Doc. No.: DCE/0/15
Revision :00

Lecture Plan-1

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- A

S. No.	Topic :- INTRODUCTORY CONCEPTS	Time Allotted
1.	Introduction Introduction to the basic concepts of control system.	05 min
2	Division of the Topic System/Plant model, types of models illustrative examples of plants and their inputs and outputs, controller, servomechanism, regulating system, linear time invariant (LTI) system	35 min
3.	Conclusion: This lecture is to give an introduction to the basic concepts of control systems.	05 min
4	Question / Answer: Q1.What is control system? Q2.Give examples of plants. Q3: What is LTI system ?	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-2

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- A

S. No.	Topic :- INTRODUCTORY CONCEPTS	Time Allotted
1.	Introduction Introduction to the different types of control system.	05 min
2	Division of the Topic time-varying system, causal system, open loop control system, closed loop control system,	35 min
3.	Conclusion: This lecture is to give an introduction to the basic concepts of control systems.	05 min
4	Question / Answer: Q1.What are time varying systems? Q2.Explain open and closed loop systems.	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-3

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- A

S. No.	Topic :- Feedback	Time Allotted
1.	Introduction Examples of open and closed loop systems.	05 min
2	Division of the Topic illustrative examples of open-loop and feedback control systems, continuous time and sampled data control systems.	35 min
3.	Conclusion: This lectures illustrates the open loop and feedback systems.	05 min
4	Question / Answer: Q1: Give two examples of the closed loop system? Q2: what is the disadvantage of the closed loop system?	05 min

Assignment to be given:-
Nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Doc. No.: DCE/0/15
Revision :00

Lecture Plan-4

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- A

S. No.	Topic :- Feedback	Time Allotted
1.	Introduction The effect of feedback on different parameters of a system.	05 min
2	Division of the Topic Effects of feedback on sensitivity (to parameter variations), stability, external disturbance (noise), overall gain etc. Introductory remarks about non-linear control systems.	35 min
3.	Conclusion: This lecture discusses the different effects of feedback on different parameters.	05 min
4	Question / Answer: Q1: Give two application of the closed loop system ? Q2: what is the disadvantage of the closed loop system?	05 min

Assignment to be given:-
Discuss the effect of feedback on
Sensitivity,stability and external disturbance.

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-5

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- B

S. No.	Topic :- TRANSFER FUNCTION & BLOCK DIAGRAM	Time Allotted
1.	Introduction It is defined as the ratio of laplace transfer of laplace transfer of the system to laplace transfer of i/p under assumption that all initial conditions are zero	05 min
2	Division of the Topic Concept of transfer function, relationship between transfer function and impulse response, order of a system, block diagram algebra	35 min
3.	Conclusion: Basically the block diagram is the pictorial representation of the given system	05 min
4	Question / Answer: Q1: Define transfer function? Q2: Define block diagram?	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-6

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- B

S. No.	Topic :- SIGNAL FLOW GRAPH	Time Allotted
1.	Introduction Terminology used in signal flow graph ,Properties of signal flow graph ,Methods of obtaining signal flow graph.	05 min
2	Division of the Topic signal flow graphs : Mason s gain formula & its application,	35 min
3.	Conclusion: To be Continued in next lecture	05 min
4	Question / Answer: $Y2= G_1Y_1+G_3 Y_3$ $Y3= G_4Y_1+G2Y_2+G_5Y_3$ $Y4= G_6Y_2+G_7Y_3$ WHERE Y_4 is o/p . Find Y_4/Y_1	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-7

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- B

S. No.	Topic :- SIGNAL FLOW GRAPH	Time Allotted
1.	Introduction Terminology used in signal flow graph ,Properties of signal flow graph ,Methods of obtaining signal flow graph.	05 min
2	Division of the Topic characteristic equation, derivation of transfer functions of electrical and electromechanical systems.	35 min
3.	Conclusion: Discusses the derivation of transfer functions of various electrical and electromechanical systems.	05 min
4	Question / Answer: Derive the transfer function of a electrical system.	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-8

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- B

S. No.	Topic :- SIGNAL FLOW GRAPH	Time Allotted
1.	Introduction Terminology used in signal flow graph ,Properties of signal flow graph ,Methods of obtaining signal flow graph.	05 min
2	Division of the Topic characteristic equation, derivation of transfer functions of electrical and electromechanical systems.	35 min
3.	Conclusion: Discusses the derivation of transfer functions of various electrical and electromechanical systems.	05 min
4	Question / Answer: Derive the transfer function of an electrical system.	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-9

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- B

S. No.	Topic :- SIGNAL FLOW GRAPH	Time Allotted
1.	Introduction Introduce cascaded and non-loading cascaded systems.	05 min
2	Division of the Topic Transfer functions of cascaded and non-loading cascaded elements. Introduction to state variable analysis and design.	35 min
3.	Conclusion: Compute the transfer function of cascade and non-loading cascaded systems.	05 min
4	Question / Answer: Derive the transfer function of cascading and non cascading systems.	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-10

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- First Order Derivative	Time Allotted
1.	Introduction time response of the system how the o/p behaves with respect to the time. , the o/p variation during the time ,it takes to achieve its final value is called as transient response of the system	05 min
2	Division of the Topic Standard test i/p. Steady state analysis Steady state error Analysis of type 0,1 and 2 system Disadvantage of static error coefficient method	35 min
3.	Conclusion: Transient response depends on 1) poles of the closed loop system T.F 2) location of the poles of the closed loop T.F and it is dependent of the magnitude of the i/p applied . any change in the magnitude of the selected i/p will not have any effect on the transient response of the system	05 min
4	Question / Answer: Q1Define steady state error? Q2: Define ramp i/p ?	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-11

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- Second Order Derivative	Time Allotted
1.	Introduction for second order system the denominator of the closed loop T.F is quadratic and the coefficients of this equation are directly related to ζ and wn	05 min
2	Division of the Topic Step response of the second order system Response of under damped system 2nd order and transient response Derivation	35 min
3.	Conclusion: Wd = wn √1- ζ ^2 Td= 1+0.7 ζ/wn Tp= Π/ wd sec Ts= 4/ζ wn sec	05 min
4	Question / Answer: Q1. Define the term delay time? Q2: define the term rise time?	05 min

Assignment to be given:-

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 have a damping ratio of .5 .for this value of k ,determine settling time, peak overshoot time and time to peak overshoot for step

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-12

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- stability of second order	Time Allotted
1.	Introduction System can be stable, marginally stable, or unstable. Stability op the linear system can be determined from the location of the closed loop poles in s-plane.	05 min
2	Division of the Topic pole zero configuration and stability, necessary and sufficient conditions for stability,	35 min
3.	Conclusion: When the system is excited by a bounded i/p ,o/p is also bounded and controllable, for unstable system bounded i/p produces unbounded o/p	05 min
4	Question / Answer: **Q1:**If there are repeated roots located purely on imaginary axis system is said to be--- ---------- Q2: define relative system?	05 min

Assignment to be given:-

Nil

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-13

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- ROUTH'S CRITERION	Time Allotted
1.	Introduction In routh's criterion all terms in the first column of routh's array must be of same sign., no sign change	05 min
2	Division of the Topic Rouths criterion Rouths array method Special cases Relative stability	35 min
3.	Conclusion: if there is no sign change ,system is stable, if two sighn change two root lie on the right half of s-plane	05 min
4	Question / Answer: Q1: s^4 + 6s^3 +26s^2 +56s +80=0 , check for stability? Q2: s^5+s^4+2s^3+2s^2+3s+15 =0, check for the stability of the system	05 min

Assignment to be given:-

Using routh's Hurwitz criterion , find the stability of the system with characteristics equation

S^%+4s^4+8s^2+7s+4=0

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-14

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- HURWITZ STABILITY	Time Allotted
1.	Introduction It represents a method of determining the location of poles of a characteristic equation w.r.t the left half and right half of the S-plane without actually solving the equation	05 min
2	Division of the Topic Hurwitz criterion Method Disadvantage Numericals	35 min
3.	Conclusion: all the coefficients of the polynomial should be of the same sign ,none of the coefficient vanishes	05 min
4	Question / Answer: Q1. s^3+s^2+s^!+4=0 is the system stable Q2.What is the disadvantage of this method?	05 min

Assignment to be given:-

Nil

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-15

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- ROOT LOCUS	Time Allotted
1.	Introduction Nature of the transient response is closely related to the location of the poles in the s-plane . the knowledge of the closed loop poles with small change in the parameters of the system helps in design of any closed loop system and moments of such poles can be known as root locus it is a graphical method , in which moments of poles in s-plane is sketched , parameter is varied from zero to infinity.	05 min
2	Division of the Topic basic concept of root locus Angle and magnitude condition Graphical method of determining 'k' Construction of root locus Rule no : 1	35 min
3.	Conclusion: Root locus of the closed loop poles obtained when system gain 'k' is varied from – infinity to + infinity is called root locus.	05 min
4	Question / Answer: Q1.Is root locus symmetrical about the real axis Q2.What is inverse root locus	05 min

Assignment to be given:-

Nil

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-16

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- Root Locus	Time Allotted
1.	Introduction root locus is always symmetrical about the real axis . the characteristic equation are either real or complex conjugate or combination of both Therefore their locus must be symmetrical about the real axis of the s-plane	05 min
2	Division of the Topic rule 2 Rule 3 : appoint on the real axis lies on the root locus if the sum of the number of open loop poles and the open loop zeros , on the real axis , to the right hand side of this point is odd Rule4: no of poles are more than number of zero and in such case P-Z branches will approach to infinity. .numerical	35 min
3.	Conclusion: To be continued.	05 min
4	Question / Answer: Q1:If p > z then no of branches are equal to ---------- Q2: if z>p then no of branches equal to ----------	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-17

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- Root Locus	Time Allotted
1.	Introduction revision of rule no 1 , rule 2, rule 3 and rule 4	05 min
2	Division of the Topic Rule 5(angles of asymptotes) Rule 6 break away point numerical	35 min
3.	Conclusion: if the adjacently placed poles on the real axis and the real axis between them is a part of root locus then there exist minimum one break away point in between adjacently placed poles	05 min
4	Question / Answer: Q1: What is the method to find break away point?	05 min

Assignment to be given:-
nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-18

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- C

S. No.	Topic :- Root Locus	Time Allotted
1.	Introduction revision of rule 5 and 6	05 min
2	Division of the Topic Rule no 7 intersection of root locus with imaginary axis Rule no 8: Angle of departure at complex conjugate poles Angle of arrival at complex conjugate zero Numerical based on rule no 7 &rule no 8	35 min
3.	Conclusion: the system stability can be checked If value of for 0<k<kmar ------- system is stable At k= kmar ---------- system is marginally stable k>kmar ----------system is unstable	05 min
4	Question / Answer: Q1: what is angle of departure?	05 min

Assignment to be given:-

draw the root locus plot of a feed back system with characteristics equation is

$1 + K / s(s+3)(s^2+2s+2) = 0$

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-19

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- RELATION BETWEEN FREQUENCY RESPONSE & TIME RESPONSE	Time Allotted
1.	Introduction variation of M & φ of G(jw) as "w'' the io/p frequency is varied from o to infinity methods used 1) bode plot 2) polar plot 3) Nyquist plot Introduction to bode plot	05 min
2	Division of the Topic magnitude plot Phase plot Logarithmic scale Co-relation between the time domain and frequency domain	35 min
3.	Conclusion: Both Mp and Mr are the function of the damping ratio for satisfactory operation Mp should be around 10-15 % while Mr should be around 1to1.4 ,i.e 0 to 3 db	05 min
4	Question / Answer: Q1: what are the two plots of the bode plot ? Q2 define magnitude plot?	05 min

Assignment to be given:-

Draw the root locus plot of a feed back system with characteristics equation is

$1 + K / s(s+3)(s^2+2s+2) = 0$

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-20

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- BODE PLOT	Time Allotted
1.	Introduction in this method without the knowledge of the transfer function , the frequency response of stable open loop system can be obtained it is easy to use for the design of control system and for finding absolute as well as relative stability of the system . frequency response are simple and easy to calculate	05 min
2	Division of the Topic Limitation of bode plot Steps involved 1. replace ‘s’ by jw to convert it to frequency domain 2. find the magnitude as function of ‘w’ 3. express magnitude in db 4. find phase angle	35 min
3.	Conclusion: The frequency response test are simple and can be made accurately . Without the knowledge of transfer function frequency response of stable open loop system can be obtained	05 min
4	Question / Answer: Q1: what are the limitations of frequency response?	05 min

Assignment to be given:-

Draw the root locus plot of a feed back system with characteristics equation is

$1 + K / s(s+3)(s^2+2s+2) = 0$

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-21

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- BODE PLOT	Time Allotted
1.	Introduction review of factor 1, factor 2,factor 3	05 min
2	Division of the Topic Factor 4: quadratic factor Steps to sketch bode plot Numerical	35 min
3.	Conclusion: To be continued	05 min
4	Question / Answer: Q1**:** what will be the magnitude if there are two poles at origin? Q2: if the magnitude is -60 db and there is a zero what will be the resultant?	05 min

Assignment to be given:-
Nil

Reference Readings:-
1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-22

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- BODE PLOT	Time Allotted
1.	Introduction draw a 20log k db to find the corner frequency, plot the sketch On semi log paper	05 min
2	Division of the Topic frequency response specification Gain margin and phase margin numerical	35 min
3.	Conclusion: very low gain give highgain margin and phase margin , But causes high steady state error , high value of rise time and settling time and in general give sluggish response	05 min
4	Question / Answer: Q1: define band width? Q2:reasonant peak?	05 min

Assignment to be given:-

Nil

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-23

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- COMPENSATION NETWORK	Time Allotted
1.	Introduction in order to improve GM and PM of the system compensating networks are used lead and lag are the different type network	05 min
2	Division of the Topic compensation network Lead lag compensation network Lead network Lag network	35 min
3.	Conclusion: The gain and phase margin are use to improve the stability of the network	05 min
4	Question / Answer: Q1: define cut off rate? Q2:How is cut off frequency denoted ?	05 min

Assignment to be given:-

Nil

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-24

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- SYNCHROS & TACOGENERATOR	Time Allotted
1.	Introduction Synchros are used in control system as detectors and encoders because of their rigidness in construction and high reliability . it is basically a rotary device an electromagnetic transducer which operates on the same principal as that of transformer	05 min
2	Division of the Topic Synchronous transmitter Synchronous control transformer Tachogenerators D.C tachometer Advantage	35 min
3.	Conclusion: Generated voltage are free from undesired wave forms and phase shifts. No residual voltage is present at zero speed.	05 min
4	Question / Answer: **Q1**:- what are the disadvantage s of tachometer? Q2: - what is the principle of synchronous transmitter?	05 min

Assignment to be given:-
write a note on tachometers.

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System

Lecture Plan-25

Semester:- VI Class:- EEE

Course Code:- EE-304-F Subject:- Control System Engineering Sec:- D

S. No.	Topic :- SERVO MOTOR , STEPPER MOTOR,MAGNETIC AMPLIFIER	Time Allotted
1.	Introduction A.C servomotors are best suited for low power application .they are robust light in weight and have no brush contact Stepper motor is a electromechanical device which actuates a train of steps (angular or linear) moments in response to train of i/p pulse on one to one basis –one step actuation for each pulse i/p.	05 min
2	Division of the Topic Servomotor (two phase) Torque –speed characteristics Stepper motor Variable reluctance Magnetic Amplifier	35 min
3.	Conclusion: A servomotor rarely operates at high speed hence for a given value of control voltage , T is directly proportional characteristics are perfectly linear	05 min
4	Question / Answer: Q1: What is the application of stepper motor? Q2: what are two types of stepper motor?	05 min

Assignment to be given:-
write a note on permanent magnet motor

Reference Readings:-

1 I.J Nagarath&Gopal
2. B .C.Kuo Automatic Control system
3. B.S .Manke
4. K. Ogata modern control engg
5. K.K.Singh , Control System