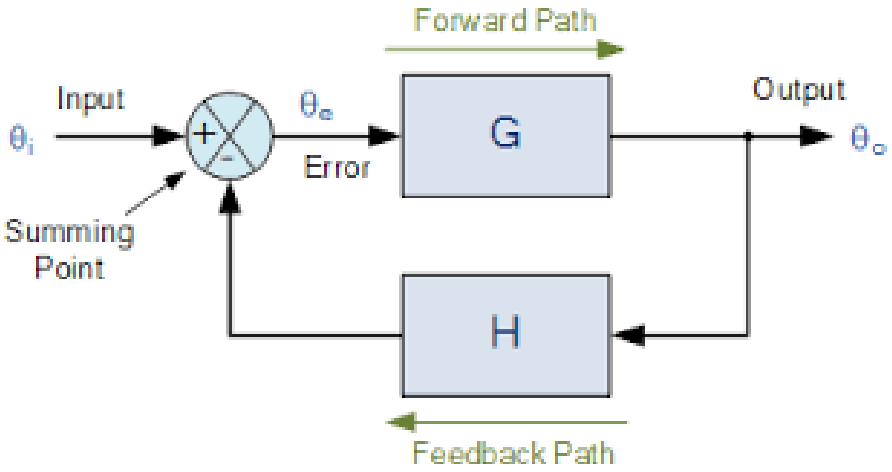
DARBHANGA COLLEGE OF ENGINEERING

Darbhanga

COURSE FILE OF

LINEAR CONTROL THEORY

(EE 031712)



Faculty Name:

Akhil Mohammed K K

Asst. Prof. EEE Dept., DCE Darbhanga

विज्ञान एवं प्रावैधिकी विभाग
Department of Science and Technology
Government of Bihar

CONTENTS

Vision of EEE: - To bring forth engineers with an emphasis on higher studies and a fervour to serve national and multinational organisations and, the society.

Mission of EEE: -

M1: - To provide domain knowledge with advanced pedagogical tools and applications.

M2: - To acquaint graduates to the latest technology and research through collaboration with industry and research institutes.

M3: - To instil skills related to professional growth and development.

M4: - To inculcate ethical valued in graduates through various social-cultural activities.

PEO of EEE

PEO 01 – The graduate will be able to apply the Electrical and Electrical Engineering concepts to excel in higher education and research and development.

PEO 02 – The graduate will be able to demonstrate the knowledge and skills to solve real life engineering problems and design electrical systems that are technically sound, economical and socially acceptable.

PEO 03 – The graduates will be able to showcase professional skills encapsulating team spirit, societal and ethical values.

PSO of EEE

PSO 01 Students will be able to identify, formulate and solve problems using various software and other tools in the areas of Automation, Control Systems, Power Engineering and PCB designing.

PSO 02 Students will be able to provide sustainable solutions to growing energy demands.

1. Scope and Objective of Course

This subject will introduce the student to the principles and practice of feedback control systems, and outlines their role in modern society. The student will learn about dynamic system modelling and controller synthesis as two key elements in the development of a modern control system, and the subject will emphasise the usage of transform theory to facilitate both of these elements. This subject will also introduce techniques for the practical implementation of the synthesized controller.

Topics that are covered in this subject include: introduction to feedback, system modelling using Laplace transform and state space representations, time domain and frequency domain design specifications, SISO control, prototype controllers based on proportional + integral + derivative elements, root locus techniques, Nyquist and Bode techniques, compensation strategies, feed-forward and cascaded loops, and practical realisation issues.

2.Course Outcomes:

After the completion of course, student will be able to:

1. **Model** a practical system in transfer function form using its governing laws.
2. **Understand** the common control schemes
3. **Apply** the knowledge of control systems to apply for practical system like servomotor.
4. **Analyze** the system response and stability in both time-domain and frequency domain
5. **Design** different types of compensators using time-domain and frequency domain specifications

CO-PO MAPPING

Sr. No.	Course Outcome
1.	**Model** a practical system in transfer function form using its governing laws.
2.	**Understand** the common control schemes
3.	**Apply** the knowledge of control systems to apply for practical system like servomotor.
4.	**Analyze** the system response and stability in both time-domain and frequency domain
5.	**Design** different types of compensators using time-domain and frequency domain specifications

CO-PO degree of Mapping

PSO 1. Acquire the knowledge of control systems and extend it to apply it in modern engineering problems to deduce effective solutions.

PSO 2. Use modern engineering tools in the attempt to derive solutions to practical problems and realize the areas that needs an effective research in control systems engineering.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	Engineering knowledge	Problem analysis	Design/development of solutions	Investigation	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communications	Project management and finance	Life-long learning		
CO1	3	3	2	2	2	1	1		2	2	1	2	2	2
CO2	3	3	3	2	1	1			2	2		2	1	1
CO3	3	3	3	3	2	2			2	2		2	2	1
CO4	3	3	2	3	2	2		1	3	3	1	3	1	2
CO5	3	2	3	2	2		2	2		1		2	3	3

EE 1712 LINEAR CONTROL THEORY L-T-P : 3-0-3 Credit : 5

SYLLABUS

1. Introduction : The control system, servomechanism, servomotors, standard test signal.

Lecture : 4

2. Time response analysis : Time response of second order system, design consideration for higher order system, stability relative stability. **Lecture : 6**

3. The root locus technique : Concept, construction of root loci root contours systems with transformation log. **Lecture : 8**

4. Frequency response analysis : Correlation between time and frequency response, bode plots, root locus and minimum phase system log magnetic vs phase plots , stability in frequency domain , polar plots. **Lecture : 8**

5. Mathematics preliminaries, Nyquest stability criteria, Assessment of relation stability using Nyquest criteria. **Lecture : 5**

6. Closed loop frequency response. **Lecture : 3**

7. Compensation of control system : Introduction, type compensation approach to compensation. **Lecture : 8**

Text Books :

1. Modern control system by Nagrath & Gopal

Reference Books :

1. Modern Control Engineering by K.Ogata, Pearson Education.

2. Control Engineering by Kuo.

GATE SYLLABUS

Linear Control Theory

WEIGHTAGE(10 marks)

Mathematical modeling and representation of systems Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix

DARBHANGA COLLEGE OF ENGINEERING, DARBHANGA **w.e.f. – 10-02-18**

Individual Time Table
Faculty Name- Akhil Mohammed (EEE Department)

Day	Branch	1 (10am-10.50am)	2 (10.50am-11.40am)	3(11.40am-12.30pm)	4(12.30pm-1.20pm)	Lunch (1.20pm – 1.50pm)	5(1.50pm – 2.40pm)	6(2.40pm-3.30pm)	7(3.30pm-4.20pm)
Monday	E.E.E.		LCT						
Tuesday	E.E.E.				LCT				
Wednesday	E.E.E.								
Thursday	E.E.E.								
Friday	E.E.E.			LCT					
Saturday	E.E.E.	LCT							

Prof . Incharge Routine
D.C.E. Darbhanga

Principal
D.C.E., Darbhanga

Institute/College Name:	Darbhanga College of Engineering
Program Name:	B.Tech (EEE, 8th semester)
Course Code:	031712
Course Name:	Linear Control Theory
Lecture/Tutorial(per week):	3/1
Course Credits:	5
Course Co-coordinator Name:	Mr. Akhil Mohammed

1. Scope and Objective of Course

This subject will introduce the student to the principles and practice of feedback control systems, and outlines their role in modern society. The student will learn about dynamic system modelling and controller synthesis as two key elements in the development of a modern control system, and the subject will emphasize the usage of transform theory to facilitate both of these elements. This subject will also introduce techniques for the practical implementation of the synthesized controller. Topics that are covered in this subject include: introduction to feedback, system modelling using Laplace transform and state space representations, time domain and frequency domain design specifications, SISO control, prototype controllers based on proportional + integral + derivative elements, root locus techniques, Nyquist and Bode techniques, compensation strategies, feed-forward and cascaded loops, and practical realization issues.

2.Course Outcomes:

After the completion of course, student will be able to:

1. **Model** a practical system in transfer function form using its governing laws.
2. **Understand** the common control schemes\with design specifications like transient response, stability and steady state errors.
3. **Apply** the knowledge of control systems to apply for practical systems like servomotor.
4. **Analyze** the system response and stability with time-domain and frequency domain.
5. **Design** different types of compensators using time-domain and frequency domain specifications

3. Textbooks

TB1: Ogata K., "Modern Control Engineering", Prentice Hall India,1994
TB2: M Gopal, "Control Systems,Principles and Design",Tata McGraw-Hill,1998.
TB3:Norman S. Nise "Control System Engineering", 6th Edition,John Wiley and sons.
TB4:A.Anand Kumar ,"Control Systems",PHI L earning,2011

4.Reference Books

RB1: Control Engineering: Theory & Practice by Bandopadhya, PH

RB2: Benjamin C. Kuo, "Automatic Control Engineering", Prentice Hall of India Pvt. Ltd.

5.Other readings and relevant websites

Sl No	Link of journals, Magazines, websites and Research papers
1.	https://ieeexplore.ieee.org/search/searchresult.jsp?queryText=control%20systems&ranges=1885_1909_Year
2.	https://www.youtube.com/user/nptelhrd/search?query=control+systems
3.	http://nptel.ac.in/courses/108103008/29
4.	http://www.engpaper.com/research-paper-control-system.htm

6.Course plan

Lecture No.	Topics	Web Links for Videos Lecture	Text Books/Reference books/Reading Materials	Page No. of Text Books
1-4	**Introduction** The control system, servomechanism, servomotors, standard test signal. Lecture : 4	https://www.youtube.com/watch?v=SUxVuGnF7wI&index=19&list=PL692A7B9169289C4F	TB1	1-9,63-70
6-10	**Time response analysis** Time response of second order system, design consideration for higher order system, stability relative stability. Lecture : 6	https://www.youtube.com/watch?v=34fYhDdZFbI&index=4&list=PL692A7B9169289C4F	TB6	159-231
	Asssignment-1			
11-18	**The root locus technique** Concept, construction of root loci root contours systems with transformation log. Lecture : 8	https://www.youtube.com/watch?v=oA4JRcF_3nI&index=30&list=PL692A7B9169289C4F	TB1	269-308

19-26	**Frequency response analysis** Correlation between time and frequency response, bode plots, root locus and minimum phase system log magnetic vs phase plots , stability in frequency domain , polar plots. Lecture : 8	https://www.youtube.com/watch?v=Lj5UDyfsmzw&list=PL42816CBDEAC1E82E&index=21	TB1	398-443
27-31	**Nyquist stability** Mathematics preliminaries, Nyquist stability criteria, Assessment of relation stability using Nyquest criteria. Lecture : 5	https://www.youtube.com/watch?v=VPXzeJGnGE4&index=39&list=PL42816CBDEAC1E82E	TB1	445-462
	Assignment 2			
32-34	**Closed loop frequency response** 6. Closed loop frequency response. Lecture : 3	https://www.youtube.com/watch?v=Xy3OxoEQGqk&list=PL692A7B9169289C4F&index=40	TB1	477-486
35-43	**Compensation of control system**			
	Introduction, type compensation approach to compensation. Lecture : 8	https://www.youtube.com/watch?v=Xgr9AA0RnSo&list=PL692A7B9169289C4F&index=41	TB2	311-342, 493-521
	Assignment 3			

7.Syllabus

Topics	No. of Lectures	Weightages
1. Introduction : The control system, servomechanism, servomotors, standard test signal.	4	9%
2. Time response analysis : Time response of second order system, design consideration for higher order system, stability relative stability.	6	14%
3. The root locus technique : Concept, construction of root loci root contours systems with transformation log.	8	19%
4. Frequency response analysis : Correlation between time and frequency response, bode plots, root locus and minimum phase system log magnetic vs phase plots , stability in frequency domain , polar plots.	8	8%
5. Mathematics preliminaries, Nyquest stability criteria, Assessment of relation stability using Nyquest criteria.	5	12%
6. Closed loop frequency response	3	7%
7. Compensation of control system : Introduction, type compensation approach to compensation.	8	19%

CO-PO degree of Mapping

Sr. No.	Course Outcome
CO1	**Model** a practical system in transfer function form using its governing laws.
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COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	Engineering knowledge	Problem analysis	Design/development of solutions	Investigation	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communications	Project management and finance	Life-long learning		
CO1	2	2	2	2						1				
CO2	2	2	2	2										
CO3	2	2	2	2										
CO4	2	2	2	2	1	2	2	1						
CO5	2	2	2	2	1	2	2	1				1		

Evaluation and Examination Blue Prints:

Internal assessment is done through quiz tests, presentations, assignments and projects work. Two sets of question paper are asked from each faculty and out of these two, without the knowledge of faculty, one question paper is chose for the concerned examination. Examination rules and regulations are uploaded on the student's portals. Evaluation is a very transparent process and the answer sheets of sessional tests, internal assessment assignments are returned back to the students.

The components of evaluation along with their weightage followed by the university is given below:

Component-1	Sessional test-1	15%
	Sessional test-2	15%
	Sessional test-3	15%
Component-2	Assignments, Quiz's, Test, Seminars	10%
Component-3	End Term Examination	60%
Total		100%

(From amongst the three sessional tests best of two are considered).

LECTURE PLAN

Institute/College Name:	Darbhanga College of Engineering
Program Name:	B.Tech (EEE, 7th semester)
Course Code:	031712
Course Name:	Linear Control Theory
Lecture/Tutorial(per week):	3/1
Course Credits:	5
Course Co-coordinator Name:	Mr. Akhil Mohammed

Topics	**No. of Lectures**	**Weightages**
Introduction to the control system, basics	1	9%
Theory of servomechanism and principles	2	
Servomotors, applications in control problems	3	
Standard test signal analysis	4	
Time response of second order system	5	14%
design consideration for higher order system	6	
Time response specifications	7	
Steady state errors	8	
Stability of control systems	9	
Stability and relative stability	10	
3. The root locus technique :	11	19%
Root locus plots	12	
Plotting rootlocus with matlab	13	
Root locus with positive feedback systems	14	
IntroductionConcept contours systems with transformation log	15	
Transient response design via gain adjustment	16	
Generalized root locus	17	
Pole sensitivity	18	
Frequency response analysis : Correlation between time and frequency response, bode plots	19	8%
Bode plots	20	
Sketching Nyquist digram	21	
Stability via Nyquist stability criterion	22	
root locus and minimum phase system	23	
log magnetic vs phase plots	24	
stability in frequency domain	25	
Stability, gain margins phase margins	26	

5. Mathematics preliminaries, Nyquist stability criteria	27	12%
Assessment of relation stability using Nyquist criteria.	28	
Relative stability analysis	29	
polar plots	30	
Sketching polar plots	31	
6. Closed loop frequency response	32	18%
Control systems design by frequency response	33	
Experimental determination of transfer functions	34	
7. Compensation of control system : Introduction, type compensation approach to compensation.	35	22%
lag compensations using root locus	36	
lead compensations using root locus	37	
Lag-lead compensations using root locus	38	
lag compensations using frequency response	39	
lead compensations using frequency response	40	
Lag-lead compensations using frequency response	41	
PID Controllers	42	
Introduction to state space	43	

SYLLABUS COMPLETION

Institute/College Name:	Darbhanga College of Engineering
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Generalized root locus	17	
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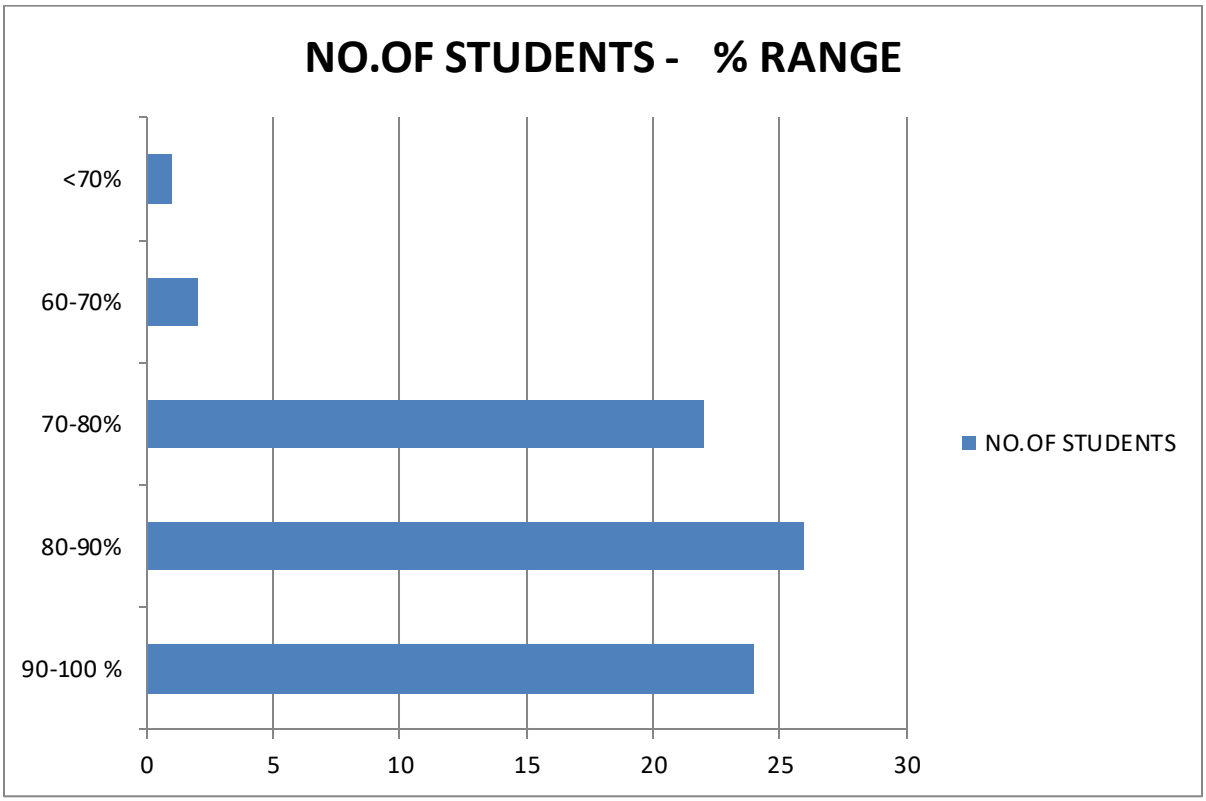
Frequency response analysis : Correlation between time and frequency response, bode plots	19	8%
Bode plots	20	
Sketching Nyquist digram	21	
Stability via Nyquist stability criterion	22	
root locus and minimum phase system	23	
log magnetic vs phase plots	24	
stability in frequency domain	25	
Stability, gain margins phase margins	26	

5. Mathematics preliminaries, Nyquist stability criteria	27	12%
Assessment of relation stability using Nyquist criteria.	28	
Relative stability analysis	29	
polar plots	30	
Sketching polar plots	31	
6. Closed loop frequency response	32	8%
Control systems design by frequency response	33	
7. Compensation of control system : Introduction, type compensation approach to compensation.	35	15%
lag compensations using root locus	36	
lead compensations using root locus	37	
Lag-lead compensations using root locus	38	
lag compensations using frequency response	39	
TOTAL	85%	

RESULT ANALYSIS
LINEAR CONTROL THEORY-7TH SEM



Darbhanga College of Engineering, Darbhanga

7th Semester Electrical and Electronics Engineering

Subject Name:-LINEAR CONTROL THEORY-RESULTS

S.N.	Registration No.	Student Name	TOTAL=20
1	17110111001	RAUSHAN MISHRA	18
2	17110111002	GULSHAN KUMAR	16
3	17110111003	ROSHAN KUMAR	14
4	17110111004	ARUNODAY LAL	20
5	17110111005	PRANTIKA SUMAN	18
6	17110111006	HIMANI	18
7	17110111007	CHANDAN KUMAR	14
8	17110111008	SUBHKANT SAHU	16
9	17110111009	SHAMIM AKHATAR	12
10	17110111010	AKSHAY KUMAR	16
11	17110111011	SUBHAM KUMAR	14
12	17110111012	PRITY SINHA	14
13	17110111013	FUDAN KUMAR	8
14	17110111014	JYOTI KUMARI	14
15	17110111015	GAURAV KUMAR	16
16	17110111016	ARVIND KUMAR	18
17	17110111017	GOVIND KUMAR	14
18	17110111018	KESHAV KUMAR	16
19	17110111019	MUNNA KUMAR	14
20	17110111020	ABHIJEET KUMAR	14
21	17110111021	AJAY RAJ	14
22	17110111022	DEEPIKA KUMARI	20
23	17110111023	LEEPI DAS	14
24	17110111024	VIKASH KUMAR	16
25	17110111025	UDAY KUMAR YADAV	18
26	17110111026	HEMANT KUMAR	16
27	17110111027	SHUBHAM KUMAR ANAND	16
28	17110111028	MD TAUHID	16
29	17110111029	MD ASIF	20
30	17110111031	AMAN KUMAR	16
31	17110111032	AMAN JAISWAL	18
32	17110111033	RAVI NAYAN KISHOR	18
33	17110111034	DILIP KUMAR	18

34	17110111035	ANIL KUMAR	16
35	17110111036	MD RAFIULLAH	14
36	17110111037	SHASHANK KUMAR	16
37	17110111038	SAKSHI SUMAN	16
38	17110111039	SUNIL KUMAR RAM	14
39	17110111041	RAHUL KUMAR	18
40	17110111042	SATYAM KUMAR	16
41	17110111043	DIPU KUMAR MISHRA	12
42	17110111044	VIKASH KUMAR	18
43	17110111045	SAROJ KUMAR	14
44	17110111046	AJAY KUMAR SINGH	14
45	17110111047	MD NAYEEM	14
46	17110111048	MD SHAMIM AKHATAR	14
47	17110111049	DEEPA KUMARI	18
48	17110111050	SUBHASH KUMAR	14
49	17110111051	PRIYA KUMARI	18
50	17110111052	AMRENDRA KUMAR	16
51	17110111053	RANI RUPA	18
52	17110111054	AMAN KUMAR SRIVASTVA	20
53	17110111055	ADITYA KUMAR	14
54	17110111056	RAUSHAN KUMAR RAM	14
55	17110111057	POOJA KUMARI	18
56	17110111058	AVINASH KUMAR MISHRA	14
57	17110111059	RAHUL KUMAR	16
58	17110111060	VARUN KUMAR	18
59	17110111061	BRAJESH KUMAR	14
60	17110111063	ALOK KUMAR	16
61	17110111064	ROHIT KUMAR SAH	18
62	17110111065	MAYANK RAJ	16
63	18110111901	RAJESH KUMAR	16
64	18110111902	NAVEEN KUMAR	14
65	18110111903	NIKITA RAJ	18
66	18110111904	RITU RAJ	16
67	18110111905	SONAKSHI KUMARI	16
68	18110111906	PAWAN KUMAR	16
69	18110111907	NITISH KUMAR BANTY	16
70	18110111908	ADITYA CHANDRA RANJAN	16

71	18110111909	KUMARI SUPRABHA	16
72	18110111910	BRAJ KISHORE	18
73	18110111911	SAKSHI KUMARI	20
74	18110111912	VIDYAPATI CHAURASIYA	14
75	17110111904	LALIT KUMAR RAM	16
76	17110111907	DEEPAK KUMAR PRABHAT	18

Sign:-

Darbhanga College of Engineering, Darbhanga

7th Semester Electrical and Electronics Engineering

LCT-STUDENT LIST

S.N.	Registration No.	Student Name				
1	17110111001	RAUSHAN MISHRA				
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76	17110111907	DEEPAK KUMAR PRABHAT				

Sign:-