When subjected to a unit-step unit. Obtain the expression for the closed-loop transfer function. **(Apr 04)**

54. i. Explain error constants K_p, K_V and K_a for types-II system.

ii. A unity feed-back system is characterized by the open-loop transfer function $G(s) = \frac{1}{s(0.5s+1)(0.2s+1)}$ Determine the steady-state errors for unit-step, unit-ramp and unit-acceleration input. Also find the damping ratio and natural frequency of the dominant roots. **(Apr 04)**

55. i. Derive the expression for rise time, peak time peak overshoot and settling time of second order system subjected to a step input.

ii. A unit feedback control system has a loop transfer function. G(s)=10/s(s+2) Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units. **(Apr 04)**

56. i. The open loop transfer function of a control system with unity feedback is given by G(s)=100/s(s+0.1s). Determine the steady state error of the system when the input is $10+10t+4t^2$.

ii. A unit feedback system has an open loop transfer function $G(s)=k/(s^2+4s+5)(s+2)$. Use RH test to determine the range of positive values of K for which the system is stable. **(Apr 04)**

57. A unity feedback system with $G(s)=k/s(s+1)^2$ is desired to limit the steady state error to a value not exceeding 0.25 to unit ramp input.
   i. find the value of K and also
   ii. Find the requirement value of K for stability. **(Apr 04)**

58. The open loop transfer function of a control system unit feedback is given by $G(s)=\frac{150}{s(1+0.25s)}$
   i. Evaluate the generalized error series for the system.
   ii. Determine the steady state error for an input r(t) = (1+5) u(t). **(Apr 04)**

59. i. For an underdamped second order system, define various time domain specifications.
   ii. A unity feedback control system has the forward transfer function: $G(s)=25/s(s+6)$ Find the rise time, peak time and the maximum over shoot for unit step input. **(Apr 04)**

60. Determine different error co-efficient for a system having $G(s)=k/s(s^2+2s+5)$ and. $H(s)=\frac{10}{s+4}$
   Determine the steady state error if input is r(t) = 5 + 10t + . Assume K = 20. **(Apr 04)**

61. i. Obtain the unit-impulse response and the unit-step response of a unity-feedback system whose open-loop transfer function is $G(s)=\frac{2s+1}{s^2}$
   ii. A unity feedback system is characterized by the open loop transfer function $G(s)=\frac{1}{s(0.5s+1)(0.2s+1)}$. Determine the damping ratio and natural frequency of the dominant roots **(Apr 04)**

62. The control system having unity feedback has $G(s)=20/s(s+1)(1+4s)$. Determine
   i. Static error co-efficient.
   ii. Steady state error if input = $r(t) = 2+4t+t^2/2$. **(Apr 04)**

63. For a unit feedback system $G(s) =36/s(s+0.72)$. Determine the characteristic equation of the system. Hence calculate the undamped frequency of oscillations, damped frequency of oscillations, damping ratio, peak overshoot, time required to reach the peak output, settling time. A unit step input is applied to the system. **(Apr 04)**

64. i. Explain the concept of stability of a control system and explain a method to determine the stability of a dynamical system.

ii. A unity feedback control system is characterized by the open-loop transfer function $G(s)=\frac{K(s+13)}{s(s+3)(s+7)}$

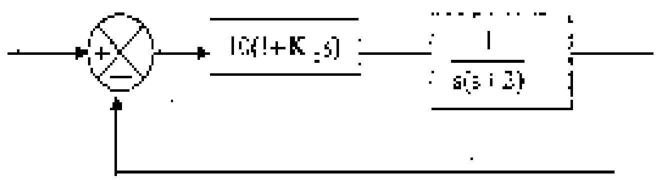
a. Using the Routh's criterion, determine the range of values of K for the system to be stable.

b. Check if for K=1, all the roots of the characteristic equation of the above system have damping factor greater than 0.5. **(Apr 04)**

65. A unity feedback control system has G(s) =100/s(s+5).If it is subjected to unity step input. Determine
  i. Damped frequency of oscillation.
  ii. Maximum peak overshoot
  iii. Time to reach for first overshoot
  iv. Settling time
  v. Output response **(Nov 03)**

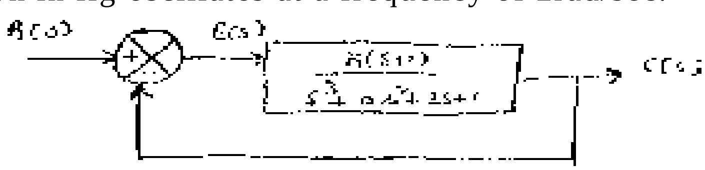
66. i. For the given system shown in the figure below, find damping factor and natural frequency when:

a. $K_D = 0$; b. $K_D = 1$. **(Apr 03)**

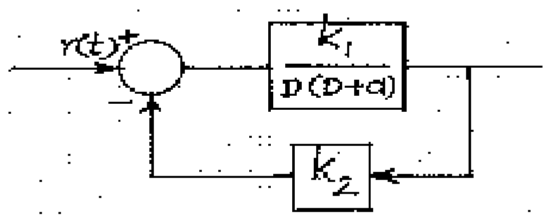


ii. Determine the damping ratio and undamped natural frequency of oscillatory roots and percentage of peak over shoot for a unit step given by $G(s)=\frac{1}{s(1+0.5s)(1+0.2s)}$ and the system is unity feedback type.

67. A system oscillates with frequency w, if it has poles at s = ±jw and no poles in the right half s-plane.Determine the values of 'k' and 'a', so that the system shown in fig oscillates at a frequency of 2rad/sec. **(Apr 03)**

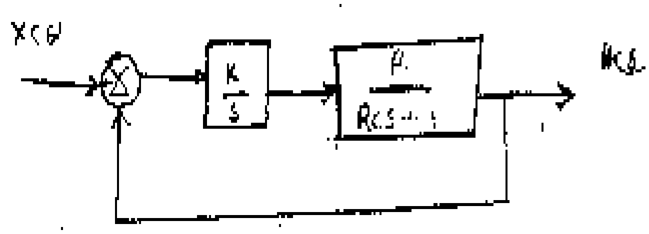


68. i. For the system shown in the figure below, determine K_1, K_2, and a such that the system will have a steady state gain of 1.0,a damping ratio, d= 0.6,w_n=5.0.



ii. A unity feedback control system has the forward transfer function, find the rise time, peak time and the maximum over shoot for unit step input. **(Apr 03)**

69. i.Explain the terms :
a. Proportional control;
b. Integral control; and
c. Proportional plus derivative control.



Show that the steady error for unit step input is zero. **(Apr 03)**

70. i. Find the step, ramp and parabolic error coefficients and their corresponding steady state errors for unity feedback control system having transfer function:

$$G(s)=\frac{14(s+3)}{s(s+5)(s^2+2s+5)}$$

ii. A unity feedback control system has the forward transfer function: $G(s)=\frac{25}{s(s+6)}$
Find the rise time, peak time and the maximum over shoot for unit step input.
(Jan 03)

71. In a closed loop control system, the open loop transfer function $G(s)=K/s^2$and feedback transfer function H(s) = as+b. If k = 20, find the values of a,b so that overshoot is 16% and the time constant is 0.1sec. Also determine the steady state error, if the input to the system is a unit ramp. **(Jan 03)**

72. The open-loop transfer function of a Servo system with a unity feedback is G(s)=4/s(1+0.1s) Determine the dynamic error for a input $r(t) = 1+2t+t^2$ by using the dynamic error coefficients. **(Jan 03)**

73. The open loop transfer function of a servo system with unity feedback is given by G(s)=500/s(1+0.1s).Evaluate the error constants K_P, K_V and K_a. Determine the steady state error when the input is $r(t) = 1+2t+t^2$. **(Jan 03)**

74. i. The open loop transfer function of a servo system with unity feed back is given by G(s)=500/s(1+0.1s).Evaluate the error series for the above system and determine the steady state error when the inputs $r(t) = 1+2t+t^2$.

ii. The open loop transfer function of a unity feed back control system is given by $G(s)=\frac{K}{(S+2)(S+3)(s^2+6S+25)}$ Applying Routh Hurwitz criterion discuss the stability of the closed loop system as a function of K.

(Jan 03)

75. i. Define: (i) rise time (ii) settling time (iii) delay time (iv)over shoot for a second order system.

ii. The open loop transfer function of a unit feed back control system is given by $G(s)=\frac{A}{S(1+ST)}$

By what factors should the amplifier gain A be multiplied so that:
a. Damping ratio is increased from 0.2 to 0.4.
b. The over shoot of unit step response is reduced from 80% to 40%. **(Apr 02)**

76. i. Define the following time domain specifications
a. Rise time
b. Peak time
c. Setting time
d. Peak over shoot and
e. Steady state error

ii. For unity feedback system having forward path transfer function $G(s)=\frac{K}{S(Ts+1)}$, determine the time domain specifications for units step input, with K = 100 and T = 0.1 sec.

iii. Derive the expressions for steady state error coefficients for unity feedback system with
a. Step input b. Velocity input and c. Acceleration input. **(Apr 02)**

77. Sketch the time domain response C(t) of typical under damped 2^{nd} system to a step input r(t). In this sketch indicate the time domain specifications.

(IES 96)

78. An open loop transfer function of unity feedback system is given by $G(s)=5/s^2(s+5)$ Determine the damping factor, undamped natural frequency, damped natural frequency and time response for a unit step input. **(IES 95)**

79. A circuit has the following transfer function, $\frac{C(S)}{R(S)} = \frac{S^2+35+4}{S^2+45+4}$ .Find C(t) when r(t) is a unit step. State if the circuit is undamped, underdamped, critically damped or overdamped. **(IES 02)**

UNIT-IV

1. The open loop transfer function of a feedback system is G(s) H(s) =K/s(s+4) (s^2+4s+20). Draw the root locus and investigate the stability of the system.
(Dec 14)

1. The open loop transfer function of a unity feedback system is given by G(s)=K/(s+2)(s+4)(s2+6s+25) Using R-H criterion discuss the stability of the closed-loop system as a function of 'K'. Determine the values of 'K' which will cause sustained oscillations in the closed-loop system. What are the corresponding oscillation frequencies? **(May/June 13)**

2. A unity feedback control system has an open loop transfer function G(s) = K/s ^{2} (s+2) Sketch the Root-Locus plot and show that the system is unstable for all values of'K'.
(May/June 13)

3. a) sketch the root locus plot for the control system with a forward transfer function G(s)=k(s+2)/s^2+2s+3 and H(s)=1
b) A unity feedback system has the forward transfer function G(s) =k(s+2)/s(s+3)(s+7).using R-H criterion ,find the range of K for which the closed loop system is stable. **(Nov/Dec 12)**

4. Sketch the root-locus diagram of a control system whose loop transfer function is G(s)H(s) = K/s(s+4)(s+10) . Using the diagram or otherwise find the values of gain at breakaway points and at point of intersection of the loci with the imaginary axis.
(May/June 12)

5. A unity feedback control system has an open loop transfer functionG(s) = K(1+0:2s)(1+0:025s)/s^3(1+0:001s)(1+0:004s) Sketch the complete root locus for -K<œ.Indicate the crossing points of the loci on the j! axis and the corresponding values of K at these points. Also indicate the range of K for which system closed loop system is stable. **(May/June 12)**

6. (a) Determine the range of value of k for the system to be stable which is characterized by the equation s3 + 3Ks2 + (k+2)s+4 = 0.

(b) Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system. **(May/June 12)**

7. The open loop transfer function of a feedback control system with unity feedback is G(s) = K/(s+10)n . Sketch the root loci of the characteristic equation of the closed loop system for -œ< K < œ, with

(a) n=3

(b) n=4. Show all important information on the root loci. **(May/June 12)**

8. i. Define the the following terms

   a. absolute stability

   b. marginal stability

   c. conditional stability

   ii. By means of RH criterion determine the stability of the system represented by the characteristic equation $S^4 + 2S^3 + 8S^2 + 4S + 3 = 0$

   iii. State the advantages of RH Stability criterion? **(Apr 11)**

9. i. Define the following terms

   a. Stable system

   b. Critically stable system

   c. Conditionally stable system.

   ii. For the system having characteristic equation $2S^4 + 4S^2 + 1 = 0$, find the following

   a. the no. of roots in the left half of s-plane

   b. the no. of roots in the right half of s-plane

   c. the no. of roots on the imaginary axis.

   Use the RH stability criterion **(Dec 10)**

10. i.Show that that the break-away and break-in points, if any, on the real axis for the root locus for $G(s)H(s) = \frac{KN(s)}{D(s)}$ where N(s) and D(s) are rational polynomials in S, can be obtained by solving the equation $\frac{dK}{ds} = 0$.

   ii. Check whether the points (-1+ j) and (-3+ j) lie on the root locus of a system given by $G(s)H(s) = \frac{K}{(s+1)(s+2)}$. Use the angle condition. **(Dec 10)**

11. Sketch the root locus plot of a unity feed back system whose open loop T.F is $G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$.

(Dec 10)

12. The open loop T.F. of a control system is given by $G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$. Sketch the root locus plot and determine

i. the break-away points
ii. The angle of departure from complex poles
iii. the stability condition. **(Dec 10)**

13. i. Sketch the root locus plot of a unity feed - back system whose open loop T.F is $G(s) = \frac{s}{(s^2+4)(s+2)}$
ii. What is break-away and break-in point? How to determine them?
iii. From the given root locus plot how can you determine the gain margin and phase margin for the specified gain value `K'. **(May 10)**

14. Sketch the root locus plot for the system having $G(s) = \frac{K}{s+1}, H(s) = \frac{s+1}{s^2+4s+5}$. **(May 10)**

15. Using RH stability criterion determine the stability of the following system.
i. Its loop t.f. has poles at s=0, s= -1, s= -3 and zero at s= -5, gain K of forward path is 10
ii. It is a type-1system with an error constant of 10 sec-1 and poles at s= -3 and s=-6. **(May 10)**

16. Determine the values of k and b, so that the system whose open transfer function is $G(s) = \frac{k(s+1)}{s^3+bs^2+3s+1}$ oscillates at a frequency of oscillations of 2 rad/sec. Assume unity feed back. **(May 10)**

17. Sketch the root locus plot of a unity feedback system whose open loop T.F is $G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$ **(May 09, Sep 08)**

18. i. The open loop t.f. of a unity feed-back system is given by $G(s) = \frac{K}{s(1+0.25s)(1+0.4s)}$. Find the restriction on K so that the closed loop system is absolutely stable?
ii. A feed-back system has an an open loop t.f of $G(s)H(s) = \frac{Ke^{-s}}{s(s^2+5s+9)}$. Determine by the use of the RH criterion, the max. value of K for the closed loop system to be stable? **(May 09, Sep 07)**

19. i. Sketch the root locus plot for a unity feedback system whose open loop T.F. is given by $G(s) = \frac{K(s+0.5)}{s^2(s+4.5)}$.
ii. What is break-away and break-in point? How to determine them?
iii. From the given root locus plot how can you determine the gain margin and phase margin for the specified gain value ‘K’. **(May 09)**

20. i. State and explain Routh Hurwitz stability criterion
ii. Construct Routh array and determine the stability of the system whose characteristic equation is $S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + S16 = 0$. Also

determine the no.of roots lying on right half of s-plane, left half of s-plane and on imaginary axis? **(May 09)**

21. Sketch the root locus plot for the systems whose open loop transfer function is given by $G(s)H(s) = \frac{K}{s(s+1)(s+3)}$. Determine
    - i. the gain margin
    - ii. the phase margin for K=6. **(May 09)**

22. i. What is root locus plot? Explain with suitable example?
    - ii. What are the features of root locus plot?
    - iii. Check whether the point s= -3 + j 5 lies on the root locus of a system having $G(s)H(s) = \frac{K}{(s+1)(s+5)}$. Determine the corresponding value. **(May 09)**

23. Explain the stability of the system from the root locus plot in the following situations with suitable examples?
    - i. addition of open loop poles
    - ii. addition of open loop zeros. **(May 09)**

24. i. Show that the Routh?s stability criterion and Hurwitz stability criterion are equivalent.
    - ii. Consider a unity-feedback control system whose open-loop transfer function is G(s) = $\frac{K}{s(Js+B)}$. Discuss the effects that varying the values of K and B has on the steady-state error in unit-ramp response. **(Sep 08)**

25. i. The open loop transfer function of a control system with unity feedback is G(s) = $\frac{9}{(1+s)(1+2s)(1+3s)}$. Show that the system is stable.
    - ii. A unity feedback system is characterized by the open loop transfer function G(s) = $\frac{1}{s(0.5s+1)(0.2s+1)}$. Determine the steady state errors for unit step, unit ramp and unit acceleration input. **(Sep 08)**

26. i. The open loop Transfer function for a unity feedback system is given by G(s) = $\frac{K}{s(1+s+T_1)(1+sT_2)}$ Find the necessary conditions for the system to be stable using Routh-Hurwitz method.
    - ii. The open loop transfer function of a unity feedback system is G(s) = $\frac{100K}{s(s+10)}$. Find the static error constants and the steady state error of the system when subjected to 10 an input given by the polynomial .r(t) = $P_o + P_1 t + P_2 2t^2$ **(Sep 08)**

27. i. Find the Number of roots with positive, Negative and Zero real parts for a following polynomial using Routh's Hurwitz criterion $s^4 + 6s^3 - 31s^2 + 80s - 100=0$.

ii. System Oscillates with a frequency W if it has poles at s=+ jw and no poles in the right half of the s-plane. Determine the values of K and a for the characteristics equation $s^3 + as^2+2s+1+K(s+1) =0$ at a frequency of 2rad/sec.

(Sep 08)

28. Sketch the root locus plot of a unity feedback system whose open loop T.F is $G(s) = \frac{K(s^2+2s+2)}{(s+2)(s+3)(s+4)}$

(Sep 08)

29. Determine the values of k and b, so that the system whose open transfer function is $G(s) = \frac{K(s+1)}{s^3+bs^2+3s+1}$ oscillates at a frequency of oscillations of 2rad/sec. Assume unity feed back.

(Sep 08)

30. i. Explain the RH stability Criterion ?

ii. The open loop transfer function of a unity feed back control system is given by $G(s) = \frac{K}{s(1+sT_1)(1+sT_2)}$. Apply RH stability criterion, determine the value of K in terms of T\ and T_2 for the system to be stable? **(Sep 08, 07)**

31. i. Define the term root locus and state the rule for finding out the root locus on the real axis?

ii. Calculate the angle of asymptotes and the centroid for the system having $G(s)H(s) = \frac{K(s+3)}{s(s+2)(s+4)(s+5)}$.

iii. For $G(s)H(s) = \frac{K}{s(s+1)(s+3)}$, find the intersection point of the root locus with the jw - axis? **(May 08)**

32. i. What are the necessary conditions to have all the roots of the characteristic Equation in the left half of s-plane?

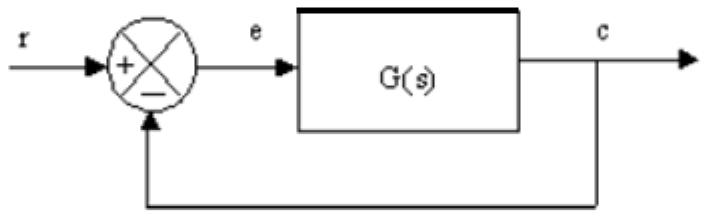
ii. What are the difficulties in RH stability criterion? Explain, how you can over come them? **(May 08)**

33. i. Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system.

ii. For the feedback control system shown in Figure. it is required that :

a. the steady-state error due to a unit-ramp function input be equal to 1.5.

b. the dominant roots of the characteristic equation of the third-order system are at ?1+j1 and ?1-j1. Find the third-order open-loop transfer function G(s) so that the foregoing two conditions are satisfied.



(May 08)

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(May 08, 07)

35. i. Find the roots of the characteristic equation for systems whose open-loop transfer functions are given below. Locate the roots in the s-plane and indicate the stability of each system.

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

  b. G(s) H(s) = $\frac{5(s+3)}{s(s+3)(s+8)}$

  ii. A feedback system has an open-loop transfer function of G(s)H(s)= $\frac{Ke^{-s}}{s(s^2+5s+9)}$. Determine the use of Routh criterion, the maximum value of K for the closed-loop system to be stable. **(May 08)**

36. Using RH stability criterion determine the stability of the following systems.

  i. Its loop t.f. has poles at s=0, s= -1, s= -3 and zero at s= -5, gain K of forward path is 10

  ii. It is a type-1system with an error constant of 10 sec-1 and poles at s= -3 and s=-6. **(Sep 07)**

37. i. Open loop T.F. of a unity feedback system is G(s) = $\frac{K(s+a)}{s(s+b)}$ **(Sep 07)**
  a. Prove that break-away and break-in points will exist only when |a| > |b|

  ii. Prove that the complex points on the root locus form a circle with center (-a, 0) and radius $\sqrt{a^2 - ab}$.

38. i. Show that the breakaway and break-in points, if any, on the real axis for the root locus for G(s)H(s)= $\frac{KN(s)}{D(s)}$ where N(s) and D(s) are rational polynomials in s, can be obtained by solving the equation $\frac{dK}{ds} = 0$.

  ii. By a step by step procedure draw the root locus diagram for a unity negative feedback system with open loop transfer function G(s)= $\frac{K(s+1)}{s^2(s+9)}$. Mark all the salient points on the diagram. Is the system stable for all the values of K? **(May 07, 06)**

39. The open-loop transfer function of a unity feedback control system is given by G(s)= $\frac{K}{(s+2)(s+4)(s^2+6s+25)}$. By applying the Routh criterion, discuss the stability of the closed-loop system as a function of K. Determine the values of K, which will cause sustained oscillations in the closed-loop system. What are the corresponding oscillation frequencies? **(May 07)**

40. i. What are root loci? Summarize the steps that are used as rules for constructing the root locus.

ii. Draw the root locus of a system having open loop transfer function G(s)H(s)= $\frac{K}{s(s+4)(s^2+4s+20)}$. Indicate the salient points of root locus. **(May 07)**

41. A unity feedback system has an open loop transfer function G(s)= $\frac{K}{(s+2)(s^2+4s+5)}$. Use RH test to determine the range of positive values of K for which the system is stable. **(May 07)**

42. The open loop transfer function of a unity feedback system is G(s) = $\frac{K}{S(s^2+8s+20)}$. Sketch the complete root locus and determine the value of K

i. For the system to be stable

ii. For the system to be marginally stable and hence the frequency of oscillation

iii. To provide critical damping

iv. To give an e”ecting damping factor 0.5. **(May 07)**

43. The open loop T.F. of a control system is given by G(s)H(s) = $\frac{K}{s(s+6)(s^2+4s+13)}$ Sketch the root locus plot and determine

a. the break-away points

b. The angle of departure from complex poles

c. the stability condition. **(May 07)**

44. For a unity feedback system having forward path transfer function G(S) = $\frac{K}{s(1+0.6S)(1+0.4S)}$. Determine

a. The range of values of K

b. Marginal value of K

c. Frequency of sustained oscillations. **(May 07)**

45. Sketch the root locus plot a unity feed back system with an open loop transfer function $G(s)=\frac{K}{s(s+2)(s+4)}$. Find the range K for which the system has damped oscillatory response. Explain the procedures for constructing root locus **(Sep 06)**

46. i. The characteristic equation of a feedback control system is $s^3 + (K + 0.5)s^2 + 4Ks + 50 = 0$. Using R-H criterion determine the value of K for which the system is stable.

ii. Determine whether the largest time constant of the characteristic equation given below is greater than, less than, or equal to 1.0 sec. $s^3 + 4s^2 + 6s + 4 = 0$ **(Apr 06)**

47. The characteristic equation of a control system is given by $s^4 + 20s^3 + 15s^2 + 2s + k = 0$ use Routh -Hurwitz criterion to find the value of K for which the system will be marginally stable and the frequency of the corresponding sustained Oscillations. **(Apr 06)**

48. A unity feedback system has a plant G(s) = $\frac{K(s+0.5)}{s(s+1)(s^2+2s+2)}$ sketch the root locus and find the roots when $\zeta = 0.5$ **(Apr 06)**

49. A unity feedback system has the plant transfer function $G(s) = \frac{K}{s(s^2+24s+144)}$. Find the angle of departure from the complex pole and the gain when the poles are at imaginary axis. **(Apr 06)**

50. i. Find the angle of arrival and the angle of departure at the complex zeros and complex poles for the root locus of a system with open-loop transfer function $G(s)H(s) = \frac{K(s^2+1)}{s(s^2+4s+8)}$

ii. Draw the root locus diagram for a feedback system with open-loop transfer function $G(s) = \frac{K(s+5)}{s(s+3)}$ following systematically the rules for the construction of root locus. Show that the root locus in the complex plane is a circle.

(Apr 05)

51. i. Determine the Breakaway points of the system which have hte open loop transfer function

$G(S)\,H(S) = k\,(s+4) / (s^2 + 2s + 4)$

ii. Derive the magnitude and phase angle. **(Apr 05)**

52. For the function $G(s)H(s) = \frac{K(s+3)}{(s+1)(s+2)}$ prove that part of root locus is circular. Find the center, and radius of the circle. What are the breakaway points?

(Apr 05)

53. i. Determine the breakaway points of the system which have the open loop transfer function $G(s)H(s) = \frac{K(s+4)}{(s^2+2s+4)}$

ii. Derive the magnitude and angle criteria for stability. **(Nov 04)**

54. i. Determine the range of value of k for the system to be stable and is characterized by the equation

$s^3 + 3Ks^2 + (K+2)s+4 = 0.$

ii. A unity feedback system has an open loop transfer function $G(s)=\frac{K}{(s+2)(s^2+4s+8)}$. Use Routh's test to determine the range of positive values of 'K' for which the system is stable. **(Nov 04)**

55. A unit feedback control system given by $G(s)=\frac{K}{s(1+0.1s)(1+0.2s)}$

i. Sketch the root locus diagram of the system.
ii. Determine the limiting value of gain K for stability
iii. Determine the value of gain at which the system is critically damped.

(May 04)

56. Calculate the values of K and w for the point in s-plane at which the root locus of intersects the imaginary axis. **(May 04)**

57. A unity feedback system has an open loop transfer function $G(s)H(s)=\frac{K}{s(s+3)(s^2+2s+2)}$. Sketch the root locus as "K" varied from 0 to infinity. **(May 04)**

58. The open loop transfer function of a unity feedback system control system is given by $G(s)=\frac{K(s+2)}{s(s+3)(s+4)(s^2+2s+2)}$

i. Sketch the root locus diagram as a function of K.
ii. Determine the value of K which makes the relative damping ratio of the closed loop complex poles equal to 0.707. **(May 04)**

59. i. Discuss the rules of construction of root loci.

ii. A unity feedback control system has the following open loop transfer function $G(s)=\frac{K(s+3)}{S(s^2+2s+2)(s+5)(s+6)}$ Sketch the root locus diagram. Calculate the value of K corresponding to the damping ratio of 0.42. **(Jan 03)**

60. Sketch the root locus plot of a unity feedback system with an open-loop transfer function $G(s)=\frac{K}{S(s+2)(s+4)}$ **(Jan 03)**

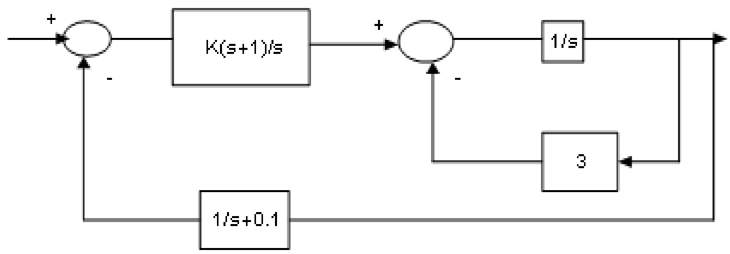
Find the range of values of K for which the system has damped oscillatory response. What is the greatest value of K which can be used before continuous oscillations occur? Also determine the frequency of continuous oscillations.
Determine the value of K so that the dominant pair of complex poles of the system has a damping ratio of 0.5.

61. The characteristic polynomial of a system is $q(s) = 2s^5 + s^4 + 4s^3 + 2s^2 + 2s + 1$. The system is

i. stable
ii. unstable
iii. marginally stable
iv. oscillatory **(GATE 02)**

62. Consider the feedback control system as shown

i. Find the transfer function of the system and its characteristic equation
ii. Use the R-H criterion to determine the ranges of k for which the system is stable **(GATE 01)**



63. The loop transfer function of a feed back control system is given by G(s)H(s) $= \frac{k(s+1)}{s(1+Ts)(2s+1)}$, k>0, using R-H criterion determine the region of k-T plane in which the closed loop system is stable

(GATE 99)

64. The loop transfer system .of a single loop control system is given by $s^4 + 20s^3 + 15s^2 + 2s + k = 0$

i. Determine the range of k for the system to be stable
ii. Can the system be marginally stable? if so, find the required value of k and the frequency of sustained oscillation

(GATE 98)

57. A system having an open loop transfer function G(s) $= \frac{k(s+3)}{s(s^2+2s+2)}$ is used in the control system with unity feedback. Using R-H criterion find the range of k for which the feed back system is stable.

(GATE 96)

58. State the properties of Hurwitz Polynomial. **(GATE 93)**

59. Test the following Polynominals for Hurwitz Property.
$F(S) = S^4 + S^3 + 5S^2 + 3S + 4$ **(IES 94)**

60. By means of Routh's Criteria determine the stability of the following system.
$S^5 + S^4 + 3S^3 + 9S^2 + 16S + 10 = 0$
$S^6 + 3S^5 + 5S^4 + 9S^3 + 8S^2 + 6S + 4 = 0$ **(IES 93)**

61. Which of the following statements about the equation below, for R-H criterion is true $4s^4 + s^3 + 3s^2 + 5s + 10 = 0$

i. it has only one root on the imaginary axis
ii. it has two roots in the right half of the s-plane
iii. the system is stable
iv. the system is unstable **(IES 91)**

UNIT-V

1. Sketch the Bode plot for the transfer function $G(s) = ke^{-0.1s}/s(1+s)(1+0.01s)$ and determine the system gain k for the gain cross over frequency to be 5 rad/sec.
(Dec 14)

1. Define phase margin and gain margin and sketch the bode plot for the following Transfer function G(s) H(s) =K s2 / (1+0.25s) (1+0.025s)
(May/June13)

2. The open loop transfer function of a unity feedback control system is $G(s) = k/s(1+0.1s)(1+s)$
 a) Determine the value of the k so that the resonance peak M_P of the system isequal to 1.4
 b) Determine the value of k so that the gain margin of the system is 20db
 c) Determine the value of the k so that the phase margin of the system is 60^0
(Nov/Dec12)

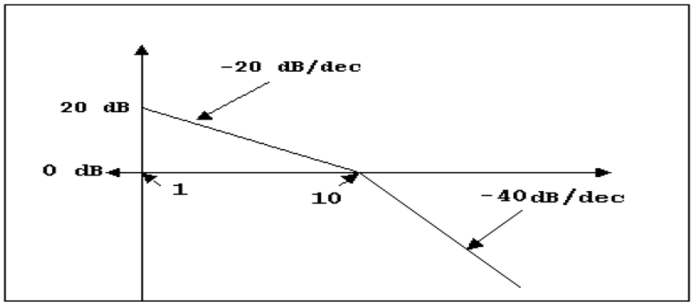
3. A unity feedback control system has the transfer function G(s) = K/s(s+a)
 (a) Find the value of `K' and `a' to satisfy the frequency domain specifications of Mr=1.04 and! r = 11.55 rad/sec.
 (b) Evaluate the settling time and bandwidth of the system for the values of K and a determined in part (a). **(May/June12)**

4. Sketch the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency !c to be 5 rad/sec. $G(s) = Ks^2/(1+0:2s)(1+0:02s)$
(May/June12)

5. The block diagram representation of a second-order type 0 system is shown in Figure 8. Derive the frequency domain characteristics. **(May/June12)**

6. (a) Explain the following terms:
 i. Frequency response
 ii. Phase and gain margins.
 (b) Sketch the Bode plot for the following transfer function $G(s) = 75(1+0.2s)/s(s^2+16s+100)$
(May/June12)

7. i. Explain the significance of Bandwidth in the design of linear control systems.
   ii. Show that the error contributed by a simple pole in the Bode magnitude plot is -3 dB at corner frequency.
   iii. The asymptotic plot of a system is shown in figure.



Find the loop transfer function of the system. **(Apr 11, Dec 10)**

8. i. Define
   a. Bandwidth
   b. Resonant peak
   ii. Explain how stability can be determined from Bode plots
   iii. Find resonant peak & resonant frequency given $\zeta = 0.5$. If the damping ratio is changed to 0.9 find resonant peak & resonant frequency. Comment on the result. **(Dec 10)**

9. i. Define
   a. Minimum phase tf
   b. Non minimum phase tf
   ii. Enlist the steps for the construction of Bode plots
   iii. Explain the procedure for determination of transfer function from Bode plots. **(Dec 10)**

10. i. What do you mean by a critically stable system? How do you find out whether a given system is critically stable from Bode plots?
    ii. Define
    a. Gain Margin
    b. Phase Margin
    iii. Sketch Bode phase angle plot of a system $G(s) = \frac{1}{(1+s)(1+2s)}$ **(Dec 10)**

11. i. Explain why it is important to conduct frequency domain analysis of linear control systems.
    ii. Sketch the Bode Magnitude plot for the transfer function $G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}$

    Hence find `K' such that gain cross over freq. is 5 rad/sec. **(May 10)**

12. i. Given $G(s) = \frac{42.77}{s(s+6.54)}$ If r(t) = 6.8 Sin 4t find the output at steady state.
   ii. Write a brief note on log-magnitude Vs phase plots.
   iii. In Bode plots if gain cross over frequency is greater than phase cross over frequency then the system is UNSTABLE. Elaborate. **(May 10)**

13. i. Explain the term frequency response analysis.
   ii. Show that in Bode magnitude plot the slope corresponding to a quadratic factor is -40 dB/dec.
   iii. Explain with the help of examples
      a. Minimum phase function
      b. Non minimum phase function
      c. All pass function. **(May 10)**

14. i. Define frequency response.
   ii. Discuss the advantages & disadvantages of frequency response analysis.
   iii. Bring out the correlation between time response & frequency response and hence show that the correlation exists for the range of damping ratio 0 <ζ< 0:707. **(May 10)**

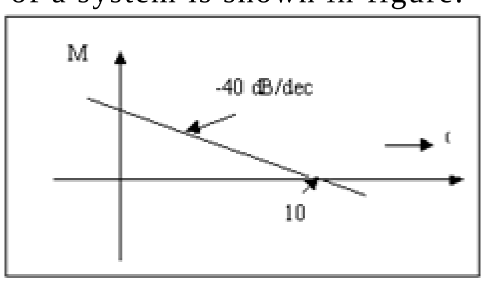
15. Sketch the Bode plot s of

$$G(s) = \frac{15(s+5)}{s(s^2+16s+100)}$$

Hence find gain cross over frequency. **(May 09, 08)**

16. i. Explain the term frequency response analysis.
   ii. Show that in Bode magnitude plot the slope corresponding to a quadratic factor is -40 dB/dec.
   iii. Explain with the help of examples
      a. Minimum phase function
      b. Non minimum phase function
      c. All pass function. **(May 09, 07, Sep 07)**

17. i. Explain the significance of Bode plots in stability studies of linear control systems.
   ii. Show that in case of a quadratic factor the phase angle is a function of frequency *w* and damping ratio ζ.
   iii. The magnitude plot of a system is shown in figure.

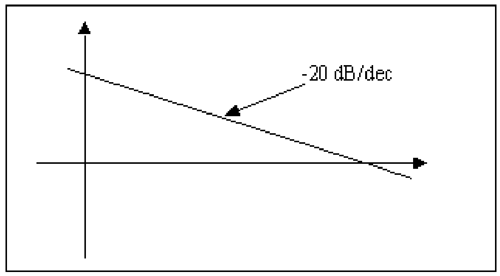


Find the open loop transfer function. **(May 09)**

18. i. Show that Bode plots of a system with transfer function having many factors can be obtained by adding the Bode plots of individual factors.

ii. In the Bode magnitude plot of a system the slope changed by -40 db / dec at a frequency $w = w_2$. What can be the corresponding factor in the loop transfer function?

iii. The magnitude plot of a system is shown in figure.



19. A system is given by $G(s)H(s) = \frac{250}{s(s+1)(s+10)}$

i. Draw Bode plots

ii. Find GM & PM

iii. Hence determine the closed loop stability of the system. **(May 09)**

20. i. Find the angle of arrival and the angle of departure at the complex zeros and complex poles for the root locus of a system with open-loop transfer function $G(s)H(s)= \frac{K(s^2+1)}{s(s^2+4s+8)}$.

ii. Draw the root locus diagram for a feedback system with open-loop transfer function $G(s)= \frac{K(s+5)}{s(s+3)}$., following systematically the rules for the construction of root locus. Show that the root locus in the complex plane is a circle.

(Sep 08)

21. Define phase margin and gain margin. **(Sep 08)**

22. i. For the function $G(s)H(s)= \frac{K}{s(s+2)(s+4)}$ determine the breakaway point and the value of K for which the root locus crosses the imaginary axis.

ii. Explain the terms with reference to root locus.

a. Asymptotes

b. Centroid

c. Break away point. **(Sep 08)**

23. i. Derive expression of peak resonance and bandwidth.

ii. Define the following frequency response specifications.

a. Peak Resonance b. Bandwidth c. Phase Margin d. Gain Margin

(Sep 08)

24\. i. Show that the breakaway and break-in points, if any, on the real axis for the root locus for G(s)H(s)= kN(s)/D(s) , where N(s) and D(s) are rational polynomials in s, can be obtained by solving the equation dK/dS =0.

ii. By a step by step procedure draw the root locus diagram for a unity negative feedback system with open loop transfer function G(s)= $\frac{K(s+1)}{s^2(s+9)}$. Mark all the salient points on the diagram. Is the system stable for all the values of K?

(Sep 08)

25\. i. Find the value of K and a to the following frequency domain specifications M_r = 1.04, w_r = 11.55 rad/sec. Assume G(s) = $\frac{K}{s(s+a)}$ unity feed back system.

ii. Sketch the Bode Plot for the following transfer function and determine in each case the system gain K for the gain cross over frequency wc to be 5 rad/sec. G(s) = $\frac{Ke^{0.1s}}{s(s+1)(1+0.1s)}$ **(Sep 08)**

26\. i. With usual notations derive equations for the angle of departure and the angle of arrival of the root locus from complex poles and zeros.

ii. The characteristic equation of closed-loop system is s^2+ (2+k) s+26=0. Draw the root locus of the system. Mark the salient points on the diagram. **(Sep 08)**

27\. Write short notes:

i. Frequency domain specifications

ii. Stability analysis from Bode plots. **(Sep 08)**

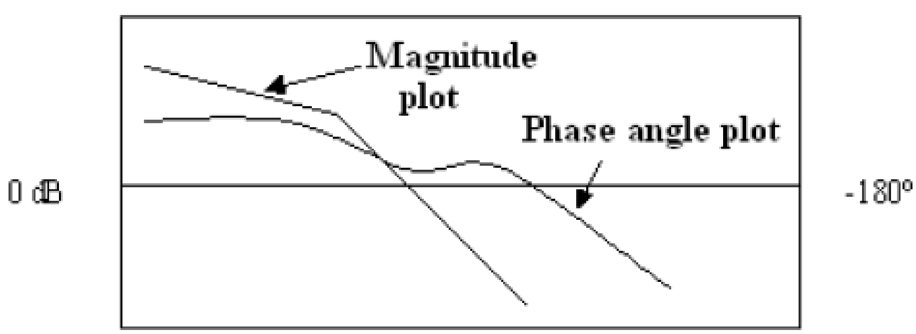
28\. i. Derive the expressions for resonant peak & resonant frequency and hence establish the correlation between time response & frequency response.

ii. Given ζ = 0.7 & w_n = 10r/s find resonant peak, resonant frequency & Bandwidth. **(Sep 08, May 07)**

29\. i. Show that for a critically stable system the gain cross over frequency is equal to phase cross over frequency.

ii. The Gain Margin of a type-1, 2nd order system is always infinity. Justify.

iii. The Bode plots of a system is shown in figure.



iv. From the Bode plots of a unity feed back system, at gain cross over frequency is found to be .150o &|| at phase cross over frequency is found to be -12 dBs. Find the stability of the system. **(Sep 08)**

30. i. State the advantages & limitations of frequency domain analysis

ii. Sketch the Bode plots of G(s) = $\frac{28.5e^{-0.1s}}{s(1+s)(1+0.1s)}$ Hence find gain cross over frequency. **(May 08)**

31. i. Explain gain margin and phase margin. **(May 08, 04)**

ii. The open loop transfer function of feed back system is G(s)H(s)=k(s+1)/(s-1) .Comment on stability.

32. i. Define frequency response.

ii. Discuss the advantages & disadvantages of frequency response analysis.

iii. Bring out the correlation between time response & frequency response and hence show that the correlation exists for the range of damping ratio 0 <ζ< 0.707. **(May 08)**

33. A unity feedback system has a plant G(s) = K (s+0.5) /s(s+ 1) (s^2+2s+ 2) sketch the root locus and find the roots when ζ= 0.5. **(May 08)**

34. i. Explain the frequency response specifications.

ii. Draw the Bode Plot for the system having G(s)H(s) = $\frac{100(0.02s+1)}{(s+1)(0.1s)(0.01s+1)}$. Find gain and phase cross over frequency. **(May 08)**

35. Sketch the Bode Plot for a unity feedback control system with forward path transfer function G(s) = $\frac{24}{(s+2)(s+6)}$ Determine the gain margin and phase margin. **(May 08)**

36. i. The open loop transfer function of a feed back control system is G(s)H(s)= $\frac{K(1+2s)}{s(1+s)(1+s+s^2)}$. Find the restrictions on K for stability. Find the values of K for the system to have a gain margin of 3 db. With this value of K, find the phase cross over frequency and phase margin.

ii. Explain how Bode plot is used to find gain margin and phase margin. **(May 08)**

37. i. Determine the breakaway points of the system which have the open loop transfer function G(s)H(s)= $\frac{K(s+4)}{(s^2+2s+4)}$

ii. Derive the magnitude and angle criteria for stability. **(May 08)**

38. i. Explain the Relative stability.

ii. The open loop transfer function of a unity feed back system is G(s)H(s)= $\frac{s+2}{(s+1)(s-1)}$ Comment on the stability. **(May 08)**

39. i. Write a note on determination of range of 'K' for stability using Bode plots.
 ii. Define GM & PM and explain how you can determine them from Bode plots. **(Sep, May 07)**

40. i. Explain clearly the steps involved in the construction of Bode plots of a system with loop transfer function consisting of
 a an open loop gain K b. one pole at origin c. one quadratic factor
 ii. Given G(s) = $\frac{(s-5)}{(s+5)}$
 Determine the phase angle at 0, 5 & œ frequencies. **(Sep 07)**

41. i. Define
 a. Minimum phase tf b. Non minimum phase tf
 ii. Enlist the steps for the construction of Bode plots
 iii. Explain the procedure for determination of transfer function from Bode plots. **(Sep 07)**

42. i. Explain the concept of phase margin and gain margin.
 ii. Draw the Bode Plot for a system having G(s) = $\frac{100}{s(1+0.5s)(1+0.1s)}$, Determine:
 a. Gain cross over frequency and corresponding phase margin.
 b. Phase cross over frequency and corresponding gain margin.
 c. Stability of the closed loop system. **(May 07)**

43. i. Explain the correlation between time and frequency response of a system
 ii. Sketch the Bode Plot for a unity feed back system characterized by the open loop transfer function G(s) = $\frac{K(1+0.2s)(1+0.025s)}{s^3(1+0.001s)(1+0.005s)}$. Show that the system is conditionally stable. Find the range of values of K for which the system is stable **(May 07)**

44. i. The open loop transfer function of a unity feed back system is G(s)= $\frac{K}{s(1+s)(1+0.1s)}$ Determine the value of K for the following case:
 a. Resonance Peak is required to be equal to 1.58. b. Gain margin of the system is 21 db.
 ii. A certain unity feed back control system is given by the value of K so as to have $\frac{K}{s(1+s)(1+0.1s)}$ .Draw the Bode Plot of the above system. Determine from the plot of the value of 'K' so as to have:
 a. Gain margin = 10 db b. Phase margin = 50^0 **(May 07)**

45. i. Explain the frequency response specifications.

ii. Draw the Bode Plot for the system having G(s)H(s) = $\frac{100(0.02s+1)}{(s+1)(0.1s)(0.01s+1)}$. Find gain and phase cross over frequency. **(May 07)**

46. i. Explain why it is important to conduct frequency domain analysis of linear control systems.

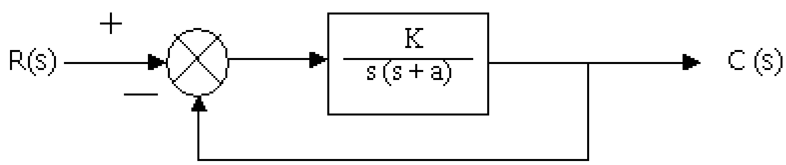
ii. Sketch the Bode Magnitude plot for the transfer function $G(s) = \frac{Ks^2}{s(1+0.2s)(1+0.02s)}$ Hence find 'K' such that gain cross over freq. is 5 rad/sec. **(May 07)**

47. Sketch the Bode plot for a unity feed back system characterized by the open loop transfer function. Show that the system is conditionally stable. Find the range of K for which the system is stable. **(Sep 06)**

48. Plot the root locus for a system having G(s)H(s) $= \frac{K}{S(S+3)(s^2+2S+3)}$ for all positive values K. Hence obtain gain margin and phase margin. **(Apr 06)**

49. i. For a 2nd Order system with G(s) = $\frac{200}{s(s+8)}$ and unit feed back, find various frequency domain specifications.

ii. Consider a feedback system as shown below figure;



(Apr 06)

Find the value of 'K' & 'a' to satisfy following frequency domain specification Mr=1.04, =11.55 rad/sec.

50. i Define phase margin and gain margin

ii. Sketch Bode plot & find value of "K" such that gain crossover frequency is 5 rad/sec. $G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}$

(Apr 06)

51. For a 2nd order system characteristic equation is $S^2+4S+25$. Determine the resonance magnitude, normalized resonance, normalized resonance freq, and resonance angle. Also find resonance frequency w_r **(Apr 06)**

52. Sketch asymptotic Bode plot & find gain margin & phase margin. By what factor should 'K' be increased or decreased to obtain a gain margin of 40 db.

$G(s)H(s) = \frac{K \times 10 \times (1-a)}{s(s+2)(s^2+2s+25)}$ *with* $K = 1$

(Apr 06)

53. Draw the Bode diagram and determine the stability of the closed loop system with following open-loop transfer function. **(Apr 06)**

54. Sketch the Bode Plot for the following Transfer function $G(s)=\frac{10(1+0.5s)}{s(1+0.1s)(1+0.2s)}$ Calculate Gain margin and phase margin. **(Apr 05)**

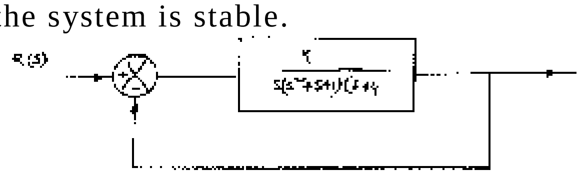
55. Draw the Bode Plot for the system having $G(s)H(s)=\frac{100(0.02s+1)}{(s+1)(0.1s+1)(0.01s+1)}$. Find gain and phase cross over frequency. **(May 04)**

56. Sketch the Bode plot for the Transfer function $G(s)=\frac{Ke^{-0.5S}}{s(2+s)(1+0.3s)}$ **(May 04)**

57. Sketch the Bode plot for the following transfer functions and determine in each case the system gain K for the gain cross over frequency w_C to be 5 rad/sec. $G(s)=\frac{Ke^{-0.1S}}{s(s+1)(1+0.1s)}$ and the Bode plot for a system having $G(s)=\frac{3}{s(1+0.05s)(1+0.2s)}, H(s)=1.$
Determine the gain margin, phase margin and stability of closed loop system $G(S)H(S)=\frac{2(S+3)}{2(S-1)}$. **(May 04)**

58. By analytical method calculate the gain margin in dB of the unity feedback control system with transfer function $G(s)=\frac{10}{s(s+1)(s+2)}$. **(May 04)**

59. Consider the closed loop feedback system shown below. Determine the range of K for which the system is stable.



(May 04)

60. Sketch the Bode Plot for $G(s)=\frac{(1+100s)(1+s)}{(1+10s)(1+0.1s)}$. Assume unity feed back. Obtain gain margin and phase margin using semi log sheet. **(May 04)**

61. i. Define peak resonance and band width

ii. Sketch Bode plot for $G(s)=\frac{256(1+0.5s)}{s(1+2s)(s^2+3.2s+64)}$

(May 04)

62. Draw the Bode plot for the system having G(s)H(s) = $\frac{100(0.02s+1)}{(s+1)(0.1s+1)(0.01s+1)}$ Find gain and phase cross over frequency. **(Nov 03)**

63. Sketch the Bode Plot for the following transfer function
G(s) = $\frac{10(1+0.5s)}{s(1+0.1s)(1+0.2s)}$ Calculate gain margin and phase margin. **(Nov 03)**

64. Draw the Bode magnitude and phase plots for the following transfer function:
$G(s)=\frac{10}{S\left(s^2+0.4s+4\right)}$

Also obtain the gain margin and phase margin from the plots. **(Jan 03)**

65. Sketch the Bode magnitude and phase plots of a closed-loop system which has the open-loop transfer function G(s) = 2e-sT/ S(1+s)(1+0.5s).Determine the maximum value of T for the system to be stable. **(Jan 03)**

66. Draw the Bode magnitude and phase diagrams for the system with the transfer function

$$G(s) = \frac{200\,(s+0.5)}{s(s+10)\,(s+50)}$$

Also obtain the phase margin and gain margin from the plots. **(Jan 03)**

67. The gain margin and the phase margin of a feedback system with $G(s)H(s)=\frac{s}{(s+100)^3}$ are
(a) 0 dB,0^0 (b)infinite, infinite (c) infinite,0^0 (d) 88.5dB,infinite
(GATE 03)

68. The system with the open loop transfer function G(s) H(s) =$\frac{1}{s(s+1)}$ has a gain margin of
(a) -6 dB (b) 0dB (c) 3.5dB (d) 6dB

(GATE 02)

69. By analytical method calculate the gain margin in dB of the unity feedback control system with transfer function G(s)= $\frac{10}{s(s+1)(s+2)}$
(IES 00)

70. Define stability. Discuss any two methods for finding the stability of a linear system what are the advantages of Routh criteria of finding stability of a system over other methods? **(IES 00)**

71. The open loop transfer function of unity feedback control system is given by the expression G(s) $=\frac{k}{(s+2)(s+5)}$ **(IES '99)**

UNIT-VI

1. Sketch the nyquist plot for the transfer function G(s)H(s)$=\frac{52}{(s+2)(s2+2s+5)}$ .find the relevant stability parameters and discuss its stability. **(Nov/Dec12)**

2. State and explain Nyquist stability criterion. Draw the Nyquist plot for the open loop transfer function G(s) = 1/s(1+0:1s)(1+s) and discuss the stability of the closed loop system. **(May/June12)**

3. The characteristic equation of a feedback control system is s3+4Ks2+(K+3)s+10=0. Apply the Nyquist criterion to determine the values of K for a stable closed loop system. Check the answer by means of the Routh Hurwitz criterion. **(May/June12)**

4. (a) State and explain the Nyquist stability criterion.
(b) Sketch the Nyquist plot for the transfer function G(s)H(s) = 32/(s+1:5)(s2+2s+5) .Discuss its stability. **(May/June12)**

5. (a) Explain the Nyquist criterion for assessing the stability of a closed loop system.
(b) Sketch the polar plot of the transfer function G(s) = 1/(1+T1s)(1+T2s)(1+T3s) . Determine the frequency at which the polar plot intersects the real and imaginary axis of G(jw) plane. **(May/June12)**

6. i. Explain the selection criteria of Nyquist contour in stability analysis of linear control systems.
   ii. Discuss the effect of adding poles& zeros on the stability of a system with the help of Nyquist plots.
(Apr 11)

7. i. Distinguish between polar plots & Nyquist plots.
   ii. Discuss the effect of adding poles & zeros to G(s)H(s) on the shape of Nyquist plots. **(Dec 10)**

8. i. Addition of a non zero pole to a transfer function results in further rotation of the polar plot by -90^0 as w→œ". Justify with the help of an example
   ii. A system is given by $G(s) = \frac{1}{s^2(s+1)(s+10)}$. Determine the magnitude & phase angle at zero & œ frequencies. Hence sketch the polar plot. **(Dec 10)**

9. i. Compare the Nyquist stability method with other methods & hence bring out the advantages of the Nyquist method.

ii. Relative stability analysis for open loop unstable cannot be carried out by Nyquist method. Why?

(Dec 10)

10. i. Explain Nyquist stability criterion.

ii. With the help of Nyquist plot assess the stability of a system G(s)= $\frac{3}{s(s+1)(s+2)}$ What happens to stability if the numerator of the function is changed from 3 to 30? **(Dec 10)**

11. i. Draw & explain polar plots for type-0, type-1 & type-2 systems.

ii. Write a note on relation between root loci & Nyquist plots. **(May 10)**

12. Starting from the "principle of argument" show that the Nyquist plot encircles the (-1+j0) point (P-Z) times in anticlockwise direction where `P' is the no. of open loop poles & `Z' is the no. of closed loop poles lying in the right half of s-plane. **(May 10)**

13. i. Define Polar plot.

ii. Explain how you can determine relative stability using polar plots.

iii. Sketch the polar plot of a system given by G(s)=$\frac{1}{s(1+s)(1+2s)}$. If the plot crosses the real axis determine the corresponding frequency & magnitude.**(May 10)**

14. i. State Nyquist Stability Criterion.

ii. Explain the use of Nyquist Stability Criterion in the assessment of relative stability of a system.

iii. Enlist the step-by-step procedure for the construction of Nyquist plots**(May 10)**

15. i. Explain Nyquist stability criterion.

ii. With the help of Nyquist plot assess the stability of a system G(s) = $\frac{3}{s(s+!)(S+2)}$ what happens to stability if the numerator of the function is changed from 3 to 30? **(May 09, Sep 07)**

16. i. State & explain "principle of argument"

ii. Given$G(s) = \frac{k}{s(s+2)(s+10)}$. Sketch Nyquist plot & find range of? K? For stability. **(May 09)**

17. i. A unity feed back system has $G(s) = \frac{k}{s(1+sT1)(1+sT2)}$.Discuss the effect on Nyquist plot when the value of K is

a. low (<critical value)

b. = critical value

c. high (>critical value)

ii. Pure time delay usually deteriorates the stability. Explain with the help of Nyquist plots. **(May 09)**

18. i. Bring out the relevance of relative stability analysis in linear control systems
    ii. Discuss the effect of adding one pole & one zero (simultaneously & separately) to a given transfer function on the polar plot. **(May 09)**

19. i. What is "Nyquist Contour"?
    ii. A system is given by G(s) = $\frac{4s+1}{s^2(s+1)(2s+!)}$.Sketch the Nyquist plot & hence determine the stabilityof the system. **(May 09, 07)**

20. i. Explain the effect of addition of a pole at the origin on the polar plot of a given system.
    ii. Sketch the polar plot & hence find the frequency at which the plot intersects the +ve imaginary axis for the system G(s) = $\frac{0.1}{s^2(1s)(1+0.1s)}$ .Also find the corresponding magnitude. **(May 09)**

21. i. Construct the complete Nyquist plot for a unity feed back control system whose open loop transfer function is G(s)H(s) = $\frac{k}{s(s^2+2s+2)}$. Find maximum value of K for which the system is stable.
    ii. The open loop transfer function of a unity feed back system is G(s) =$\frac{1}{s(1+0.5s)(1+0.1s)}$. Find gain and phase margin. If a phase lag element with transfer function of $\left(\frac{1+2s}{1+5s}\right)$ is added in the forward path, find how much the gain must be changed to keep the margin same. **(Sep, May 08)**

22. i. The open loop transfer function of a feed back system is G(s)H(s)=$\frac{k(1+s)}{(1-s)}$ Comment on stability using Nyquist Plot.
    ii. The transfer function of a phase advance circuit is $\frac{1+0.2s}{1+0.2s}$. Find the maximum phase lag. **(Sep 08)**

23. Draw the Nyquist Plot for the open loop system G(s) =$\frac{k(s+1)}{s(s-1)}$and find its stability. Also find the phase margin and gain margin. **(Sep 08)**

24. Sketch the polar (Nyquist) plot on a plain paper for the following transfer function G(s) =$\frac{10}{s(1+s)(1+0.005s)}$. **(Sep 08)**

25. i. Define Polar plot.
    ii. Explain how you can determine relative stability using polar plots.
    iii. Sketch the polar plot of a system given by G(s) = $\frac{1}{s(1+s)(1+2s).}$If the plot crosses the real axis determine the corresponding frequency & magnitude. **(Sep 08)**

26. i. State Nyquist Stability Criterion.
    ii. Explain the use of Nyquist Stability Criterion in the assessment of relative stability of a system.

iii. Enlist the step-by-step procedure for the construction of Nyquist plots.

(Sep 08, 07)

27\. i. Explain Nyquist stability criterion

ii. A unity feedback control system has an open loop transfer function given by G(s)H(s) = $\frac{100}{(s+5)(s+2)}$ Draw the Nyquist diagram and determine its stability.

(Sep 08, May 07)

28\. Write short notes:

i. Comparision of polar & Nyquist plots

ii. Applications of Nyquist criterion. **(May 08)**

29\. i. With respect to a function q(s) "Every s-plane contour which does not pass through any singular points of q(s) has a corresponding contour in q(s) plane" Elaborate.

ii. What is the effect of adding a zero at origin to the to the open loop transfer function on polar plot?

(May 08)

30\. The open loop transfer function of a unity feedback control system is G(s) $=\frac{10}{(s+1)(s+5)}$. Draw its polar plot and hence determine its phase margin and gain margin. **(May 08)**

31\. i. Explain how the type of a system determines the shape of polar plot. **(Sep 07)**

ii. Write a note on Nyquist criterion for minimum phase & non minimum phase transfer functions.

32\. i. What is "Nyquist Contour"? **(Sep 07)**

ii. A system is given by

G(s) = $\frac{4s+1}{s^2(s+1)(2s+1)}$Sketch the Nyquist plot & hence determine the stability of the system.

33\. The open loop transfer function of a feed back system is G(s)H(s)=$\frac{k(1+s)}{(1-s)}$ Comment on stability using Nyquist Plot. **(May 07)**

34\. i. Plot the polar plot of $G(s) = \frac{29(s^2+s+0.1}{s(s+1)(s+10)}$

ii. Explain the concept of Nyquist stability criterion. **(May 07)**

35\. Draw the Nyquist Plot for the open loop system g(s)= $\frac{k(s+3)}{s(s-1)}$and find its stability. Also find the phase margin and gain margin **(May 07)**

36\. i. A system has one open loop pole & two closed loop poles in Right Half of s plane. Show that the Nyquist plot encircles the (-1+j0) point once in clockwise direction.

ii. Addition of poles to the loop transfer function reduces the closed loop stability of the system. Justify by Nyquist plots. **(May 07)**

37. i. Explain how polar plots are useful in finding the stability of a system

ii. Sketch the Nyquist plot and the stability of the following system $g(s)H(s) = \frac{100}{(s+2)(s+4)(s+8)}$ **(Sep 06)**

38. Comment on the stability of the system whose open loop transfer function $G(s)H(s) = \frac{1}{s(1+2s)(1+s)}$ Also find gain and phase margin (using Nyquist plot). **(Sep 06)**

39. Explain how Nyquist contour is selected for stability analysis. **(Apr 06)**

40. Discuss the stability of the following system using Nyquist stability criterion $G(s)H(s) = \frac{K}{(Ts+1)s}$

(Apr 06, 05)

41. i. Explain what is meant by the Relative stability of a system and the manner in which this is specified.

ii. Construct the complete Nyquist plot for a unity feed back control system whose open loop transfer function is $G(s)H(s) = \frac{k}{s(s^2+3s-10)}$ Find maximum value of K for which the system is stable. **(Apr 05)**

42. i. The open loop transfer function of a feed back system is $(s)H(s) = \frac{k(1+2s)}{(1-s)}$. Comment on stability using Nyquist Plot.

ii. The transfer function of a phase adance circuit is $\frac{1+0.2s}{1+0.2s}$. Find the maximum phase lag. **(May 04)**

43. Sketch the Nyquist Plot for $G(s)H(s) = \frac{1}{s^4(s+p)}, p > 0$ Explain the terms gain margin and phase margin. **(May 04)**

44. i. Explain the Polar Plots. **(May 04)**

ii. The open loop transfer function of a unit feed back control system is given by G(s)H(s)= $\frac{(1+100s)(s+40)}{s^3(s+200)(s+1000)}$.Discuss the stability of a closed loop system as a function of k. Determine values of K which will cause sustained oscillations in the closed loop system. What are the frequencies of oscillations? Use Nyquist approach.

45. Make a rough sketch of the Nyquist plot for system whose open loop transfer function is G(s)H(s)=$\frac{5}{s(1+0.2s)(1+s)}$

i. Is the above system stable? Explain.

ii. Define gain margin of a system and determine the GM of the system specified in (i).

iii.Define the PM of a system and indicate how this can be determined from the Nyquist plot. **(May 04)**

46. Sketch the complete Nyquist plot for the following loop transfer function $G(s)H(s) = \frac{10}{s^2(1+0.25s)(1+0.5s)}$

And test its stability under closed-loop condition. **(Jan 03)**

47.i. Explain the Nyquist criterion for accessing the stability of a closed-loop control system.

ii. Sketch the Nyquist plot of the transfer function: $G(s)H(s) = \frac{100}{S(s+1)(s^2+2s+2)}$

Discuss its stability. **(Jan 03)**

48.i. Sketch the polar plot for the transfer function $G(s) = \frac{10}{s(s+1)(s+2)}$

ii. Explain the Nyquist stability criterion. **(Jan 03)**

49. Draw the complete Nyquist plot forG(s)H(s)= $\frac{3(s+2)}{s^2+3s+1)}$ and discuss stability of the system. **(Jan 03)**

50. The loop transfer function of a single loop control system is given by G(s)H(s) = $\frac{100}{s(s+0.01s)}e^{-sT}$ Using the Nyquist criterion ,find the condition for the closed loop system to be stable. **(GATE 98)**

51. Explain the meaning and significance of phase and gain margins of a feedback control systems. How will you obtain the values of these margins from

i. Polar plots

ii. Bode plots

Illustrate your answer by giving plots for stable and unstable systems separately. **(GATE 94)**

52. Sketch the Nyquist plots of the given transfer function $G(s) = \frac{1}{(1+s)(1+2s)}$

(IES 00)

53. Sketch the Nyquist plot for the system and comment on the stability or the closed loop systems $GH = \frac{1.06}{s(s+1)(s+2)}$

(IES 99)

UNIT-VII

1. a) what are the different type of compensators? Explain briefly.
   b) show that the lead network and the lag network inserted in cascaded in an open loop acts as proportional plus derivative control(in the region of small *w*) and proportional plus integral control (in the region of large *w*) respectively. **(Nov/Dec12)**

2. A unity feedback system has an open loop transfer function G(s) = K/s(s+2)(s+60) .Design a Lead-Lag compensator to meet the following specifications:
(a) Phase margin is at least 400
(b) Steady state error for ramp input is 0.04 rad**.** **(May/June 12)**

3. The open-loop transfer function of a control system with unity feedback is G(s) =K/s(0.1s+1)(0.2s+1) . Design a suitable compensator so that the system satisfies the following performance specifications:
(a) Kv=100; or the steady-state error of the system due to a step ramp function input is 0.01 in magnitude and
(b) Phase margin _40 degrees. **(May/June 12)**

4. A unity feedback system has an open loop transfer function G(s) = K/s(s+2)(s+60) .Design a Lead-Lag compensator to meet the following specifications: **(May/June 12)**

5. The open loop transfer function of the uncompensated system is G(s) = 2500K/s(s+25) . Design a suitable compensator so that the system satisfies the following performance specifications:
(a) The phase margin of the system should be greater than 45 degrees.
(b) The steady-state error due to a unit ramp function input should be less than or equal to 0.01 rad/sec. **(May/June 12)**

6. For the unity feed back control system forward path transfer function G(S) = K/S (S+4) (S+20). Design a lag-lead compensator so that PM $\geq$ 40 and steady state error for unit ramp input $\leq$ 0.04 rad.
(Apr 11, Dec 10)

7. i. Explain the need of lead compensator and obtain the transfer function of lead lag compensator.
   ii. Explain the significance of compensator? **(Dec 10)**

8. i. What is compensation? What are the different types of compensators?
   ii. What is lag-lead compensator, obtain the transfer function of lag-lead compensator and draw its pole-zero plot?
   iii. Explain the different steps to be followed for the design of lag lead compensator using Bode plot?

(Dec, May 10)

9. The open loop transfer function of unity feedback system is G(s)=k/s(s+1) It is desired to have the velocity error constant KV = 12 Sec^{-1} and phase margin as 40^0 Design lead compensator to meet the above specifications. **(May 10)**

10. Design a lead compensator for unity feed back system whose open loop transfer function $G(s) = \frac{k}{s(s+1)(s+5)}$ to satisfy the following specifications.
    i. velocity error constant $K_V \geq 50$
    ii. Phase margin $\geq 20^0$. **(May 10)**

11. Consider a Unity feedback system with open loop transfer function G(s)=$\frac{100}{(s+1)(S+2)(s+10)}$. Design a PID controller. So that the phase margin of the system is 45^0 at a frequency of 4 rad/sec. and steady state error for unit ramp input is 0.1. **(May 10)**

12. Design a lead compensator for unity feed back system whose open loop transfer function G(S) = $\frac{k}{s(s+1)(s+5)}$to satisfy the following specifications.
    i. Velocity error constant $K_V \geq 50$
    ii. Phase margin $\geq 20^0$. **(May 09, 08)**

13. i. What is compensation? What are the different types of compensators?
    ii. What is a lead compensator, obtain the transfer function of lead compensator and draw pole-zero plot?
    iii. Explain the different steps to be followed for the design of lead compensator using Bode plot?

(May 09, 07, Sep 08, 07)

14. For G(s)=.$\frac{k}{s(s+2)(s+20)}$ Design a lag compensator given phase margin $\geq 35^0$ and $K_V \leq 20$. **(May 09)**

15. i. Explain the need of lead compensator and obtain the transfer function of lead-lag compensator.
    ii. Explain the significance of compensator? **(May 09)**

16. Design a phase lead compensator for unity feed back system whose open loop transfer function$\frac{k}{s(s+1)}$. The system has to satisfy the following specifications.
    i. The phase margin of the system $\geq 45^0$
    ii. Steady state error for a unit ramp input. $\leq 1/15$
    iii. The gain crossover frequency of the system must be less than 7.5 rad/sec.

(May 09)

17. For the unity feed back control system forward path transfer function G(S) = K/S (S+4) (S+20). Design a lag-lead compensator so that PM =40 and steady state error for unit ramp input $\leq$ 0.04 rad. **(Sep 07)**

18. The transfer function of a phase advance circuit is $\frac{1+0.2s}{1+.2s}$ Find the maximum phase lag. **(May 07)**

19. The open loop transfer function of unity feedback is G(S)=$\frac{1}{s(s+1)(0.5s+1)}$.Design a compensator to meet the following specifications. Velocity error constant K_V=5 sec^{-1}: phase margin=40^0: gain margin = 10 db **(Apr 06)**

20. i. Define sensitivity and explain mathematically.
 ii. What is a PID controller and derive its transfer function. **(Nov 03)**

21. A unity feedback system has the plant transfer function $G_p(s) = \frac{1}{(s+1)(2s+1)}$
 i. Determine the frequency at which the plant has phase lag of 90^0
 ii. An integral controller with transfer function Gc (s) = (k/s) is placed in the feed forward path of the feedback system. Find the value of k such that the compensated system has an open loop gain margin of 2.5.
 iii. Determine the steady errors of the compensated to unit step and unit ramp inputs. **(GATE 02)**

22. The phase-lead network function Gc(s)= $\frac{s+1/T}{s+1/aT}$,where a<1 would provide maqximum phase-lead at a frequency of
 (i) 1/T (ii) a/ (aT) (iii)$\frac{1}{T\sqrt{a}}$ (iv) $\frac{1}{a\sqrt{T}}$ **(IES 98)**

23. Consider a feedback control with open loop transfer function G(s) = k/s(s+1) Design a series compensator to provide the following specifications:
 i. The phase margin of the system must be greater than 45^0 .
 ii. When the input to the system is a ramp ,the steady state error of the output in position should be less than 0.1 degree/deg/sec of the final out velocity **(IES 93)**

24. What are compensators explain clearly lag, lead and lag-lead compensators. How do you proceed to design a lag compensator? **(IES 92)**

25. Draw the polar plot of the following transfer function, $GH(s)\frac{sk1}{s(s+p1)(s+p2)}$ design a lead compensator. **(T1-Ch8)**

26. Draw the polar plot of the following transfer function $GH(s)\frac{k1}{s(s+p1)(s+p2)}$, design a lag compensator. **(T1-Ch8)**

27. Draw the polar plot of the following transfer function, design a lead compensator. **(T1-Ch8)**

28. Draw the polar plot of the following transfer function $GH(s)\frac{k1}{s(s+p1)(s+p2)}$, design a lag compensator. **(T1-Ch8)**

29. Draw the polar plot for designing a lag compensator the system. **(T1-Ch8)**

30. Draw the polar plot for designing a lead compensator the system. **(T1-Ch8)**

31. Draw the polar plot for designing a lead lag compensator the system. **(T1-Ch8)**

32. Consider the open loop transfer function check whether the system is stable or unstable, if unstable design a appropriate compensator **(T1-Ch10)**

33. Is the system represented by the characteristic equation, ever conditionally stable? Why? **(T1-Ch10)**

34. How would the inclusion of a minor feedback loop with a transfer function K_2s,(K_2>0). Determine the transient and steady performance of the system. K1/(s(s+a) **(T1-Ch10)**

35. Outline the design of unity feed back system with a plant given by $GH(s)\frac{k1}{s(s+p1)(s+p2)}$ and the performance specifications Kv=50,(3)The bandwidth BW of the compensated system must be approximately equal to or not much greater than that of the uncompensated system because high frequency 'noise' disturbance are present under operating conditions. **(T1-Ch10)**

36. Design a compensator which will yield a phase margin of approximately 45^o for the system defined by. $GH(s)\frac{1.06}{s(s+1)(s+2)}$ **(T1-Ch10)**

37. Design a compensator which will yield a phase margin of 40^o and a velocity constant K_V=40 for the system given by $GH(s)\frac{84}{s(s+6)(s+2)}$ **(T1-Ch10)**

38. What kind of compensation can be used to yield a maximum overshoot of 20% for the system defined by $GH(s)\frac{84}{s(s+6)(s+2)}$ **(T1-Ch10)**

39. Design a lead compensator for the given transfer function, $GH(s)\frac{10}{s(s+8)(s+2)}$ **(T1-Ch10)**

40. Design a lag compensator for the given transfer function ,$GH(s)\frac{10}{s(s+8)(s+2)}$ **(T1-Ch10)**

41. Design a electronic lead –lag compensator using operational amplifier. **(T1-Ch10)**

42. Derive the necessary equations for all possible case for root locus based compensator design. **(T1-Ch10)**

43. Design a lead- lag compensator for the given transfer function, $\frac{C(s)}{R(s)} = \frac{2s+0.1}{s^3+0.1s^2+6s+0.1}$ **(T1-Ch10)**

44. Design a lag, lead and lead lag compensators for RL. Series circuit **(T1-Ch10)**

45. Design a lag, lead and lead lag compensators for RC. Series circuit **(T1-Ch10)**

46. Design a lag, lead and lead lag compensators for RLC. Series circuit **(T1-Ch10)**

47. Consider a unity feed back system which has an open loop transfer function **(T1-Ch10)**

48. A unity feedback system is given the transfer function .Design a compensator such that dominant closed lop poles are located at and the static velocity error constant equal to $80^{o}sec^{-1}$, **(T1-Ch10)**

49. Consider a unity feed back system given by chooses a=1 and determine the values of K and b if the closed loop poles are located at $\frac{c(s)}{R(s)} = \frac{2s+0.1}{s^2+0.1s^2+6s+0.1}$ **(T1-Ch10)**

50. The model of aircraft system which has unity feed back is given as Design a lead lag compensator to reduce the peak overshoot by 20%. **(T1-Ch10)**

51. Design a lead compensator for a second order unstable system. **(T1-Ch10)**

52. Describe the briefly the dynamic characteristics of the PI controller, PD controller and PID controller. **(T1-Ch10)**

53. Consider a unity feed back system which has an open loop transfer function $\frac{c(s)}{R(s)} = \frac{2s+0.1}{s^2+0.1s^2+6s+0.1}$ Design a PID controller to reduce the peak over shoot. **(T1-Ch10)**

UNIT-VIII

1. Write short notes on:
 a) Procedure to sketch the polar plot.
 b) lead- Compensation.
 c) State Transition Matrix and its properties **(May/June13)**

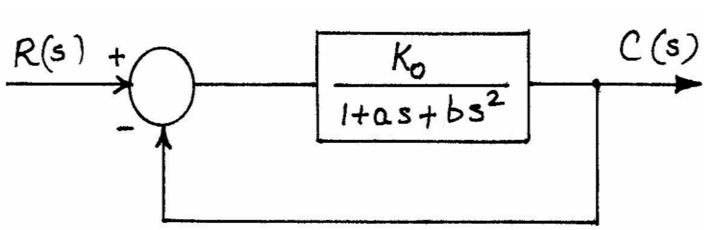
2. A system is given by the following vector matrix equation: $\dot{X} = \begin{bmatrix} 0 & 1 \\ -4 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} [u]$,
 Where the initial conditions are given by $X(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ Determine

a) state transition matrix
b) zero input response
c) zero state response for u= 1
d) total response **(Nov/Dec12)**

3. Explain the properties of state transition matrix. A linear time invariant system is described by the state equation: $\dot{X} = \begin{bmatrix} 0 & 6 \\ -1 & 5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} [u]$ and $Y = [1 \quad 0]X, X(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$
 Obtain the state transition matrix. Hence obtain the output response y(t) , t > 0 for a unit step input. **(May/June12)**

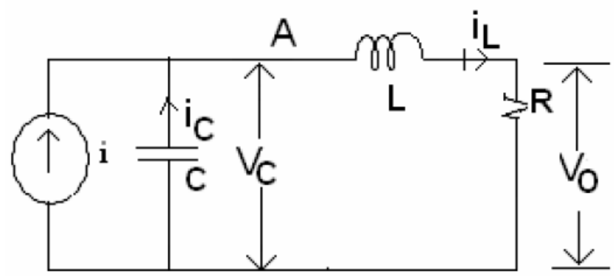
4. Explain the terms `state' and `state variable'. Prove that the state space representation is not unique. $\dot{X} = \begin{bmatrix} 0 & 6 \\ -1 & 5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} [u]$ and $Y = [1 \quad 0]X, X(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ **(May/June12)**

5. A linear time-invariant system is described by the following differential equation:
 $\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + y(t) = u(t)$



 Find the state space representation and obtain the complete response to unit step input and zero initial conditions **(May/June12)**

6. Consider the network shown in figure and obtain the state variable form ?



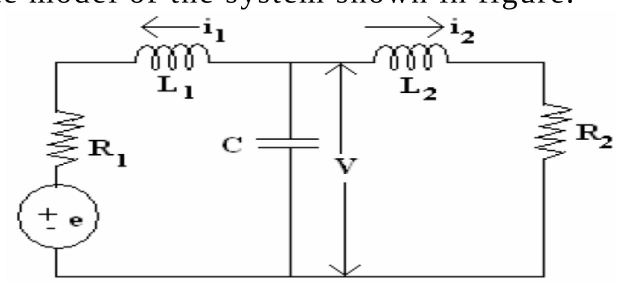
A linear time in variant system is characterized by homogenous state equation.

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

Compute the solution of homogenous equation, assuming the initial state vector.

(Apr 11)

7. i. Obtain the state model of the system shown in figure.



Consider the state variables as i_1, i_2, v

ii. Obtain the state model of a field controlled motor? **(Dec, May 10)**

8. i. Discuss the properties of state transition matrix.

ii. Determine the canonical state model of system, whose transfer function is $T(s) = \frac{2(s+5)}{(s+2)(s+3)(s+4)}$.

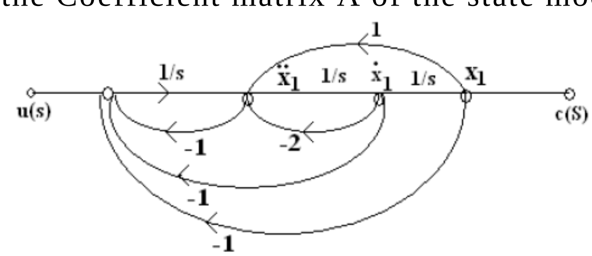
iii. What are advantages of state space analysis compared to transfer function analysis? **(Dec 10)**

9. i. Find a state model (phase variable form) for the system with transfer function. $\frac{y(s)}{u(s)} = \frac{s+4}{s^3+6s^2+11s+6}$

ii. A feedback system is represented by a signal flow graph shown in figure.

a. Construct a state model of the system

b. Diagonalize the Coefficient matrix A of the state model.



(Dec, May 10)

10. i. Obtain the state model of the system whose transfer function is given as.

$$\frac{y(s)}{u(s)} = \frac{s+10}{s^3+4s^2+2s+1}$$

ii. Consider the matrix A compute e^{At}?

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$$

(Dec 10)

11. i. A control system has a transfer function given by $G(s)=\frac{s+3}{(s+1)(s+2)^2}$. Obtain the canonical state variable representation.

ii. A system is described by

$$\dot{x} = \begin{bmatrix} -1 & -4 & -1 \\ -1 & -6 & -2 \\ -1 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} [x]$$

Find the transfer function? **(May 10)**

12. The state equation of a linear time invariant system is given by

$$\begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r(t)$$

i. Find the transition matrix ft and the characteristic equation of the system.

ii. Obtain the phase variable form of state model for the given system whose differential equation is given below.

$$\frac{d^2y(t)}{dt^2}+11\frac{dy(t)}{dt}+6y(t)=6u(t)$$

(May 10)

13. i. For the given T.F T (s) = $\frac{b_0}{S^3+a_2S^2+a_1S+a_0}$

Obtain the state model (phase variable form)?

ii. Construct the state model for a system characterized by the differential equation. ¨y + 5 ÿ y + 6y = u. **(May 09, 07, Sep 07)**

14. i. Discuss the significance of state Space Analysis?

ii. Define state variables.

iii. Obtain the state variable representation of an armature controlled D.C Servomotor? **(May 09, 07)**

15. i. A control system has a transfer function given by $G(s) = \frac{S+3}{(S+1)(S+2)^2}$.

Obtain the canonical state variable representation.

ii. A system is described by

$$\dot{x} = \begin{bmatrix} -1 & -4 & -1 \\ -1 & -6 & -2 \\ -1 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} [x]$$

Find the transfer function?. **(May 09, 07, Sep 07)**

16. A system described by

$$\dot{\bar{x}} = \begin{bmatrix} -1 & -4 & -1 \\ -1 & -6 & -2 \\ -1 & -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u$$

y = [1 1 1] x

Find the transfer function and construct the signal flow graph.

(May 09, Nov 03)

17. i. A linear tine invariant system is characterized by homogenous state equation.

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

Compute the solution of homogenous equation, assuming the initial state vector.

ii. Obtain the state model of armature controlled de motor? **(May 09)**

18. i. Consider the vector matrix differential equation describe the dynamics of the system as $X = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$ Determine state transition matrix?

ii. What are the properties of state transition matrix? **(May 09)**

19. i. Obtain the stat variable model in phase variable form for the following system: $\ddot{y} + 2y + 3\ddot{y} + 4\dot{y} = u(t)$

ii. The closed loop transfer function is given by $\frac{y(s)}{u(s)} = \frac{160(s+4)}{s^3+8s^2+192s+640}$ Obtain the state variable model using signal flow graph. **(Sep 08)**

20. i. Explain properties of state transition matrix

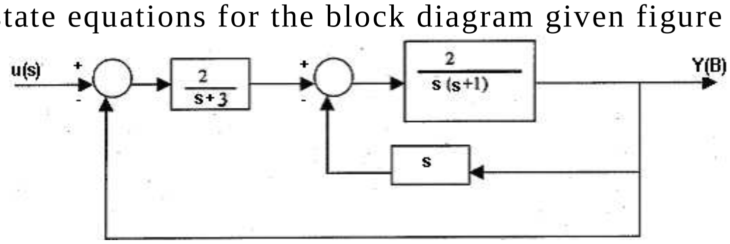
ii. Consider the transfer function

$Y(s) / U(s) = (2s^2 + s + 5)/(s^3 + 6s^2 + 11s + 4)$

Obtain the state equation by direct decomposition method and also find state transition matrix.

(Sep 08)

21. i. Write the state equations for the block diagram given figure



ii. For the given plant transfer functions construct the signal flow diagram and determine the state space model. **(Sep, May 08)**

22. i. For the given system $\dot{X} = Ax + Bu$

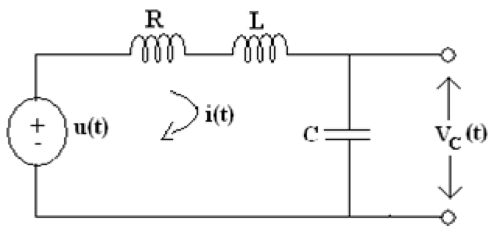
where $A = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 1 & 3 \\ 1 & 1 & 1 \end{bmatrix}$ $B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$

ii. Given $\dot{X}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 & (t) \\ x_2 & (t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$ Find the unit step response when, $X(0)=\begin{bmatrix} 1 \\ 1 \end{bmatrix}$

(Sep 08, May 07)

23. i. The system is represented by the differential equation $\ddot{y} + 5\dot{y} + 6y = u$
Find the transfer from state variable representation.

ii. Consider the RLC network shown in figure 8b. Write the state variable representation.

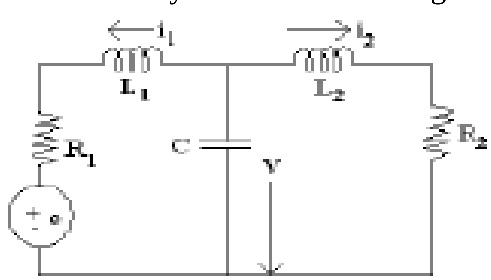


24. i. Discuss the significance of state Space Analysis?

ii. Define state variables.

iii. Obtain the state variable representation of an armature controlled D.C Servomotor? **(Sep 08)**

25. i. Obtain the state model of the system shown in figure



Consider the state variables as i_1, i_2, v

ii. Obtain the state model of a field controlled motor? **(Sep 08, 07)**

26. Obtain the two differential state representation for the system with transfer function. $\frac{Y(s)}{U(s)} = \frac{2}{s^3 + 6s^2 + 11S + 6}$ **(May 08)**

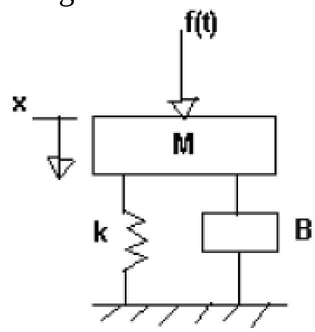
27. Obtain the state model of the system whose transfer function is given as. $\frac{Y(s)}{U(s)} = \frac{10}{S^3 + 4S^2 + 2S + 1}$

Consider the matrix A compute e^{At}?

$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

(May 08)

28. i. Obtain state space mode for given mechanical system. Figure



(May 08)

ii. Obtain the state equations in canonical form for transfer function given

$\frac{Y(s)}{U(s)} = (3s^2 + 5s + 13)/(s+2)(s^2 + 4s + 8)$

29. Find the unit step response for the following system with the initial conditions **(May 08)**

$x(0) = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$

$\dot{X} = \begin{bmatrix} 0 & 1 \\ -6 & -2 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + u(t) \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

$Y(t) = [3\ 0]\ X\ (t)$

30. i. Explain properties of state transition matrix **(May 08)**

ii. Consider the transfer function

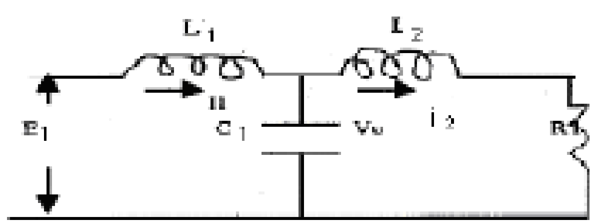
$Y(s) / U(s) = (2s^2 + s + 5)/(s^3 + 6s^2 + 11s + 4)$

Obtain the state equation by direct decomposition method and also find state transition matrix.

31. i. Define the terms

a. State variable b. State transition matrix.

ii. Obtain the state equation and output equation of the electric network show in Figure



(May 07, Dec 05, Nov 03)

32. i. Obtain the state variable model in phase variable form for the following system: $\ddot{y} + 2y + 3y + \ddot{4}\dot{y} = u(t)$

ii. The closed loop transfer function is given by $\dfrac{y(s)}{u(s)} = \dfrac{160(s+4)}{s^3+8s^2+192s+640}$
Obtain the state variable model using signal flow graph **(May 07)**

33. Find the canonical format representation and state transition matrix.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 2 & -2 & 3 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 11 \\ 1 \\ -14 \end{bmatrix} u$$

$$y = \begin{bmatrix} -3 & 5 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

(May 07)

34. Consider the system represented by the differential equation as:

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y = 6u$$

where y is output and u is the input. Obtain the state space representation of the system. **(Apr 06)**

35. i. For the given system. $\dot{X} = AX + BU,\ Y = CX.$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$$

$$\mathring{X} = \begin{bmatrix} -2 & -1 \\ b & a \end{bmatrix} x$$

Obtain Jordan form representation of state equation of A. Also find the transfer function.

ii.Derive the expression for the transfer function G(s) = Y(s) / U(s) .Given the state model

$$\dot{X} = A\,X + B\,U$$
$$Y = C\,X + D\,U$$

(Dec 05)

36. i. Construct the state variable model for the system characterized by the differential equation

$$\dddot{Y} + 6\ddot{Y} + 11\dot{Y} + 2y = 41 + 1$$

ii. Explain properties and significance of state transition matrix. **(Dec 05)**

37. i. For the given transfer function.Obtain the state model of the system.

$$T(s) = \frac{(b_0\, s^3)}{s^3 + a_2 s^2 + a_1 s + a_0}$$

ii. Obtain the state transition matrix (t) given the system matrix $A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$.**(Dec 05)**

38. Discuss the advantages and disadvantages of proportional, proportional derivative, proportional integral and proportional integral derivative control system **(Dec 05)**

39. i. For the given system X = AX + BU, Y = CX.

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad C = [1 \quad 0 \quad 0]$$

Obtain Jordan form representation of state equation of A. Also find the trans-fer function.

ii. Derive the expression for the transfer function G(s) = Y(s) / U(s) .Given the state model

X = AX + BU

Y = CX + D U **(Apr 05)**

40. i. Reduce the matrix A to diagonal matrix.

$$A = \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix}$$

ii. Derive the state models for the system described by the differential equation in phase variable form. y +4 y +5 y +2y = 2u+5u **(Apr 05)**

41. i. Determine the state variable matrix for the circuit shown

ii. A single input-single output system has the matrix equation, find the transfer function **(Apr 05)**

42. i. A linear time invariant system is denoted by the differential equation

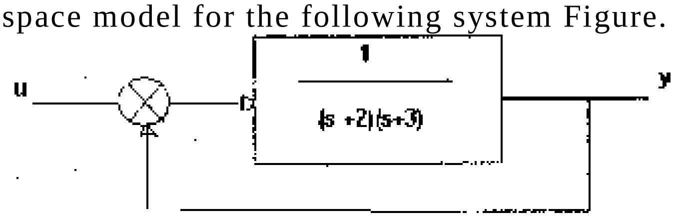
$D^3y + 3D^2y + 3Dy + y = U$ where D = d y/dt

a. Write the state equations

b. Find the state Transition matrix

c. Find the characteristic equation and eigen values of A. **(Apr 05, Nov 04)**

ii. Obtain state space model for the following system Figure.



43. i. Explain properties of state transition matrix **(Nov 04)**

ii. Consider the transfer function

$Y(s)/U(s) = (2s^2 + s + 5) / (s^3 + 6s^2 + 11s + 4)$

Obtain the state equation by direct decomposition method and also find state transition matrix.

44. i. Given the state equation $\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_{1(t)} \\ x_{2(t)} \end{bmatrix}$ Find the State Transmission Matrix and zero input response for $x_0 = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

ii. Obtain state variable model in Jordan form for the following system **(May 04)**

45. i. Obtain the state variable model in phase variable form for the following system :

ii. The closed loop transfer function is given by

$$\frac{Y(s)}{U(s)} = \frac{160(s+4)}{s^3 + 8s^2 + 192s + 640}$$

Obtain the state variable model using signal flow graph. **(May 04)**

46. Obtain the time response of the following system.

and output y = [1 0] x

$$x = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

where u(t) is the unit step input and the initial condition $x_1(0)$, $x_2(0) = 0$.

(May 04)

47. Derive the expression for the transfer function from the state model.

x = Ax + Bu

y = Cx + Du **(May 04)**

48. i. Obtain state variable representation of a field controlled D.C. motor.

$$X = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -2 \end{bmatrix} x$$

ii. Find the state transition matrix for a given system. **(May 04)**

49. Find the unit step, response of the following system.

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

$X^T(0) = [1, 0]$ **(May 04)**

50. i. Construct the state variable model for the system characterized by the differential equation.

y + 6y + 11y + 2y = 41 + 1

Also give the block diagram of the model.

ii. Explain properties and significance of state transition matrix. **(May 04)**

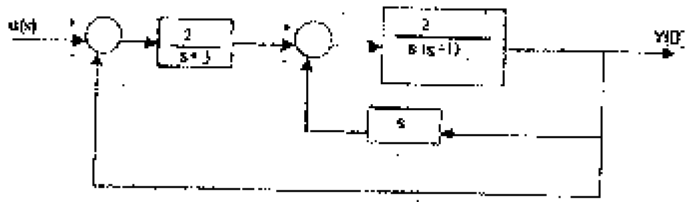
51. i. Given the Matrix $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -5 \end{bmatrix}$

Write down the characteristic equation and obtain the eigen values. Also obtain the diagonal matrix.

ii. Explain the advantages of state space model over input-output model.

(May 04)

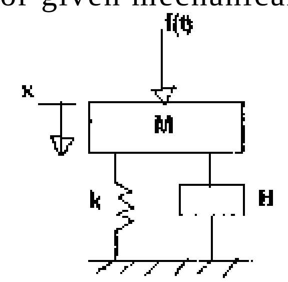
52. i. Write the state equations for the block diagram given.



(Nov 03)

ii. For the given plant transfer function construct the signal flow diagram and determine the state space model.

53. i. Obtain state space model for given mechanical system.



(Nov 03)

ii. Obtain the state equations in canonical form for transfer function given $y(s)/u(s)= (3s^2+5s+13)/(s+2)(s^2+4 +8)$.

54. i. The state equations of a Linear system are as follows.

$$\dot{x} = \begin{bmatrix} -2 & 0 & 1 \\ 1 & -3 & 0 \\ 1 & 1 & -1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u$$

(Nov 03)

$y = [2 \;\; 1 \;\; -1]\, x$

Determine the transfer function y(s)/u(s).

ii. Explain various methods of evaluation of state transition matrix.

55. i. Derive the expression for the transfer function from the state model.

$x = Ax + Bu$

$y = Cx + Du$

ii. Obtain state variable representation of an armature controlled D.C. motor.

(Nov 03)

56. i. For the given system X = Ax + Bu where $A = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 1 & 3 \\ 1 & 1 & 1 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

Find the characteristic equation of the system and its roots.

ii. Given x(t)=$\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}\begin{bmatrix} x1(t) \\ x2(t)+ \end{bmatrix}\begin{bmatrix} 0 \\ 1 \end{bmatrix}u(t)$ Find the unit step response when, X(0) = $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$ **(Nov 03)**

57. i. For the system represented by the following equations, find the transfer function X(s)/U(s) by signal flow graph technique.

$X = x_1 + b_3 u$

$\dot{x}1 = -a_1x_1 + x_2 + b_2u$

$\dot{x}2 = -a_2x_1 + b_1u$ **(May 03)**

58. i. Obtain the solution of a system whose state model is given by X = A X(t) + B U(t) ; X(O) =X_0 and hence define state Transition matrix.

ii. Obtain the transfer function of a control system whose state model is :

X (t) = A X(t) + B U(t)

Y(t) = CX(t)

Where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -10 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix}$ $C = [1 \quad 0 \quad 0]$ **(May 03)**

59. i. Obtain the solution of a system whose state model is given by X = A X(t) + B U(t) ; X(0) =X_0 and hence define state Transition matrix.

ii. Obtain the transfer function of a control system whose state model is

$\overset{\circ}{X}(t) - AX(t) + BU(t) \qquad Y(t) = CX(t)$

$Where \quad A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -10 \end{bmatrix}$

$B = \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix} \qquad C = [1 \quad 0 \quad 0]$

(May 03)

60. i. Obtain state variable representation of a field controlled D. C. motor.

ii. Find the state transition matrix for a given system. **(May 03)**

$\overset{\circ}{x} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -2 \end{bmatrix} x$

61. A system is characterized by the following state space equations.

$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \ t > 0$

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

i. Find the Transfer Function

ii. Compute the state transition matrix

iii. Solve the state equation for a unit step input under zero initial condition

(Jan 03)

62. Write a short on the following:

i. State vector

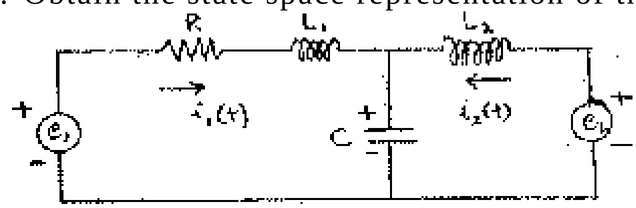
ii. State transition matrix

(Jan 03)

63. i. Find a state model for the system with transfer function.

$$\frac{C(s)}{U(s)} = \frac{s+4}{s^3+6s^2+11s+6}$$

ii. Obtain the state space representation of the electrical network shown.



(Jan 03)

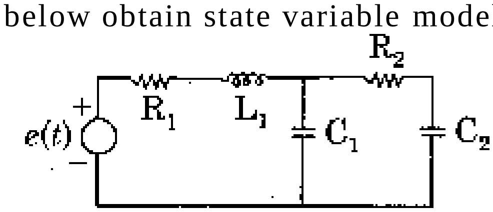
64. For the following system determine: $X = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} V(t)$

i. State transition matrix;

ii. State vector x (t). **(Jan 03)**

Assume $X(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ *and* $V(t) = 1$

65. For system shown below obtain state variable model: **(Jan 03)**



66. A control system is described by the differential equation $\frac{d^3 y(t)}{dt^3} = 4(t),$ where y(t) is the observed output and u(t) is the input.

i. Describe the system in the state variable form

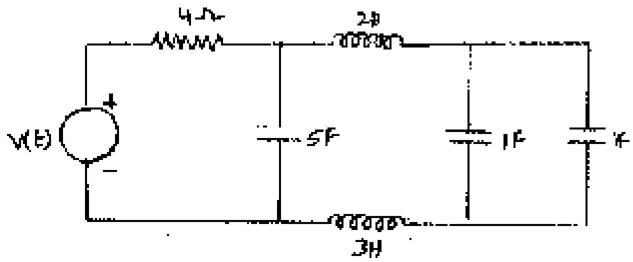
ii. Calculate the state transition matrix

iii. Is the system controllable **(GATE 92)**

67. From the following state variable representation, determine the transfer function of the system. $X = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -40 & -44 & -44 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} U$

y = [0 1 0]x **(IES 02)**

68. For the circuit choose a set of state variables and derive the voltage/current equation necessary for solving the circuit in terms of the choosen state variables.



(IES 99)

69. Show that the system designated by $\begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a & -b & -c \end{bmatrix} \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$ is completely state controllable

(IES 96)