INSTITUTE VISION

- To be a preferred institution in Engineering Education by achieving excellence in teaching and research and to remain as a source of pride for its commitment to holistic development of individual and society**.**

INSTITUTE MISSION

- To continuously strive for the overall development of students by educating them in a state-of-the-art-infrastructure, by retaining the best practices, people and inspire them to imbibe real time problem solving skills, leadership qualities, human values and societal commitments, so that they emerge as competent professionals**.**

DEPARTMENT VISION

To be a centre of excellence in teaching and learning to produce the competent & socially responsible professionals in the domain of electrical & electronics engineering.

DEPARTMENT MISSION

To educate students with core knowledge of electrical and electronics engineering by developing problem solving skills, professional skills, social awareness to excel in their career.

PROGRAM EDUCATIONAL OBJECTIVES (PEO's) :

1. Posses successful careers in Electrical Sciences & apply the knowledge of mathematics & Engineering fundamentals to analyze & formulate the solution to solve real time problems.
2. Excel in academics, industry, entrepreneurship, administrative services through lifelong learning.
3. Exhibit professional & ethical values, effective communication skills, teamwork skills, multidisciplinary approach & an ability to realize engineering issues to broader social context.

PROGRAM OUTCOMES (PO's) :

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in

multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO's) :

1. An ability to demonstrate knowledge & competencies to analyze & design electrical & electronics circuits, control and power systems, machines & industrial drives.
2. An ability to use software tools for the design, simulation and analysis of electrical and electronics systems.

Contents of IV-SEM

S N	TOPIC
1	Vision,Mission,PEO's,PO's
2	PSO's,Student Help Desk
3	Departmental Resources
4	Teaching Faculty Details
5	Institute Academic Calendar
6	Department Academic Calendar
7	Scheme of Teaching & Examination III- Semester
	15EE61 - Control Systems 15EE62 - Power System Analysis – 1 15EE63 - Digital Signal Processing 15EE64- Electrical Machine Design 15EE651- Computer Aided Electrical Drawing 15EE662- Sensors and Transducers **Laboratory – Course Plan and Viva Questions** 15EEL67- Control System Laboratory 15EEL68- Digital Signal Processing Laboratory

1.0 Student Help Desk

SL. No	Puarticulars	Contact Person	
		Faculty	Instructor
1	Attestations	Dr. B. V.Madiggond	--
2	Exam forms signature, Overall department administration, Counseling/interaction with parents.		--
3	Research Centre Coordinator	Dr. B. V.Madiggond	--
4	Academic Coordinator	Prof. S.D.Hirekodi	--
5	Online submission of exam form/revaluation form to VTU,IA coordinator, Wall Magazine	Prof. S S Birade	Shri.V.N.Kamate Shri.S.B.Beelur
6	Department Association Coordinator	Prof. S. B. Patil, Prof.A.U.Neshti	--
7	Dept NBA Coordinator	Prof.M.P.Yanagimath	--
8	AICTE/VTU,NIRF	Prof. K. B Negalur	Sri. R. S. Bardol
9	Dept.TP Cell Coordinator	Prof. O. B. Heddurashetti	Sri. V. N. Kamate
10	Dept Alumni, Internship, III Cell Coordinator	Prof. P M Murari	--

11	Dept Robovidya, IEEE,ISTE coordinator	Prof. S.G.Huddar	Sri. V.M.Mutalik, Shri.R.S.Bardol, Shri.V.N.Kamate
12	Department Library Coordinator	Prof. Amit U Nesthi	Sri.S.B.Beelur
13	Department News Letter Coordinator	Prof. S.B.Patil	Sri.V.M.Mutalik
14	Project Coordinator	Prof. M.P.Yanagimath	--
15	Seminar Coordinator	Prof. M.P.Yanagimath	--
16	Dept meeting Coordinator	Prof.H.R.Zinage	--

SL. No	Puarticulars		
17	Electrical Maintenance	Prof.S.D.Hirekodi	
18	Warden HIT Ladies Hostel	Prof.H.R.Zinage	
19	Chief Alumini Coordinator	Prof.O.B.Heddurshetti	
20	Extra Curricular/Sports/Cultural Institute industry Engineering Coordinator	Prof.A.U.Neshti	
21	SC/ST cell Convener, Entrepreneurship cell Coordinator, Discipline cell Coordinator	Prof. K. B. Negalur	
22	IEEE, News/Publicity committee member	Prof.S.G.Huddar	
23	Dept. Web coordinator	Prof. V.B.Dhere	
24	Dispensary	Dr. Arun G. Bullannavar Contact No. 9449141549	

2.0 Departmental Resources

- Department of Electrical and Electronics Engineering was established in the year 1996 and is housed in a total area of **1339 Sq. Mtrs**.

2.1 Faculty Position

S.N.	Category	No. in position	Average experience
1	Teaching faculty	12	16
2	Technical supporting staff	4	20
3	Helper	2	15

2.2 Major Laboratories

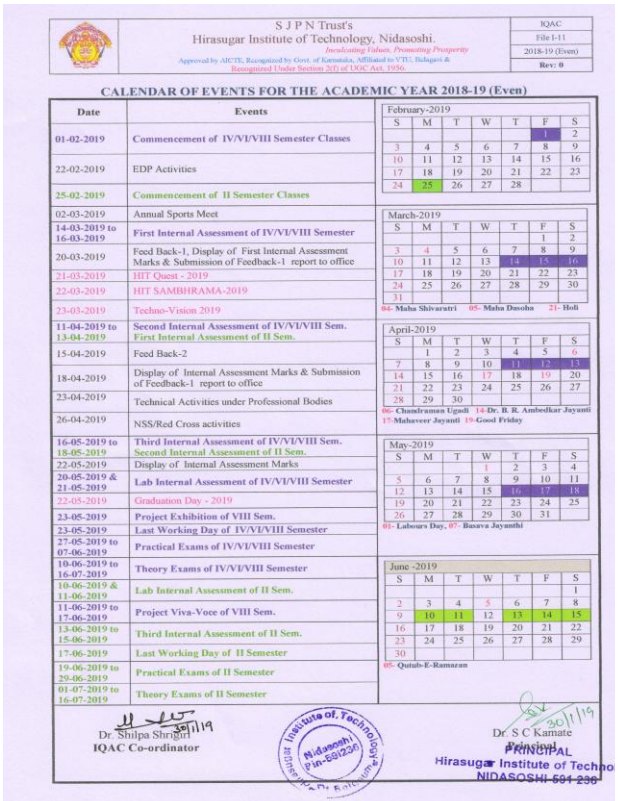
SN	Name of the Laboratory	Carpet Area (Sq.mt)	Total investment till date
1.	Electronics Lab	92	576516.80
2.	Operational Amplifiers & Linear IC Lab	72	111537.00
3.	Power Electronics Lab	92	770111.00
4. Microcontroller Lab 5. DSP Lab		72	582174.00
6.	Control System Lab	72	212755.00
7.	Electrical Machines Lab	200	807672.00
8.	Relay & HV Lab	138	603254.00
10.	Computer Aided Electrical Drawing Lab	71	650988.43
Grand Total :		**5441609.00**	

3.0 Teaching Faculty Details

Sr. No.	Faculty Name	Designatio	Qualification	Area of specialization	Professional membership	Industry Experience (in years)	Teaching Experience (in years)	Contact Nos.
1.	Dr.B.V.Madiggond	HOD/Prof	Ph.D	Power Electronic	LMISTE,YHAI	-	25	9343454993
2	Prof. S. B. Patil	Asst. Prof.	M. Tech	Power & Energy System	LMISTE	-	33	8050234360
3	Prof.V.B.Dhere	Asst.Prof	M.Tech, (Ph.D)	Electronics & Telicommunication	LMISTE, IMPARC	4	21	9886597573
4	Prof. S. D. Hirekodi	Asst. Prof.	M. Tech.	Power Electronics	LMISTE	1	18	9480849338
5	Prof. H. R. Zinage	Asst. Prof.	M. Tech	Power System	LMISTE	-	18	9480849335

6	Prof. M. P. Yanagimath	Asst. Prof.	M.Tech (Ph.D)	VLSI & ES	LMISTE	1	13	9341449466
7	Prof. O. B. Heddurshetti	Asst. Prof.	M. Tech.	Power Electrics	LMISTE	1	11	9448120509
8	Prof. A. U. Neshti	Asst. Prof.	M. Tech.	Digital Electronics	LMISTE	-	10	9538223362
9	Prof. P. M. Murari	Asst. Prof.	M. Tech.	PS & PE	LMISTE	-	07	9739733001
10	Prof. S. S. Birade	Asst. Prof.	M. Tech.	VLSI Design & ES	LMISTE	-	06	9945105480
11	Prof. K. B. Negalur	Asst. Prof.	M. Tech.	Industrial Electronics	LMISTE	-	05	9886644507
12	Prof. S. G. Huddar	Asst. Prof.	M. Tech.	Power System	LMISTE	-	05	9742066852

4.0 Institute Academic calendar



S J P N Trust's
Hirasugar Institute of Technology, Nidasoshi.
Inculcating Values, Promoting Prosperity
Approved by AICTE, Recognized by Govt. of Karnataka, Affiliated to VTU, Belagavi & Recognized Under Section 2(f) of UGC Act, 1956.

IQAC
File I-11
2018-19 (Even)
Rev: 0

CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2018-19 (Even)

Date	Events
01-02-2019	Commencement of IV/VI/VIII Semester Classes
22-02-2019	EDP Activities
25-02-2019	Commencement of II Semester Classes
02-03-2019	Annual Sports Meet
14-03-2019 to 16-03-2019	First Internal Assessment of IV/VI/VIII Semester
20-03-2019	Feed Back-1, Display of First Internal Assessment Marks & Submission of Feedback-1 report to office
21-03-2019	HIT Quest - 2019
22-03-2019	HIT SAMBHRAMA-2019
23-03-2019	Techno-Vision 2019
11-04-2019 to 13-04-2019	Second Internal Assessment of IV/VI/VIII Sem. First Internal Assessment of II Sem.
15-04-2019	Feed Back-2
18-04-2019	Display of Internal Assessment Marks & Submission of Feedback-1 report to office
23-04-2019	Technical Activities under Professional Bodies
26-04-2019	NSS/Red Cross activities
16-05-2019 to 18-05-2019	Third Internal Assessment of IV/VI/VIII Sem. Second Internal Assessment of II Sem.
22-05-2019	Display of Internal Assessment Marks
20-05-2019 & 21-05-2019	Lab Internal Assessment of IV/VI/VIII Semester
22-05-2019	Graduation Day - 2019
23-05-2019	Project Exhibition of VIII Sem.
23-05-2019	Last Working Day of IV/VI/VIII Semester
27-05-2019 to 07-06-2019	Practical Exams of IV/VI/VIII Semester
10-06-2019 to 16-07-2019	Theory Exams of IV/VI/VIII Semester
10-06-2019 & 11-06-2019	Lab Internal Assessment of II Sem.
11-06-2019 to 17-06-2019	Project Viva-Voce of VIII Sem.
13-06-2019 to 15-06-2019	Third Internal Assessment of II Sem.
17-06-2019	Last Working Day of II Semester
19-06-2019 to 29-06-2019	Practical Exams of II Semester
01-07-2019 to 16-07-2019	Theory Exams of II Semester

February-2019

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

March-2019

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

04- Maha Shivaratri 05- Maha Dasoha 21- Holi

April-2019

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

06- Chandraman Ugadi 14-Dr. B. R. Ambedkar Jayanti
17-Mahaveer Jayanti 19-Good Friday

May-2019

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

01- Labours Day, 07- Basava Jayanthi

June -2019

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

05- Qutub-E-Ramazan

Dr. Shilpa Shrigiri
IQAC Co-ordinator
30/1/19

Nidasoshi P.in-591236

Dr. S C Kamate
Principal
PRINCIPAL
Hirasugar Institute of Techno
NIDASOSHI 591 236
30/1/19

5.0 Department Academic calendar

S J P N Trust's
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E&E Engg. Dept | COE | 2018-19 (Even)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2018-19 (Even)

Date	Events
01-02-2019	Commencement of IV/VI/VIII Semester Classes
04-02-2019 to 08-02-2019	GATE Coaching classes
22-02-2019	EDP Activities
23-02-2019	Poster Presentation/Clay Modeling
25-02-2019	Commencement of II Semester Classes
01-03-2019	Hobby Project Exhibitation of VI sem
02-03-2019	Annual Sports Meet
14-03-2019 to 16-03-2019	First Internal Assessment of IV/VI/VIII Semester
20-03-2019	Feed Back-1,Display of First Internal Assessment Marks & Submission of Feedback-1 report to office
21-03-2019	HIT Quest - 2019
22-03-2019	HIT SAMBHRAMA-2019
23-03-2019	Techno-Vision 2019
29-03-2019	Technical Talk
11-04-2019 to 13-04-2019	Second Internal Assessment of IV/VI/VIII Sem. First Internal Assessment of II Sem.
15-04-2019	Feed Back-2
18-04-2019	Display of Internal Assessment Marks & Submission of Feedback-2 report to office
19-04-2019	Industrial visit
23-04-2019	Technical Activities under Professional Bodies
26-04-2019	NSS/Red Cross activities
03-05-2019	Outdoor game-Cricket
16-05-2019 to 18-05-2019	Third Internal Assessment of IV/VI/VIII Sem. Second Internal Assessment of II Sem.
20-05-2019 & 21-05-2019	Lab Internal Assessment of IV/VI/VIII Semester
22-05-2019	Display of Internal Assessment Marks
22-05-2019	Graduation Day - 2019
23-05-2019	Project Exhibition of VIII Sem.
23-05-2019	Last Working Day of IV/VI/VIII Semester
27-05-2019 to 07-06-2019	Practical Exams of IV/VI/VIII Semester
10-06-2019 to 16-07-2019	Theory Exams of IV/VI/VIII Semester
10-06-2019 & 11-06-2019	Lab Internal Assessment of II Sem.
11-06-2019 to 17-06-2019	Project Viva-Voce of VIII Sem.
13-06-2019 to 15-06-2019	Third Internal Assessment of II Sem.
17-06-2019	Last Working Day of II Semester
19-06-2019 to 29-06-2019	Practical Exams of II Semester
01-07-2019 to 16-07-2019	Theory Exams of II Semester

February-2019

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

March-2019

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

04- Maha Shivaratri 05- Maha Dasoha 21- Holi

April-2019

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

06- Chandraman Ugadi 14-Dr. B. R. Ambedkar Jayanti 17-Mahaveer Jayanti 19-Good Friday

May-2019

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

01- Labours Day

June -2019

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

05- Qutub-E-Ramazan

Coordinator H.O.D. 9.2.19 Principal 9/2/19

5.1 Scheme of Teaching & Examination
VI SEMESTER

VI SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EE61	Core Subject	Control Systems	EEE	04	--	03	80	20	100	4
2	15EE62	Core Subject	Power System Analysis – 1	EEE	04	--	03	80	20	100	4
3	15EE63	Core Subject	Digital Signal Processing	EEE	04	--	03	80	20	100	4
4	15EE64	Core Subject	Electrical Machine Design	EEE	04	--	03	80	20	100	4
5	15EE65X	Professional Elective	Professional Elective – II	EEE	03	--	03	80	20	100	3
6	15EE66Y	Open Elective	Open Elective - II	EEE	03	--	03	80	20	100	3
7	15EEL67	Laboratory	Control System Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
8	15EEL68	Laboratory	Digital Signal Processing Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
				TOTAL	Theory:22 hours Practical: 06 hours		24	160	640	800	26

Elective

Professional Elective		Open Elective*** Offered by the Department of Electrical and Electronics Engineering	
Courses under Code 15EE65X	Title	Courses under Code 15EE66Y	Title
15EE651	Computer Aided Electrical Drawing	15EE661	Artificial Neural Networks and Fuzzy logic
15EE652	Advanced Power Electronics	15EE662	Sensors and Transducers
15EE653	Energy Audit and Demand side Management	15EE663	Batteries and Fuel Cells for Commercial, Military and Space Applications
15EE654	Solar and Wind Energy	15EE664	Industrial Servo Control Systems

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided;

- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Electives relevant to chosen specialization/ branch.

3. Open Elective: Electives from other technical and/ or emerging subject areas.

Subject Title	**CONTROL SYSTEM**		
Subject Code	15EE61	**IA Marks**	20
Number of Lecture Hrs /	04	**Exam Marks**	80
Total Number of Lecture	50	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. Keshav B. Negalur	**Designation:** Asst. Professor	**Experience:** 06
No. of times course taught: 05	**Specialization:** Industrial Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical &Electronics Engineering	VII	Basic Electrical Engineering
02	Electrical &Electronics Engineering	I/II	Basic Electronics Engineering
03	Electrical &Electronics Engineering	III	Analog Electronic Circuits

2.0 Course Objectives

- To define a control system.
- To explain the necessity of feedback and types of feedback control systems.
- To introduce the concept of transfer function and its application to the modeling of linear systems.
- To discuss the stability of linear time invariant systems and Routh - Hurwitz criterion.
- To obtain transfer function of systems through block diagram manipulation and reduction.
- To use Mason's gain formula for finding transfer function of a system.
- To demonstrate mathematical modeling of control systems, components and to develop design criteria for manipulating the time response in terms of time domain response specification.
- To discuss transient and steady state time response of a simple control system.
- To investigate the trajectories of the roots of the characteristic equation when a system parameter is varied.
- To conduct the control system analysis in the frequency domain.
- To determine the controller or compensator configuration and parameter values relative to how it is connected to the controlled process given the design specifications.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to draw and use modeling software's to generate

	Course Outcome	Cognitive Level	POs
CO1	Discuss the effects of feedback and types of feedback control systems	L1,L2,L3,L4	1,2,5,9,10
CO2	Evaluate the transfer function of a linear time invariant system.	L1,L2,L3,L4	1,2,5,9,10
CO3	Evaluate the stability of linear time invariant systems.	L1,L2,L3,L4	1,2,5,9,10
CO4	Apply block diagram manipulation and signal flow graph methods to obtain transfer function of systems.	L1,L2,L3,L4	1,2,5,9,10
CO5	Demonstrate the knowledge of mathematical modeling of control systems and components.	L1,L2,L3,L4	1,2,5,9,10
CO6	Determine transient and steady state time response of a simple control system.	L1,L2,L3,L4,L5	1,2,5,9,10
CO7	Investigate the performance of a given system in time and frequency domains.	L1,L2,L3,L4,L5	1,2,5,9,10
CO8	Determine the controller or compensator configuration and parameter values relative to how it is connected to the controlled process given the design specifications.	L1,L2,L3,L4	1,2,5,9,10
	Total Hours of instruction	**50**	

4.0 Course Content

Module-1

Introduction to control systems: Introduction, classification of control systems.
Mathematical models of physical systems: Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains. **10 Hours**

Module-2

Block diagram: Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function.
Signal flow graphs: Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems. **10 Hours**

Module-3

Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems.
Routh Stability criterion: BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis. **10 Hours**

Module-4

Root locus technique: Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. Frequency Response analysis: Co-relation between time and frequency response – 2 nd order systems only.
Bode plots: Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin. **10 Hours**

Module-5

Nyquist plot: Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion.
Design of Control Systems: Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller **.** **10 Hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	M-Tech	Advance Control System	Observability, Controllability, State variables

6.0 Relevance to Real World

Sl No	Real World Mapping
01	Design of various components
02	Conduct investigations of complex Problems
03	Development of prototype models

7.0 Gap Analysis and Mitigation

Sl No	Delivery Type	Details
01	Tutorial	Introduction, Feedback, Mathematical Models, Modelling of Mechanical Systems, Electrical Analogies of Mechanical Systems, Block Diagrams etc
02	NPTEL	Control Engineering. The Control Problem· Different Kinds of Control Systems· History of Feedback · Modern Control Problems

8.0 Books Used and Recommended to Students

Text Books
1. Control Systems by Anand Kumar.
Reference Books
1. Automatic Control Systems by Farid Golnaraghi, Benjamin C. Kuo, Wiley , 9th Edition, 2010.

2. Control Systems Engineering by Norman S. Nise, 4th Edition, 2004.
3. Modern Control Systems by Richard C Dorf et al, Pearson, 11th Edition, 2008.
4. Control Systems, Principles and Design by M.Gopal , McGaw Hill, 4th Edition, 2012.
5. Control Systems Engineering by S. Salivahanan et al, Pearson, 1st Edition, 2015.

Additional Study material & e-Books

1. Control Engineering by Ganesh Rao and Chennavenkatesh, Pearson.

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
www.VSSUT.com , www.Smartzworld.ac.in, www. Scribd.com, www.NPTEL.com

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	IEEE Xplore: IEEE Control Systems Magazine	www.ieeexplore.ieee.org
2	Journal of Control Theory and Applications, Journal of Real-Time Image Processing etc	www.Springer.com

11.0 Examination Note

Internal Assessment: 20 Marks
Sketches shall be in sketch books and drawing shall through use of software on A3/A4 sheets. Sketch book and all the drawing printouts shall be submitted.

Scheme of Evaluation for Internal Assessment (20 Marks)
(a) Internal Assessment test in the same pattern as that of the main examination (best of the two Tests): 20marks.

SCHEME OF EXAMINATION:
Two questions to be set from each module.
Student has to answer one question each from all the modules.
18marks x 5 modules = 80Marks

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
UNIT 1	1	Introduction	20
	2	Classification of control systems	
	3	Modelling of mechanical system elements	
	4	Electrical systems	
	5	Analogous systems	
	6	Transfer function	
	7	Single input single output systems	
	8	Procedure for deriving transfer functions	

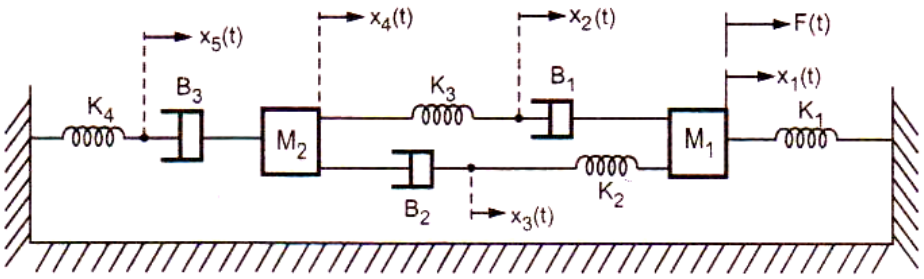
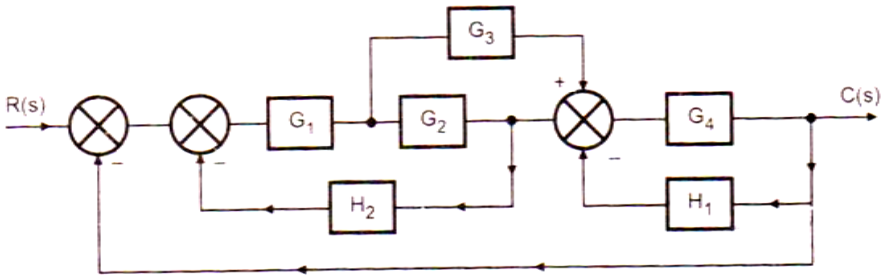
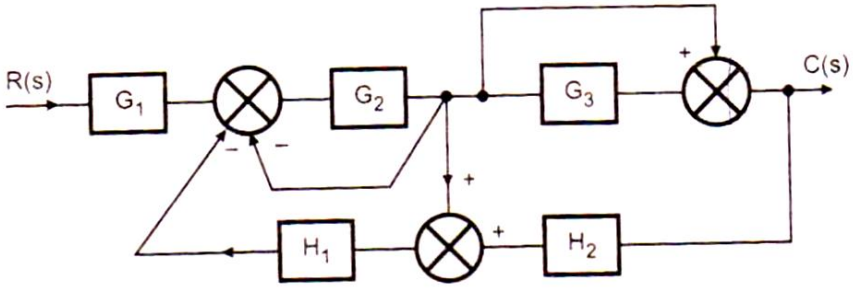
	9	Servomotors, synchros	
	10	Gear trains	
UNIT 2	11	Block diagram of a closed loop system,	20
	12	procedure for drawing block diagram	
	13	Block diagram reduction problems	
	14	Block diagram reduction to find transfer function	
	15	Construction of signal flow graphs	
	16	Basic properties of signal flow graph	
	17	Signal flow graph algebra	
	18	construction of signal flow graph for control systems	
	19	Problems	
	20	Problems	
UNIT 3	21	Standard test signals	20
	22	Time response of first order systems	
	23	Time response of second order systems	
	24	Steady state errors	
	25	Error constants	
	26	Types of control systems	
	27	Routh Stability criterion: BIBO stability	
	28	Necessary conditions for stability, Routh stability criterion	
	29	Difficulties in formulation of Routh table	
	30	Application of Routh stability criterion to linear feedback systems, relative stability analysis	
UNIT 4	31	Introduction	20
	32	Root locus concepts	
	33	Construction of root loci	
	34	Rules for the construction of root locu	
	35	Frequency Response analysis: Co-relation between time and frequency response – 2 nd order systems only	
	36	Bode plots introduction	
	37	Bode plots: Basic factors G(iw)/H(jw	
	38	General procedure for constructing bode plots	
	39	computation of gain margin	
	40	computation of phase margin	
UNIT 5	41	Nyquist plot: Principle of argument	20
	42	Nyquist stability criterion	
	43 & 44	Assessment of relative stability using Nyquist criterion	
	45 & 46	Design of Control Systems: Introduction	
	47	Design with the PD Controller, Design with the PI Controller	
	48	Design with the PID Controller, Design with Phase-Lead Controller	
	49 & 50	Design with Phase - Lag Controller, Design with Lead-Lag Controller	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Questions on module 1	Students study the Topics and write the Answers. Get practice to solve questions.	Module 1 of the syllabus	3	Individual Activity.	Anand Kumar
2	Assignment 2: Questions on module 2	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	5	Individual Activity.	Anand Kumar
3	Assignment 3: Questions on module 3	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	8	Individual Activity.	Anand Kumar
4	Assignment 4: Questions on module 4	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	10	Individual Activity.	Anand Kumar
5	Assignment 5: Questions on module 5	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	12	Individual Activity.	Anand Kumar

14.0 Assignment Questions

Assignment No	Questions	Marks
I	1) Define and compare open loop control systems with closed loop control system, with examples. 2) For the system shown in Fig Q1.a Write the equations of performance and draw its analogous circuit based on force voltage analogy.	5marks 5marks

		
II	1) Determine the transfer function C(s)/R(s) of the system shown below by block diagram reduction method.  2) Find the overall Transfer function C(s)/R(s) using Block diagram reduction method. 	5marks 5marks
III	1. Define the following for an under damped second order system. a) Rise Time b) Peak overshoot c) Settling Time. 2. Define steady state error coefficients. 3. Using R H Criterion determine the stability of the system having the characteristics equation a) $S^6+2S^5+5S^4+8S^3+8S^2+8S+4=0$ b) $S^6+3S^5+4S^4+S^3+5S^2+3S+2=0$	5marks 5marks 5marks
IV	1. Define root locus. 2. Explain the steps to obtain root loci graph. 3. Obtain Transfer Function K/(s+5)(s+10) 4. Define the following term a)Gain margin b)Phase margin c) Gain crossover frequency d) Phase crossover frequency	5marks 5marks 5marks 5marks
V	1. Find the GM and PM for negative feedback control system having	5marks

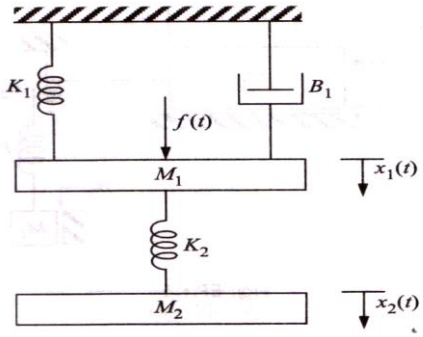
	open loop TF G(s)H(s)=6 /(s^2+2s+2)(s+2) 2. State and explain Nyquist stability criterion.	5marks

15.0 QUESTION BANK

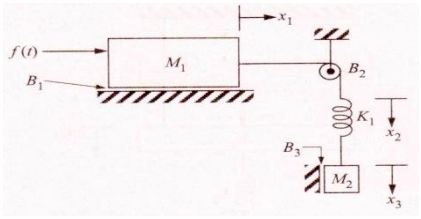
MODULE 1

1) Define and compare open loop control systems with closed loop control system, with examples.

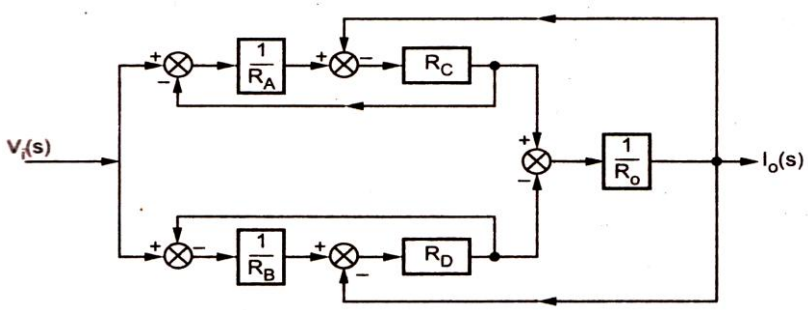
2) For the system shown in Fig. Write the equations of performance and draw its analogous circuit based on force voltage analogy.



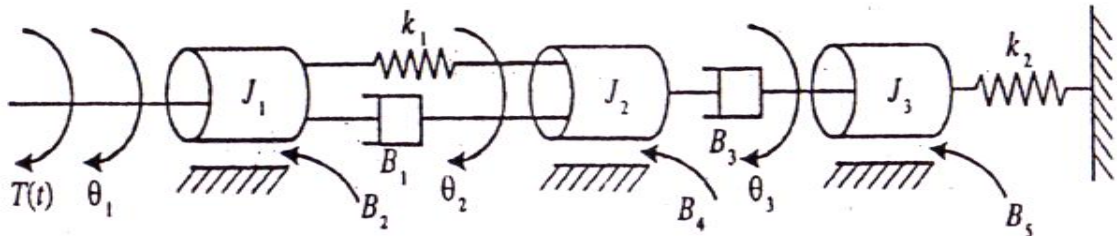
3) For the system shown in Fig. Write the equations of performance and draw its analogous circuit based on force current.



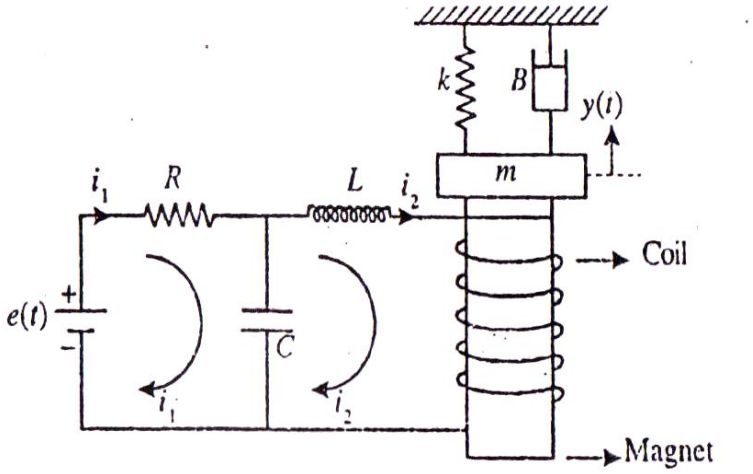
4) For the system shown in Fig. below determine $I_0(s)/V_i(s)$ by block diagram reduction technique.



5) For the system shown in Fig. Write the equations of performance and draw its analogous circuit based on force voltage .



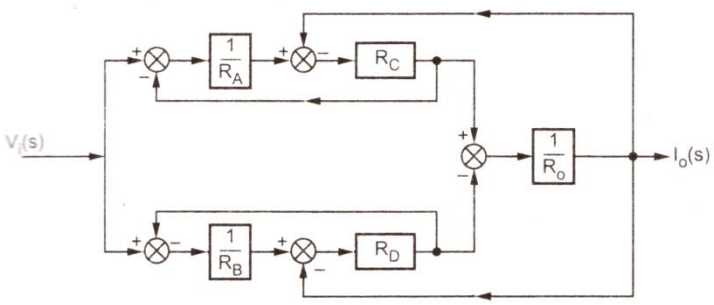
6) For the system shown in Fig. Write the equations of performance and draw its analogous circuit based on force voltage.



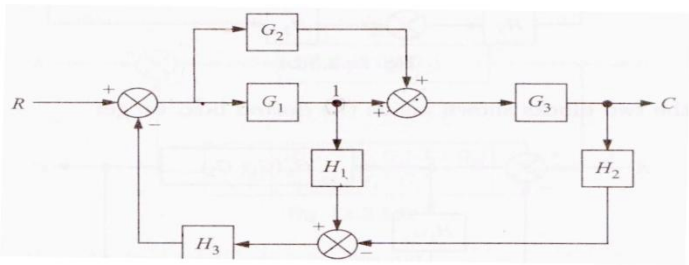
7) Obtain the transfer function of an armature controlled DC servomotor.
8) Mention merits and demerits of open loop and closed loop control systems and give an example for each.

MODULE 2

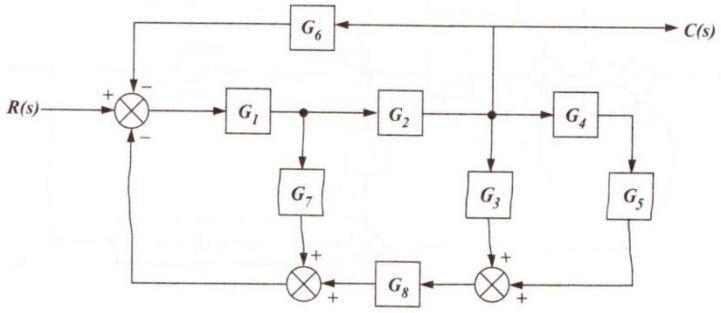
1) Determine the transfer function C(s)/R(s) of the system shown below by block diagram reduction method.



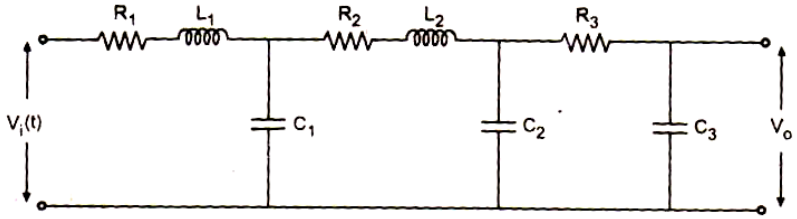
2) Determine the transfer function C(s)/R(s) of the system shown below by block diagram reduction method.



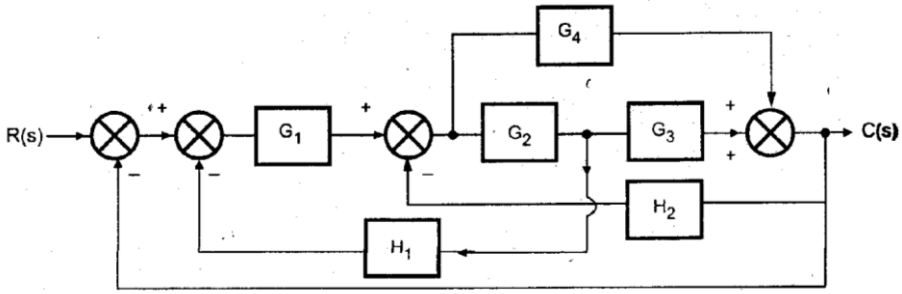
3) Determine the transfer function C(s)/R(s) of the system shown below by block diagram reduction method.



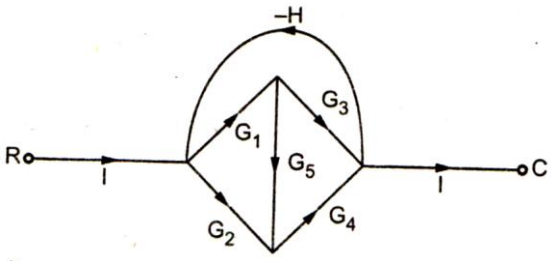
4) Discuss rule of block reduction technique in detail.
5) Draw a block diagram to describe the electrical circuit given in the Fig.



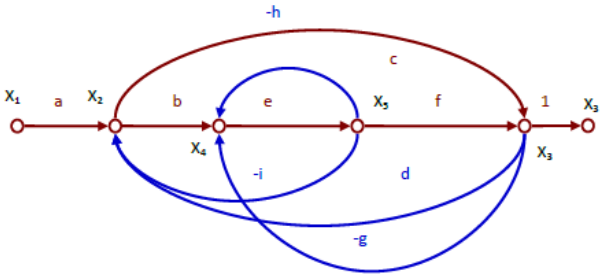
6) Obtain the overall transfer function for the block diagram shown below by the block diagram reduction technique.



7) Obtain MGF.



8) For the system described by the signal flow graph shown in fig, obtain the closed loop transfer function C(s) / R(s) , using Mason's gain formula.



MODULE 3

1) Define the following for an under damped second order system.
   a) Rise Time b) Peak overshoot c) Settling Time.
2) Define the following terms
   a) Transient response b) steady state response.

3) Derive the expression for peak time.

4) The loop transfer function of transfer function is given by
   i) Determine the static error coefficients
   ii) Determine steady state error coefficients for the input $r(t) = 2t^2 + 5t + 10$

$$G(s)H(s) = \frac{100}{s^2(s+4)(s+12)}$$

5) Derive expressions for peak response time t_p and maximum overshoot M_p of an under damped second order control system subjected to step input
6) For a unity feedback control system with $G(s) = 10(S+2) / S^2(S+1)$. Find
   i) The static error coefficients
   ii) Steady state error when the input transform is

$$R(s) = \frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^2}$$

7) Explain Routh-Hurwitz's criterion for determining the stability of a system and mention any three limitations of R-H criterion.
8) Define: i) Marginally stable systems; ii) absolutely stable system; iii) conditionally stable systems.

MODULE 4

1) Sketch the root locus for a unity feedback control system with open loop transfer function:

$$G(s) = \frac{K}{s(s+6s+25)}$$

2) The open loop transfer function of a feedback control system in

$$G(s)H(s) = \frac{K}{(s+1)(s+2)(s+3)}$$

Check whether the following points are on the root locus. If so, find the value of K at these

points, i) S = -1.5 ii) S = -0.5 + j2.

3) Sketch the root locus plot for a negative feedback control system characterized by an open loop transfer function, Comment on stability.

$$G(s)H(s) = \frac{K}{s(s+3)(s^2+3s+11.2s)}$$

4) Define brake away / in point on a root locus. Explain any one method of determining the same.
5) State the advantages and limitations of frequency domain approach.
6) Determine the transfer function, of a system whose asyptotic gain plot is shown in fig.

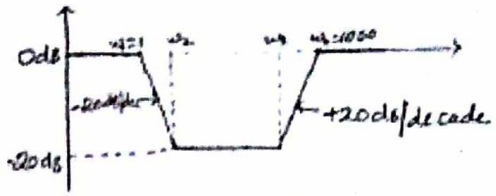


Fig. Q6 (b)

7) List the effects of lead compensation.

MODULE 5

1) Explain Nyquist's stability criterion.
2) What is Proportional controller and what are its advantages?
3) What is the drawback in P-controller?
4) What is integral control action?
5) What is the advantage and disadvantage in integral controller?
6) What is PI controller?
7) What is PD controller?
8) What is PID controller?

16.0 University Result

Examination	FCD	FC	SC	% Passing
2017-18	--	--	--	97.87
2015-16	--	01	47	90.16
2014-15	05	07	48	89.55

Prepared by	Checked by		
31/01		31.1.19	
Shri. Keshav B Negalur	Shri. S B Patil	HOD	Principal

Subject Title	**POWER SYSTEM ANALYSIS-1**		
Subject Code	15EE62	**IA Marks**	25
Number of Lecture Hrs / Week	04	**Exam Marks**	100
Total Number of Lecture Hrs	50	**Exam Hours**	03

FACULTY DETAILS:		
Name: Prof. Pramod Murari	**Designation:** Asst.Professor	**Experience:** 08
No. of times course taught: 08	**Specialization:** Power Systems & Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engg	III	EPG
02	Electrical and Electronics Engg	V	TD

2.0 Course Objectives

- To introduce the per unit system and explain its advantages and computation.
- To explain the concept of one line diagram and its implementation in problems.
- To explain the necessity and conduction of short circuit analysis.
- To explain analysis of three phase symmetrical faults on synchronous machine and simple power systems.
- To discuss selection of circuit breaker.
- To explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits.
- To explain the concept of sequence impedance and its analysis in three phase unbalanced circuits.
- To explain the concept of sequence networks and sequence impedances of an unloaded synchronous generator, transformers and transmission lines.
- To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- To discuss the dynamics of synchronous machine and derive the power angle equation for a synchronous machine
- Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system.

3.0 Course Outcomes

Having successfully completed this course, the student will be able to,

	Course Outcome	Cognitive Level	Pos
C316.1	Model the power system components & construct per unit impedance diagram of power system.	L1,L2,L3, L4	1,2,6,8
C316.2	Analyze three phase symmetrical faults on power system.	L1,L2,L3, L4	1,2,6,8
C316.3	Analyze various unsymmetrical faults on power system using symmetrical components & sequence networks.	L1,L2,L3, L4,L5	1,2,6,8
C316.4	Determine power system stability.	L1,L2,L3, L4	1,2,6,8
Total Hours of instruction		**50**	

4.0 Course Content

Module-1

Representation of Power System Components : Introduction, Single-phase Representation of Balanced Three Phase Networks, One-Line Diagram and Impedance or Reactance Diagram, Per Unit (PU) System,Steady State Model of Synchronous Machine, Power Transformer, Transmission of electrical Power, Representation of Loads .**10 Hours Revised Bloom's Taxonomy Level** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing.

Module-2

Symmetrical Fault Analysis: Introduction, Transient on a Transmission Line, Short Circuit of a Synchronous Machine(On No Load), Short Circuit of a Loaded Synchronous Machine, Selection of Circuit Breakers.**10 Hours. Revised Bloom's Taxonomy Level** L1 – Remembering, L2 – Understanding. L3 – Applying, L4 – Analysing.

Module-3

Symmetrical Components: Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta Transformers, Sequence Impedances of Transmission Lines , Sequence Impedances and Sequence Network of Power System, Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines , Sequence Impedances and Networks of Transformers , Construction of Sequence Networks ofa Power System, Measurement of sequence Impedance of Synchronous Generator.**10 Hours. Revised Bloom's Taxonomy Level** L2 – Understanding, L3 – Applying, L4 – Analysing, L5-Evaluating

Module-4

Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line- To-Ground (LLG) Fault, Open Conductor Faults .**10Hours. Revised Bloom's Taxonomy Level** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing.

Module-5

Power System Stability: Introduction, Dynamics of a Synchronous Machine, Power Angle Equation Salient and Non – Salient pole Synchronous Machines , Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability.**10 Hours. Revised Bloom's Taxonomy Level** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing.

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII	Computer techniques in power system analysis	All
02	VII	Power system simulation lab	Swing curve, power angle curve, fault analysis
03	VIII	Power system operation & control	All

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Power system modeling
02	Analyze power system stability
03	Fault analysis of power system by software tools.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical	Doing fault analysis using mi-power simulation & obtaining power angle curve using MATLAB.

8.0 Books Used and Recommended to Students

Text Books
Textbook 1. Modern Power System D. P. Kothari McGraw Hill 4th Edition,2011
Reference Books
ReferenceBooks 1 Elements of Power System William D.StevensonJr McGraw Hill 4th Edition, 1982 2 Power System Analysis and Design J.Duncan Glover et al Cengage 4th Edition, 2008 3 Power System Analysis Hadi Sadat McGraw Hill 1st Edition, 2002
Additional Study material & e-Books
1. Power system analysis and stability by V. Neelakantan
2. http://ebookkdownload.blogspot.in/search/label/Electrical%20Engineering

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) http://www.power-eng.com/index.html
2) http://www.ieee-pes.org/
3) http://www.electricalsolutions.net.au/content/efficiency-renewables/article/emergency-lighting-an-essential-service-783180538
4) http://www.edisontechcenter.org/LauffenFrankfurt.html

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	IEEE Transactions on power system	http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=59
2	IEEE power engineering review	http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=39
3	Power and Energy technology systems journal	http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=6687318

11.0 Examination Note

Question paper pattern IA exam: Conducted for 25Marks and reduced to 15marks + assignment is for 5 marks
Answer two full questions Q1a,Q1b OR Q2a,Q2b and Q3a,Q3b OR Q4a,Q4b (13 or 12 marks).
Question paper pattern Main exam:
The question paper will have ten questions. Each full question is for 16 marks. There will be 2 full questions (with a maximum of four sub questions in one full question) from each module. Each full question with sub questions will cover the contents under a module. Students will have to answer 5 full questions, selecting one full question from each module.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecture	% of Portion
I	1.	**Representation of Power System Components :** Introduction,	20
	2.	Single-phase Representation of Balanced Three Phase Networks,	
	3.	One-Line Diagram and Impedance or Reactance Diagram,	
	4.	Per Unit (PU) System, Steady State Model of Synchronous Machine,	
	5.	Power Transformer, Transmission of electrical Power, Representation of Loads .	
	6.	Numerical	
	7.	Numerical	
	8.	Numerical	
	9.	Numerical	
	10.	Numerical	
II	11.	**Symmetrical Fault Analysis:** Introduction,	20
	12.	Transient on a Transmission Line,	
	13.	Short Circuit of a Synchronous Machine(On No Load),	
	14.	Short Circuit of a Loaded Synchronous Machine,	
	15.	Selection of Circuit Breakers.	
	16.	Numerical	
	17.	Numerical	
	18.	Numerical	
	19.	Numerical	

	20.	Numerical	
III	21.	**Symmetrical Components:** Introduction,	**20**
	22.	Symmetrical Component Transformation,	
	23.	Phase Shift in Star-Delta Transformers,	
	24.	Sequence Impedances of Transmission Lines , Sequence Impedances and Sequence Network of Power System,	
	25.	Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines , Sequence Impedances and Networks of Transformers ,	
	26.	Construction of Sequence Networks of a Power System, Measurement of sequence Impedance of Synchronous Generator.	
	27.	Numerical	
	28.	Numerical	
	29.	Numerical	
	30.	Numerical	
IV	31.	**Unsymmetrical Fault Analysis:** Introduction, Symmetrical Component Analysis of Unsymmetrical Faults,	**20**
	32.	Single Line-To-Ground (LG) Fault,	
	33.	Line-To-Line (LL) Fault,	
	34.	Double Line- To-Ground (LLG) Fault,	
	35.	Open Conductor Faults	
	36.	Numerical	
	37.	Numerical	
	38.	Numerical	
	39.	Numerical	
	40.	Numerical	
V	41.	**Power System Stability:** Introduction,	**20**
	42.	Dynamics of a Synchronous Machine,	
	43.	Power Angle Equation Salient and Non – Salient pole Synchronous Machines , Simple Systems,	
	44.	Steady State Stability, Transient Stability,	
	45.	Equal Area Criterion,	
	46.	Factors Affecting Transient Stability.	
	47.	Numerical	
	48.	Numerical	
	49.	Numerical	
	50.	Numerical	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: Model Questions on modeling of PS	Students do power system modeling & get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity. Written solution expected.	Text Book 1, additional reference 1,2
2	Assignment 2: Model Questions on 3phase symmetrical faults	Students study 3ph-symmetrical faults & get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity. Written solution expected.	Text Book 1, additional reference 1,2
3	Assignment 3: Model Questions on sequence impedances	Students learn to use sequence impedances & networks, get	Module 3 of the syllabus	6	Individual Activity. Written solution expected.	Text Book 1, additional reference 1,2

	and networks	practice to solve university questions.				
4	Assignment 4: Model Questions on unsymmetrical problems	Students study the unsymmetrical faults & get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity. Written solution expected.	Text Book 1, additional reference 1,2
5	Assignment 5: Model Questions stability	Students learn stability of PS & get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity. Printed solution expected.	Text Book 1, additional reference 1,2

14.0 Assignment Questions

Assignment No	Questions	Marks
I	Q1.What is reactance diagram? Q2.What is Per Unit of a quantity? Illustrate by example. Q3.Show that Per Unit impedance of a transformer is same on either side of it. Q4. Explain change of base quantities. Q5.Write the advantages of per unit computations.	5marks each
II	Q1.Show that the subtransient reactance of the synchronous machine is the smallest and the steady state reactance of the machine is highest among all the reactance's. i.e $X"_d < X_d' < X_d$ Q2. Write about selection of circuit breakers. Q3. Write about transients on a transmission line due to short circuit. Q4. Explain the analysis of three-phase symmetrical faults by Kirchoffs laws Q5. Explain symmetrical fault analysis by Thevenin's Theorem.	5marks each
III	Q1.With the help of relevant vector diagrams for voltages establish the phase shift of symmetrical components in Y-Δ transformer bank. Q2.Derive an expression for the 3Φ complex power in terms of symmetrical components. Q3.What are symmetrical components? How they are useful in solution of power system. Q4.What are sequence impedances and sequence networks? Q5.Draw the zero sequence networks for various winding configurations of transformer.	5marks each
IV	Q1.Derive an expression for fault current for LG fault on terminals of synchronous machine without Zf. Q2.Derive an expression for fault current for LL fault on terminals of synchronous machine without Zf. Q3.Derive an expression for fault current for LLG fault on terminals of synchronous machine with Zf. Q4.Derive an expression for fault current for LG fault on Power system. Q5. Write a note on open conductor faults on Power system.	5marks each
V	Q1.Derive an expression for the swing equation. Q2.Explain the terms: 1) Steady state stability ii) Transient stability and iii) dynamic stability as applied to power systems. Q3.Derive a power angle equation for a non salient pole machine. Q4.Explain the equal area criteria. Q5.Discuss the methods of improving transient stability	5marks each

15.0 QUESTION BANK

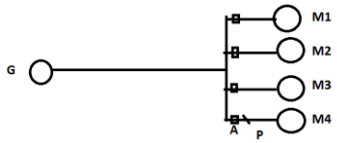
Module I (Representation of power system components)

1. What is single line diagram? Hence, explain the procedure of finding reactance diagrams, by listing all the assumptions individual.
2. Define per unit quality. Mention the advantages of P.U system.
3. Show that per unit impedance of a transformer remains same on both primary & secondary sides.
4. State the rule of inspection for finding bus admittance matrix, giving the expression for the matrix elements. Also indicate the situations where in this rule is not applicable.

5. A 300 MVA,20KV 3-phase generator has a sub-transient reactance of 20%. The generator supplies two synchronous motors over a transmission line 64Km long. The rated input to the motor are 200MVA,& 100MVA respectively. The motors have a sub-transient reactance of 20%each. The 3-phase transformer T1 is rated 350MVA, 230Y/20Δ KV with leakage reactance of 10%. The transformer T2 is composed of three, 1-phase transformers connected as 3-phase, Y-Δ bank & each rated 100MVA, 127/13.2KV with leakage reactance of 20% each. The reactance of transmission line is 0.5Ω/Km. Draw the P.U. reactance diagram of the power system, selecting the generator rating as base in the generator circuit. If the motors M1 &M2 have outputs of 120MW &60MW respectively at 13.2 KV & both operating at u.p.f. find the voltage at the terminals of the generator.

Module II (Symmetrical fault analysis)

1. With the help of oscillagrams of short circuit current, of a synchronous generator, operating on no load, distinguish between sub-transient, transient & steady state periods. Also write the corresponding equivalent circuits, which are used in computing X_d", X_d' & X_d.
2. Explain why with reference to a synchronous machine, Xd"< Xd' < Xd with usual rotations.
3. Write a note on the selection of circuit breakers.
4. A 25MVA, 11Kv generator with Xd"=20% is connected through a transformer, line & a transformer to a bus. The load at bus consists of 3 motors each having Xd"=25% & Xd'=30% on a base of 5MVA, 6.6Kv. Transformer T1 is rated 25MVA,11/66kv with a leakage reactance of 10% & transformer T2 is rated 25MVA, 66/6.6KV with a leakage reactance of 10%. The bus voltage at the motor is 6.6kv. When a 3-phase fault occurs at F for the specified fault



Compute:
   i) subtransient current in the fault
   ii) subtransient current in the breaker B
   iii) current to be interrupted by the breaker B in five cycles

5. A synchronous generator and motor are rated 30MVA, 13.2 kV and both have subtransient reactance of 20%. The line connecting them has a reactance of 10% on the base of the machine ratings. The motor drawing 20MW at 0.8 p.f leading and a terminal voltage of 12.8kV, when a symmetrical three phase fault occurs at the motor terminals. Find the subtransient current in the generator, motor and the fault by using internal voltages of the machines.

Module III (Symmetrical Components)

1. Explain what symmetrical components are & how they are useful in solving the power system problems.
2. Write brief note on the significance of the operator "a".
3. Establishing the relation $I_n = 3I_{ao}$ with usual notations.
4. Prove that zero sequence component of currents only, flow through neutral.
5. Show that the symmetrical component transformation is power invariant.
6. Discuss on the phase shift of currents or voltages in Y- Δ transformers.
7. Define sequence impedances & sequence networks. Hence, indicate the zero sequence diagrams for various primary & secondary winding connection of a 3- ø transformer.
8. Show that positive, negative sequence voltages & currents undergo a phase shift, in passing through Y-Δ transformer & the phase shift is dependent on labeling of terminals.
9. Three identical resistors are star connected. The magnitude of the voltage at the terminals are Vab=200v, Vbc=290v, Vca=250v. Determine the sequence components of line to neutral voltage of phase 'a'.
10. The sequence components of the line to neutral voltage of a 3-phase system are, Va1=100<0, Vb2=(10-j15)v, Vco=j15v. Determine line to neutral voltages.

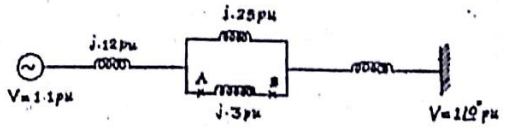
Module IV (Unsymmetrical fault analysis)

1. Write a note on the significance of unsymmetrical fault analysis by symmetrical component transformation.
2. Define sequence impedances & sequence networks. Hence, indicate the zero sequence diagrams for various primary & secondary winding connection of a 3-ø transformer.
3. A single L-G fault occurs on phase 'a of an unloaded synchronous generator. Derive an expression for the fault current & for the post fault line to line voltages. Also prove that the equivalent circuit under fault conditions comprises of +ve, -ve & zero sequence networks in series.

4. Derive an expression for the fault current in terms of the sequence impedances & hence arrive at the connection diagram of sequence networks for a L-L fault at the terminals of a star connected generator.
5. A double line to ground fault occurs at the terminals of unloaded generator. Derive an expression for the fault currents, draw the connection of sequence networks.
6. A synchronous generator has its neutral ground through a reactance Xn. Zero sequence reactance of the generator is larger that the +ve & -ve sequence reactances.
   i) shows that if the neutral is grounded solidly, SLCE fault current would be more that the 3-o fault current.
   ii) Obtain expression for Xn such that SLG fault current is less than the 3-o fault current.
7. Derive the expression for fault current if
   i) LG ii) LL iii) DLG
   fault occurs through a fault impedance Zf in a power system. Show the connections of sequence network to represent the fault.
8. Write a note on open conductor faults in power system.
9. A 30MVA, 13.8Kv alternator has Xd"=15%, X2=15%, Xo=5%. The alternator supplies two motors over a transmission line having transformers at both ends. The motors have rated inputs of 20MVA & 10MVA. Both 12.5Kv with 20% sub-transient reactance & X2=20%, & Xo=5%. The current limiting reactors of 2.0 Ω each are in the neutral of the alternator & the larger motor. The 3-phase transformers are both rated 35MVA, 13.2Δ/115Y Kv, with leakage reactance of 10% Series reactance of line is 80 Ω The zero sequence reactance of line is 200 Ω. Determine the fault current when i)L-G fault ii)L-L fault & iii)L-L-G fault takes place at point P on transmission line near transformer T1. Assume Vpf=1Kv.

ModuleV (Power system stability)

1. Define inertia constant M&H for a synchronous machine. How they relate to each other?
2. What are the assumptions made in stability studies? How do you justify them?
3. Distinguish between steady state stability limit &transient limit.
4. Derive the power angle equation of a salient pole synchronous machine connected to an infinite bus. Draw the power angle curve.
5. Derive swing equation with usual notations.
6. Write a note on equal area criterion of stability.
7. A 4pole , 50 Hz 60 MW 0.8pf lag generator with a moment of inertia 30000kg-m2 is connected through a short line to another 2 pole, 50 Hz, 80MW, 0.85pf lag generator with moment of inertia 10000kg-m2. Determine the inertia constant of the equivalent single machine on a base of 20 MVA.
8. Determine the critical clearing angle for the network shown in fig, when a 3-phase fault takes place at B and the breaker at A and B operate simultaneously. The generator is delivering 1 pu power before fault takes place. Assume the inertia constant H=4.0



9. An a.c. generator is delivering 50% of maximum power to an infinite bus . Due to a sudden short circuit, the reactance between generator & infinite bus increases to 300% of the value before fault. The maximum power that can be delivered after clearance of fault is 70% of the original maximum value. Calculate the critical clearing angle to maintain the stability of the system.

16.0 University Result

Examination	Appeared	Passed	% Passing
May/June 2018	47	45	95.74

Prepared by	Checked by		
31.1.19	31.1.19	31.1.19	
Prof.Pramod Murari	Prof.H R Zinage	HOD	Principal

Subject Title	**DIGITAL SIGNAL PROCESSING**		
Subject Code	15EE63	**IA Marks**	20
Number of Lecture Hrs /	04 L	**Exam Marks**	80
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. V. B. Dhere	**Designation:** Asst.Professor	**Experience:** 21years
No. of times course taught:01	**Specialization:** Electronics and Telecommunication	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	V	Signals and Systems
02	Electrical and Electronics Engineering	V	Linear IC's and applications

2.0 Course Objectives

1. To develop the knowledge on signals used in digital signal processing.
2. To introduce signals, systems, time and frequency domain concepts and the associated mathematical tools those are fundamental to all DSP techniques.
3. To provide a thorough understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.
4. To study various sampling techniques and different types of filters

3.0 Course Outcomes

The student, after successful completion of the course, will be able to:

	Course Outcome	Cognitive Level	POs
C317.1	Evaluate the DFT of various signals using its properties and linear filtering of two sequences.	L2,	PO1,PO2, PO3,PO5
C317.2	Apply fast and efficient algorithms for computing DFT and inverse DFT of a given sequence.	L3	PO1,PO2, PO3,PO5
C317.3	Design digital IIR filters by using different transformation techniques.	L5	PO1,PO2, PO3,PO5
C317.4	Design digital FIR filters using different sampling techniques.	L5	PO1,PO2, PO3,PO5
C317.5	Model digital filters using different realization methods.	L5	PO1,PO2, PO3,PO5
Total Hours of instruction		**50**	

4.0 Course Content

Module-1

Discrete Fourier Transforms: Definitions, properties-linearity, shift, symmetryProperties- circular convolution – periodic convolution, use of tabular arrays,circular arrays, Stock ham's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods**.** **10 Hours**

Module-2

Fast Fourier Transforms Algorithms : Introduction, decimation in time algorithm, first decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithms, Inverse radix – 2 algorithms. **12 Hours**

Module-3

Design of IIR Digital Filters: Introduction, impulse invariant transformation, bilinear transformations, All pole analog filters - Butterworth & Chebyshev filters, design of digital Butterworth filter by impulse invariant transformation and bilinear transformation, Frequency transformations. **12 Hours**

Module-4

Design of IIR Digital Filters (Continued): Design of digital Chebyshev –type 1filter by impulse invariant transformation and bilinear transformation, Frequency transformations.

Realization of IIR digital systems: direct form, cascade form and parallel form, Ladder structures for equal degree polynomial. **10 Hours**

Module-5

Design of FIR Digital Filters: Introduction, windowing, rectangular, modified rectangular. Hamming, Hanning, Blackman window, design of FIR digital filters by use of windows, Design of FIR digital filters-frequency sampling techniques.

Realization of FIR systems: direct form, cascade form, linear phase form. **10 Hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Automation

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Digital photo cameras, MP3 players to automobiles.
02	Speech processing, image processing
03	Applications of audio processing

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Lettering, Line, Methods of dimensioning
02	NPTEL	Assembly Application

8.0 Books Used and Recommended to Students

Text Books
1. Introduction to Digital Signal Processing, Jhonny R. Jhonson, Pearson, 1st Edition, 2016.
Reference Books
1. Digital Signal Processing – Principles, Algorithms, and Applications, Jhon G. Proakis, Dimitris G. Manolakis Pearson 4th Edition, 2007. 2. Digital Signal Processing A.NagoorKani McGraw Hill, 2nd Edition, 2012. 3. Digital Signal Processing, Shaila D. Apte, Wiley ,2nd Edition, 2009, 4. Digital Signal Processing, Ashok Amberdar, Cengage, 1stEdition, 2007 5. Digital Signal Processing Tarun Kumar Rawat Oxford 1st Edition, 2015
Additional Study material & e-Books
1) P.Ramesh Babu"Digital Signal Processing", Sitech publication 2003 2) "Digital Signal Processing" A Simplified approach by Dr. D Ganesh Rao & V P Gejji

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) https://www.tutorialspoint.com/digital_signal_processing/index.html

2) www.bores.com/courses/intro/basics/1_whatis.html

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Elsvier Journal	https://www.journals.elsevier.com/digital-signal-processing/
2	ICGST Journal of Digital signal processing	http://www.icgst.com/journals/journal.aspx?subid=45
3	International Journal of Advancements in Digital Signal Processing	http://journals.theired.org/ijdsp.html
4	Science Direct	http://www.sciencedirect.com/science/journal/10512004

11.0 Examination Note

Internal Assessment: 20Marks (15 Marks Internal Assessment + 5 Marks Assignment) :
Internal Assessment is conducted for 25 Marks and is scaled down to 15 Marks
Scheme of Evaluation for Internal Assessment (25 Marks)
Student has to answer two full questions as per the format shown below.

Q.1 a	13	Q.3 a	12
b		b	
OR		OR	
Q.2 a	13	Q.4 a	12
b		b	

SCHEME OF EXAMINATION (80 Marks):
- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1	1	Introduction, Definitions	20
	2	Properties-linearity, shift, symmetry etc	
	3	circular convolution – periodic convolution	
	4	Use of tabular arrays, circular arrays	
	5	Stock ham's methods- Examples	
	6	linear convolution – two finite duration sequence	
	7	one finite & one infinite duration with examples	
	8	overlap add methods with examples	
	10	overlap save methods with examples	
2	11	Introduction to Fast Fourier Transform algorithms	20
	12	Decimation in time algorithm with examples	
	13	Examples	
	14	first decomposition, number of computations	
	15	Examples	
	16	continuation of decomposition, number of multiplication	
	17	computational efficiency with examples	
	18	decimation in frequency algorithms with example	
	19	Inverse radix-2 algorithm.	
	20	Examples	
3	21	Introduction	20

	22	Impulse invariant transformation	
	23	Examples	
	24	Bilinear transformations	
	25	All pole analog filters - Butterworth & Chebyshev filters	
	26	design of digital Butterworth filter by impulse invariant transformation and bilinear transformation	
	27	Examples	
	28	Examples	
	29	Frequency transformations.	
	30	Examples	
4	31	Design of digital Chebyshev –type 1 filter by impulse invariant transformation and bilinear transformation	20
	32	Examples	
	33	Examples	
	34	Frequency transformations	
	35	Realization of IIR digital systems	
	36	direct form, cascade form and parallel form	
	37	Examples	
	38	Examples	
	39	Ladder structures for equal degree polynomial	
	40	Examples	
5	41	Design of FIR Digital Filters, Introduction	20
	42	windowing, rectangular, modified rectangular.	
	43	Hamming, Hanning, Blackman window	
	44	design of FIR digital filters by use of windows	
	45	Examples	
	46	Design of FIR digital filters-frequency sampling techniques	
	47	Examples	
	48	Realization of FIR systems: direct form, cascade form, linear phase form	
	49	Examples	
	50	Examples	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on Discrete fourier trasform properties, circular convolution, periodic convolution.	Students Understand how DFT and IDFT methods are used to implement Linear convolution	Module 1 of the syllabus	2	Individual Activity.	Book 1, 2 of the reference list.
2	Assignment 2: University Questions on DIF and DIT-FFT algorithms.	Students study the importance of Twiddle factor to reduce the DFT computations.	Module 2 of the syllabus	4	Individual Activity.	Book 1, 2 of the reference list.
3	Assignment 3: University Questions on Design of analog Butterworth low pass filter and Chebyshev lowpass filter	Students study the steps to design digital filter	Module 3 of the syllabus	6	Individual Activity.	Book 1 of the reference and additional reference list.
4	Assignment 4: University Questions	Students study the design of window based FIR filter.	Unit 4 of the syllabus	8	Individual Activity.	Book 1 of the reference and additional

	on design Of FIR digital filters					reference list.
5	Assignment 5: University Questions on Realization of IIR/FIR digital systems	Realization of IIR digital systems using direct form, cascade form and parallel form	Unit 4 and 5 of the syllabus	10	Individual Activity.	Book 1 of the reference and additional reference list.

14.0 QUESTION BANK

Module 1: Discrete Fourier Transforms

1) State and prove time shifting property of DFT.
2) Explain how the DFT can be used to compute N equispaced samples of the Z-transform of an N-point Sequence, on a circle of radius r.
3) Using Overlap-save method compute y (n) of a FIR filter with impulse response h (n) = {3, 2, 1} and input x(n)={2,1,-1,-2,-3,5,6,-1,2,0,2,1}.Use only 8 point circular convolution in your approach.
4) Compute circular convolution of two given sequences $x_1(n)=(2,1,2,1)$,$x_2(n)=(1,2,3,4)$using DFT and IDFT method.
5) For the given sequence $x_1(n) = \{1,2,3,1\}$,$x_2(n) = \{4,3,2,2\}$. Find $x_3(n)$ = such that $X3(k) = X_1(k).X_2(k)$.
6) Find $x_3(n)$ using DFT and IDFT method for the given $x_1(n) = \{1,1,2,1\}$, $x_2(n) = \{1,2,3,4\}$
7) Consider sequence $x_1(n) = \{0,1,2,3,4\}$,$x_2(n) = \{0,1,0,0,0\}$.Determine a sequence y(n) so that $Y(k) = X_1(k) . X_2(k)$
8) Find the 4 point circular convolution of the sequence $x_1(n) = \{1,2,3,1\}$,$x_2(n) = \{4,3,2,2\}$ using the time domain approach and verify the result using frequency domain approach**.**
9) Compute the 4 point DFT of the sequence x(n) = {1,0,1,0}.Also find y(n) if $Y(k) = X((k-2))_4$
10) Suppose that we are given a program to fin the DFT of a complex-valued sequence x(n). How can we use this program to find the inverse DFT of X(k).
11) Consider the sequence x1(n)= {0,1,2,3,4},x2(n) ={0,1,0,0,0},s(n)={1,0,0,0,0} and their point DFT's
    i) Determine a sequence y(n) so that y(k)=x1(k).x2(k)
    ii) Is there a sequence x3(n) such that s(k)=x1(k).x2(k)?
12) A long sequence x(n) is filtered though a filter the impulse response h(n) to yield the output y(n),if x(n) ={1,1,1,1,1,3,1,1,4,2,1,1,3,1},h(n)={1,-1}.Compute y(n) using overlap save techniques.
13) Compare linear convolution and circular convolution.
14) Compute the linear convolution of the sequences x1(n)={1,2,3,1} and x2(n)= {4,3,2,2} using circular convolution.
15) Define DFT. Derive the relationship of FT to i) the DTFT ii) the z transform.
16) A long sequence x(n) is filtered through a filter with impulse response h(n) to yield the output y(n). If h(n)=(1,2), x(n) =(1,4,3,0,7,4,-7,-7,-1,3,4,3), compute y(n), using the Overlap-add method. Use only a 5- point circular convolution.
17) Find DFT of a sequence x(n) = (1,1,0,0) and also find IDFT of Y(k) = (1,0,1,0).
18) State and Prove the Periodicity and Linearity property of DFT.
19) The two sequences $x_1(n)$ and $x_2(n)$ are given as follows $x_1(n)$ =(2,1,2,1) and $x_2(n)$ = (1,2,3,4). Find out sequence x3(n) which is equal to circular convolution of above two sequences $x_3(n) = x_1(n) \text{O} x_2(n)$. and verify the result using matrix multiplication method.
20) State and Prove Parseval's Theorem.
21) If x(n) = X(k) then show that $DFT[x((-n))_N] = X((-k))_N$
22) For the given sequence $x_1(n) = \{1,2,3,1\}$,$x_2(n) = \{4,3,2,2\}$. Find $x_3(n)$ = such that $X_3(k)= X_1(k).X_2(k)$
23) Compute the 4 point DFT of the sequence x(n) = {1,0,1,0}.Also find y(n) if $Y(k) = X((k-2))_4$
24) Find the 4 point circular convolution of the sequence $x_1(n) = \{1,2,3,1\}$,$x_2(n) = \{4,3,2,2\}$ using the time domain approach and verify the result using frequency domain approach.
25) Compute IDFT of the sequence X(k) = (2,1+j,0,1-j)
26) For the given sequence $x_1(n) = \{1,1,1,1\}$,$x_2(n) = \{2,2,2,2\}$. Find $x_3(n)$ = such that $X_3(k) = X_1(k).X_2(k)$.

Module 2: Fast Fourier transform algorithm

1) What are the properties of phase factor (W_N) that are exploited in fast fourier transform algorithms?
2) Develop decimation in time (DIT) FFT algorithm with all necessary steps and neat signal flow diagram for N-point DFT.

3) What is FFT? Explain Radix-2 DIT-FFT algorithm.
4) Develop DIF-FFT algorithm with all necessary steps and neat signal flow diagram used in computing N- point DFT, X(k) of a N-point sequence x(n).Using the same. Compute the DFT sequence x(n)={1,1,1,1,1,1,1,1}.
5) Derive Radix-2 DIF FFT algorithm to compute DFT of a N=8 point sequence and draw the complete signal flow graph.
6) Find the sequence x(n) corresponding to the 8 point DFT X(k)={4,1-j2.414,0,1-j0.414,0,1+j0.414,01+j2.414} by using any of the Radix-2 FFT algorithms to compute IDFT.
7) Determine 4 point IDFT of X(k)={2.5,-0.25+j0.75,0,-0.25-j0.75} using DIFFFT algorithm.
8) How many complex multiplications are required for direct computation of 64 point DFT? What is its value if FFT is used?
9) Determine 8 point DFT of x(n) = {1,0,-1,2,1,1,0,2} using radix-2 DIT-FFT algorithm. Show clearly all the Intermediate results.
10) Why FFT is needed? What is the speed improvement factor in calculating 64 point DFT of a sequence using direct computation and FFT algorithm.
11) What are the differences and similarities between DIT and DIF FFT algorithm?
12) Develop DITFFT algorithm for decomposing the DFT for N=6 and draw the flow diagrams for N= 2x3.
13) If x1(n) =[1,2,0,1] and x2(n) = [1,3,3,1], Obtain x1(n)©x2(n) using DIT-FFT algorithm.
14) Find the 4 point DFT of the following sequences, using a single 4 point DFT x1(n) =[1,2,0,1] and x2(n)= [2,2,1,1].
15) Compute number of complex multiplications for the direct evaluation of DFT v/s FFT algorithm for N=4,16,64,256 also find the speed improvement factor.
16) Find the 8 point DFT of the given sequence x(n). X(n)=(0,1,2,3,4,5,6,7)
17) Compute 8 point DFT of the sequence x(n)=(11111111) using DIT, DIF algorithm.
18) Compute IDFT of the sequence X(k)={4,1-j2.414,0,1-j0.414,0,1+j0.414,0,1+j2.414}
19) Determine 8 point DFT of x(n) = {1,0,-1,2,1,1,0,2} using radix-2 DIT-FFT algorithm. Show clearly all the intermediate results.
20) Find the DFT of a sequence x(n)={1,2,3,4,4,3,2,1} using DIT algorithm.
21) Compute 4-point DFT of a sequence x(n)={0,1,2,3} using DIT algorithm.
22) Develop DIT-FFT algorithm for N=9=3x3 and draw the complete signal flow graph. A 9 point real valued sequence is given by x(n)={0,1/4,1/2,3/4,1,3/4,1/2,1/4,0}
23) Find the DFT of a sequence x(n)={1,1,1,1,1,1,1,1} using DIT algorithm.

Module 3: Design of IIR Digital filters:

1) Design a lowpass digital filter using bilinear transformation. The filter is to be monotonic in both stop ban and pass band and has all of the following characteristics i) acceptable pass band ripple of 1dB, ii) a Passband edge of 0.3π rad, & iii) stop band attenuation of 40dB or greater beyond 0.6π rad.
2) Transform the analog filter H(s) = (s+3)/(S+1)(s+2) to a digital filter using the matched z transform. Let T=0.5 sec.
3) Using the bilinear transformation S= $(1- z^{-1})/ (1+z^{-1})$ .What is the image of $S=e^{j\pi/2}$ in the Z-plane.
4) Transform the analog filter $H(s)=1/(s+\alpha),\alpha>0$ to a digital filter using the backward difference mapping. Comment on the stability of the filter.
5) Determine the order of Butterworth and Chebyshev approximation analog filters used to meet the following specification: passband attenuation of 1dB at 4kHz and stop band attenuation of 40B at 6 kHz.
6) Design a chebyshev type I analog filter to meet the following specification: pass band attenuation 2 dB at 4 rad/sec and stop band attenuation of 10 dB at 7 rad/sec.
7) Write a short note on bilinear transformation.
8) Compare FIR versus IIR filters.
9) Design a analog filter which has equiripple characteristics in passband minitoni8c falloff characteristics in stop band given maximum passband attenuation of 2.5dB at Ωp= 20 rad/sec and the stop band attenuation of 30 dB at Ωs =30 rad/sec. Transform the analog filter to digital filter using impulse invariance method.
10) Transform the analog filter $H(s) = (s+0.1)^2/(s+0.1)^2+9$ to H(Z) using the impulse invariance transformation.

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3) For the analog transfer function $H(s)=(2)/((s+1)(s+2))$. Determine H(z) using impulse invariance method. Assume T=1 sec.
4) Using Bilinear transformation, design a highpass filter, monotonic in passband with cutoff frequency of 1000 Hz at α_P=3 dB and down to 10 dB at 350 Hz. The sampling frequency is 5000 Hz.
5) Determine direct form II realization for the following system y(n)=-0.1y(n-1)+0.72y(n-2)+0.7x(n)-0.252x(n-2).
6) Realize the system with difference equation y(n)=3/4y(n-1)-1/8y(n-2)+x(n)+ 1/3x(n-1) in cascade form.
7) Obtain the direct form I, direct form II, cascade and parallel form realization for the following system y(n)= -0.1y(n-1)+0.2 y(n-2)+3x(n)+3.6x(n-1)+0.6x(n-2).
8) Draw the direct form II, cascade and parallel form structure for the following system
$H(z)= (1-3/4z^{-1}+1/8z^{-1})/(1+z^{-1}+2/9z^{-2})(1+1/4z^{-1})$
9) Obtain a parallel realization for the following
$H(z)= (8z^{3}-4z^{-2}+11z-2)/(z-1/4)(z^{-2}-z+1/2)$

Module 5: Design of FIR Digital filters:

1) Show that if the impulse response has the even symmetry then FIR filter possesses linear phase Characteristics. Comment on position of zero on the Z-plane
2) Explain the frequency sampling method of designing FIR filters and draw the corresponding block diagram
3) Explain the structures used for realizing FIR filters by illustrations.
4) Show that the roots of H(z) occur in reciprocal pair for a linear phase FIR filter.
5) Consider a FIR filter with system function:
$H(z) = 1+2.82\ z^{-1}+3.4048\ z^{-2}+1.74\ z^{-3}$. Sketch the direct form and lattice realization of the filter.
6) Write a short notes on window based Fir filter design.
7) Write short notes on Butterfly operation and inplace computation.
8) What are advantages and disadvantages ith design of FIR filters using window function?
9) The frequency response of a linear phase Fir filter is given by
$H(e^{jw}) = e^{j3w}[2+1.8\ co\ 3w+1.2\ cos2w+0.5cosw]$.Find the impulse response sequence of the filter.
10) What condition on the Fir sequence h(n) are to be imposed in order that the filter can be called a linear phase filter.
11) Discuss design method of FIR filters

15.0 University Result

Examination	No. of students appeared	No. of students passed	%Passing
May/June 2018	46	36	78.26
May/June 2018	56	49	87.50

Prepared by	Checked by		
Prof. V.B.Dhere	Prof. M.P.Yanagimath	31.1.19 HOD	Principal

Subject Title	**ELECTRICAL MACHINE DESIGN**		
Subject Code	15EE64	**IA Marks**	20
Number of Lecture Hrs / Week	04 L	**Exam Marks**	80
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Shri:Shivanand Hirekodi	**Designation:** Asst.Professor	**Experience:**18
No. of times course taught:01	**Specialization:** Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	IV	TIM
02	Electrical & Electronics Engineering	V	DCSY

2.0 Course Objectives

1. To discuss design factors, limitations in design and modern trends in design and manufacturing of electrical machines.
2. To discuss the properties of electrical, magnetic and insulating materials used in the design of electrical machines
3. To derive the output equation of DC machine, single phase, three phase transformers, induction motor and synchronous machines.
4. To discuss the selection of specific loadings, for various machines
5. To discuss separation of main dimensions for different electrical machines
6. To discuss design of field windings for DC machines and synchronous machines.
7. To evaluate the performance parameters of transformer, induction motor.
8. To design of cooling tubes for the transformer for a given temperature rise.
9. To explain design of rotor of squirrel cage rotor and slip ring rotor.
10. To define short circuit ratio and discuss its effect on machine performance.

3.0 Course Outcomes

Having successfully completed this course, the student will be able

	Course Outcome	Cognitive Level	POs
C312.1	Discuss design factors,limitations,modern trends in design,manufacturing of electrical machines and properties of materials used in the electrical machines.	L1,L2,L4	PO1, PO2,PO3,PO6
C312.2	Design different parts of DC machines.	L1,L2,L3,L4	PO1, PO2,PO3,PO8
C312.3	Design single phase and three phase transformers.	L1,L2,L3,L4	PO1, PO2,PO3,PO8
C312.4	Design three phase Induction motors.	L1,L2,L3,L4	PO1, PO2,PO3,PO8
C312.5	Design three phase Synchronous machines.	L1,L2,L3,L4	PO1, PO2,PO3,PO8
Total Hours of instruction		**50**	

4.0 Course Content

MODULE – 1

Fundamental Aspects of Electrical Machine Design: Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques.

Electrical Engineering Materials: Desirabilities of Conducting Materials, Comparison of Aluminium and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials, Classification of Insulating materials based on Thermal Consideration. **10 Hours**

MODULE – 2

Design of dc machines: Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings. **10 Hours**

MODULE - 3

Design of transformers Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes. **10 Hours**

MODULE - 4

Design of induction motors: Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance. **10 Hours**

UNIT - 7 & 8

Design of synchronous machines: Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding.

10 Hours

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Industrial Drives & Applications	Selection of drives for different industrial applications.
02	VIII	Project work	Design of machines

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Design of AC and DC machines for different sectors like Industry, Agriculture, Automotives etc.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Lab visit	To gain practical knowledge about Machine Designs
02	Industry Visit	To study design and manufacturing of machines.

8.0 Books Used and Recommended to Students

Text Book
1. A Course in Electrical Machine Design by A.K.Sawhney. 6 th edition,2013, Published by:Dhanpat Rai and Co.
Reference Books
1. Performance and Design Of AC Machines by M.G.Say. 3rd edition,2002, Published by:CBS Publisher
2. Design Data Handbook- by Sanmug Sundarm 1st edition,2011 Published by:New Age International.
Additional Study material & e-Books
1. Design of Electrical Machines by Nagnoor kani
2. Design of Electrical Machines by V. N. Mittle, 4/e edition.
3. Principles of Electrical Machine Design, by R.K.Aggarwal.

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) http://www.electrical4u.com
2) www.nptel.com
3) http://nptel.iitm.ac.in/courses/IITMADRAS/Electrical_Machines_I/index.php
4) http://nptel.iitm.ac.in/courses/IITMADRAS/Electrical_Machines_II July 2012 2

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	E drive magazine	http://www.e-driveonline.com/main/
2	IEEE magazine & Journal	https://www.ieee.org/publications_standards/publications/journmag/journals_magazines.html
3	Machine design magazine	https://www.amazon.com/Machine-Design-Magazine-Electric-Reference/dp/B000KFWQKM
4	Journal pub	http://journalspub.com/journalspub/JournalsDetails.aspx?jid=95
5	Journal of engineering design	http://www.tandfonline.com/doi/abs/10.1080/09544829008901652

11.0 Examination Note

INTERNAL ASSESSMENT: 20 MARKS

Internal assessment test will be done in the same pattern as that of the main examination.
Internal assessment: 15 marks.
Assignment: 05 marks

SEMESTER END QUESTION PAPER PATTERN: 80 Marks

- The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.
- There will be two full questions from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

12.0 Course Delivery Plan

Unit No.	Lecture No.	Content of Lecture	% Portion
I	1.	**Fundamental Aspects of Electrical Machine Design:** Design of Machines. Design Factors.	20
	2.	Limitations in design. Modern Trends in design & manufacturing Techniques.	
	3.	**Electrical Engineering Materials:** Desirabilites of Conducting Materials. Comparison of Aluminum and Copper wires.	
	4.	Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials. Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel.	
	5.	Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials.	
	6.	Classification of Insulating materials based on Thermal Consideration.	
III	7.	**Design of Transformers:** Output equation of single phase and three phase transformers	20
	8.	Choice of specific loadings. Expression for volts/turn	
	9.	Determination of main dimensions of the core	
	10.	Design of windings	
	11.	Window space factor and Window Dimensions.	
	12.	Design of yoke and overall dimensions.	
	13.	Numerical Examples	
	14.	Numerical Examples	
	15.	Numerical Examples	
	16.	Estimation of no load current and numerical examples	
	17.	Expression for leakage reactance and voltage regulation	
	18.	Numerical examples	
	19.	Design of tank and cooling tubes (round and rectangular)	
	20.	Numerical Examples.	
IV	21.	**Design of Three Phase Induction Motors:** Output equation	20
	22.	Choice of specific loadings	
	23.	Main dimensions of stator	
	24.	Design of stator slots and Winding and numerical examples	
	25.	Choice of length of the air gap	
	26.	Estimation of number of slots for the squirrel cage rotor and numerical	
	27.	Design of Rotor bars and end ring and numerical examples	
	28.	Design of Slip ring induction motor and numerical examples	
	29.	Estimation of No load current and Leakage reactance	
	30.	Numerical Examples.	
V	31.	**Design of Three Phase Synchronous Machines:** Output equation	20
	32.	Choice of specific loadings	
	33.	Short circuit ratio	
	34.	Design of main dimensions and numerical examples	
	35.	Design stator slots and windings and numerical examples	
	36.	Design of rotor of salient pole synchronous machines numerical examples	

	37.	Design of rotor of non-salient pole machine & numerical examples	
	38.	Magnetic circuits	
	39.	Design of the field winding	
	40.	Numerical examples	
II	41.	**Design of DC Machines:** Output equation	**20**
	42.	Choice of specific loadings	
	43.	Choice of number of poles	
	44.	Design of Main dimensions of the DC machines	
	45.	Numerical	
	46.	Design of armature slot dimensions and numerical	
	47.	Commutators and brushes and numerical	
	48.	Magnetic circuit - estimation of ampere turns	
	49.	Design of yoke and pole	
	50.	Field windings – shunt, series and inter poles and numerical.	
	51.	Numerical Examples	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on design aspects and limitations of design.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity. Printed solution expected.	Book 1 of the Text list.
2	Assignment 2: University Questions on design of Transformer.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity. Printed solution expected.	Book 1 of the Text list.
3	Assignment 3: University Questions on of induction machine.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity. Printed solution expected.	Book 1 of the Text list.
4	Assignment 4: Des of synchronous machine.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity. Printed solution expected.	Book 1 of the Text list.
5	Assignment 5: University Questions on Design of dc machine.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 the syllabus	10	Individual Activity. Printed solution expected.	Book 1 of the Text list.

14.0 QUESTION BANK

MODULE I

1. Explain clearly the factors which impose limitations in the design of electrical machines.
2. What are the desirable properties of insulating materials? Explain the classification of insulating materials based on thermal consideration.
3. What are factors those limit the design of machine
4. What are types of magnetic materials? Give Examples.
5.

MODULE II

1. Define the term 'output coefficient' in case of d.c. machines. Explain on what factors its value depends and in what manner it varies.
2. Derive the output equation of DC Machine.
3. Define the terms 'specific magnetic loading' and 'specific electric loading', as applied to electrical Machines. Discuss various factors which influence the values of these quantities in the design of d.c. machines
4. Discuss the factors which govern the choice of number of poles in a d.c. machine
5. Find the main dimensions and the number of poles of a 37kW,230V,1400rpm shunt motor so that a square pole face is obtained. The average gap density is 0.5 wb/$m^2$and the ampere conductors per meter are 22000. The ratio of pole arc to pole pitch is 0.7 and the full load efficiency is 90 percent.
6. Calculate the reactance voltage induced per coil for single turn two layer winding with two conductors per slot, of a 250Kw,525V,6 pole lap wound dc generator driven at 220rpm.The no of armature conductors is 600. The inductance per coil is 0.0057 mH.The brush covers one segment. If the armature diameter is 1.6m and core length 0.3m, Determine flux density under the interpole. The length of interpole is 0.18m.
7. List the guide lines for selecting number of slots for DC Machine.
8. list factors for selection of armature diameter and core length.
9. Calculate the size of conductor and number of turns for the field of a 6 pole, 460V, DC shunt motor. The coil is to supply a mmf of 4000AT, at working temperature. The length of the inside turn is 0.74m, length available for winding is 0.13m, the space factor of the winding is 0.52, and the permissible dissipation from external surface excluding ends is 1200W/m^2. Solution should not be attempted by assuming winding depth. The resistivity of conductors is 0.02Ωm /mm^2. Keep 15% of applied voltage as reserve for speed control.
10. A 250KW, 500V, 600rpm, 6 pole DC generator is built with an armature diameter of 0.75m and a core length of 0.3m. The lap connected armature has 720 conductors. Using data obtained from this machine, determine the armature diameter, core length, number of armature slots, armature conductors and commutator segments for a 350KW, 440V, 720rpm, 6 pole DC generators. Assume a square pole face with ratio of pole –arc to pole pitch=0.66. The full load efficiency is 0.91 and the internal voltage drop is 4% of rated voltage. The diameter of commutator is 0.7 of armature diameter. The pitch of commutator segments should not be less than 4mm. The voltage between adjacent segments should not exceed 15V.

MODULE 3

1. Derive an output equation of a 3 phase transformer in terms of design constants and hence deduce the equation for the case of a single phase transformer.
2. Show that $E_t=k\sqrt{Q}$ for the transformer.
3. Determine the main dimensions of the core and window for a 500KVA, 6600/400V; 50Hz Single phase core type, oil immersed, self cooled transformer. Assume:Flux density= 1.2T, Current density=2.75A/mm^2, window space factor=0.32, volt/turn=16.8, type of core : cruciform, height of window=3 times window width. Also calculate the number of Turns and cross sectional area of conductors used for primary and secondary windings.

4. Calculate the no load current and power factor of a 3300/220V,50Hz,Single phase core type transformer with following data.Mean length of magnetic path =300cm, gross area of iron core =150cm^2, specific iron loss at 50Hz and 1.1T=2.1W/kg, Ampere turns / cm for transformer steel at 1.1T=6.2. The effect of joint is equivalent to an air gap of 1.0mm in the magnetic circuit. Density of iron=7.5 gm/cc, iron factor=0.92.
5 Calculate the main dimensions for a 250 KVA, 6600/400 volts, 50 Hz, 3 phase, mesh/star, core type, oil immersed, self cooled outdoor type, and power transformer. Assume suitable values for various design constants and specific magnetic loading.*(d = 18 cm; L = 50 cm; D = 33 cm)*
6 Explain the term, 'window space factor' as used for transformer design and state its importance in fixing the transformer output in relation to its working efficiency and the cost
7 Calculate the main dimensions and winding details of a 100 KVA, 2000/440 volts, 50 Hz, single phase, shell type, oil immersed, and self cooled transformer. The maximum flux density and current density are to be below 1.15 Tesla and 2.3 A/mm^2 respectively. The induced e.m.f. per turn is to be limited to 11.5 volts. The value of window space factor can be taken as 0.33 The ratio of window height to window width and ratio of core depth to width of central limb=2.5. The stacking factor is 0.9.
8 Derive an expression for the leakage reactance of the transformer with primary and secondary cylindrical coils of equal length, stating clearly the simplifying assumptions made.
9 Determine the equivalent reactance of transformer referred to the primary from the following given data:

Mean Length of h.v, turns	= 120 cm
Number of h.v. turns	=570
Mean length of l.v. turns	= 100 cm
Number of 1.v. turns	= 22
Radial width of both windings	= 2.7 cm
Width of duct in between the two windings	=1.9 cm
Length of the coils	=62 cm

MODULE 4

1. What are the various considerations in the selection of specific electric and magnetic loading, for the design of a 3 phase induction motor?
2. Derive the output equation of Induction Machine.
3. Discuss the factor for choice of specific magnetic and electric loading in induction machine.
4. Estimate the Stator Core Dimension's , Number of Stator Slots and Number of Stator Conductor's per Slot for a 100Kw, 3300Kv,50Hz,12 Pole Star Connected Slip Ring Induction Motor .Assume B_{av}=0.4Wb/m^{2,} ac =25,000A/m , Efficiency=0.9, Power Factor =0.9 and Winding Factor =0.96=K_{ws}. Choose Main Dimension's to give Best Power Factor . The Slot Loading Should Not Exceed 500 Ampere Conductors.
5. Determine the main dimensions, turns per phase, number of slots, conductor cross section and slot area of a 250Hp, 3-phase, 50Hz, 400V, 1410 rpm, slip ring induction motor. Assume B_{av}=0.5wb/m^2, ac=30,000 A/m, effieciency= 0.9 and power factor=0.9, winding factor=0.955, current density=3.5 A/mm^2, the slot space factor is 0.4 and ratio of core length to pole pitch is 1.2. The machine is delta connected.
6. Discuss the factors for choice of length of air gap in induction machine.
7. Determine the approximate diameter and length of the stator core, the number of slots and the number c conductors per slot for a 15kw, 440V, 3 phase, 4 pole, 1425 r.p.m. induction motor.

   Assume the following values for various design parameters.

Specific magnetic loading	= 0.48 Tesla
Specific electric loading	= 25000 Amp. Conductors per meter
Full load efficiency	= 88 per cent
Full load power factor	= 0.88

8. Deduce for a 3 phase induction motor an expression showing the relationship between output, its ma dimensions, speed, the specific electric and magnetic loading, efficiency and power factor.
9. Discuss the affect of flat-topped air gap flux wave on the design calculations of induction motor.
10. Why magnetizing current of a 3 phase induction motor is much more in magnitude than that of a 3 phase transformer of the same power rating?

MODULE 5

1. Derive from the fundamental principles, an expression for the output coefficient of a 3 phase alternator in terms of specific magnetic and electric loadings.
2. Define Runaway Speed? Discuss the effect of Short Circuit Ratio on machine performance.
3. Find the Main Dimension's of 2500Kva, 187.5 Rpm, 50Hz, 3-Phase, 3Kv, Salient Pole Synchronous Generator. The Generator is to be a Vertical, Water Wheel type. Assume B_{av}=0.6Wb/m^2 and ac=34000A/m. Use Circular Poles with Ratio of Core length to pole Pitch=0.65. Specify the Type of Pole Construction Used if the Runaway Speed is About 2 Times Normal Speed.
4. Explain the term "short-circuit ratio" as applied in synchronous machines. How the value of short circuit ratio does affect the design of alternators?
5. Determine the main dimensions for a 1000KVA, 50 Hz, 3 phase 375 rpm alternator. The average air gap flux density is 0.55 Wb/mm^2 and the ampere conductors per metre are 28000. Use rectangular ploes and assume a suitable value for ratio of core length to pole pitch in order that bolted on pole construction is used for which the maximum permissible peripheral speed is 50 m/s. The runaway speed is 1.8 times the synchronous speed.

15.0 University Result

Examination	FCD	FC	SC	% Passing
July 2017	-	-	-	100%
July 2016	04	08	44	96.55
July 2015	01	10	41	88.13

Prepared by	Checked by		
31/01/19		31.1.19	
Shri S.D.Hirekodi.	Shri.S.B.Patil.	HOD	Principal

Subject Title	**COMPUTER AIDED ELECTRICAL DRAWING (Professional Elective)**		
Subject Code	15EE651	**IA Marks**	20
Number of Lecture Hrs /	03	**Exam Marks**	80
Total Number of Lecture	40	**Exam Hours**	03

FACULTY DETAILS:		
Name: Prof. Shivanagouda Patil	**Designation:** Asst.Professor	**Experience: 33** years
No. of times course taught:15	**Specialization:** Power and Energy System	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	I/II	Basic Electric Engineering
02	Electrical & Electronics Engineering	III	Electric Power Generation
03	Electrical & Electronics Engineering	IV	Transformer & Induction Motor
04	Electrical & Electronics Engineering	V	DC Machine & Syn. machines
05	Electrical & Electronics Engineering	V	Transmission & Distribution

2.0 Course Objectives

- To discuss the terminology of DC and AC armature windings.
- To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
- To discuss the substation equipment, their location in a substation and development of a layout for substation.
- To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
- To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches.
-

3.0 Course Outcomes

Having successfully completed this course, the student will be able to assemble and draw modeling using software to generate

CO'S	Course Outcome	Cognitive Level	POs
CO.1	Apply the Auto-CAD commands to draw different types of generating and substations.	L1, L2, L3 & L4	1,2,3, 5,8,9, 11,12
CO.2	Design and develop the winding diagram for DC and AC winding (Lap and Wave)	L1, L2, L3 & L4	1,2,3, 5,8,9, 11,12
CO.3	Develop sectional views of core and shell types transformers using the design data	L1, L2, L3 & L4	1,2,3, 5,8,9, 11,12
CO.4	Draw sectional views of assembled DC machine or its parts using the design data or the sketches.	L1, L2, L3 & L4	1,2,3, 5,8,9, 11,12
CO.5	Draw sectional views of assembled alternator or its parts using the design data or the sketches.	L1, L2, L3 & L4	1,2,3, 5,8,9, 11,12
	Total Hours of instruction		**40**

4.0 Course Content

PART A

Module-1

Winding Diagrams:
(a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.
(b) Developed Winding Diagrams of A.C. Machines:
(c) Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.
(d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings.

08 Hours

Module-2

Single Line Diagrams: Single Line Diagrams of Generating Stations and Substations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalised Single, Main and Transfer, Double Bus Double Breaker, Sectionalised Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main),Power Transformers, Circuit Breakers, Isolators, Earthing Switches, Instrument Transformers, Surge or Lightning Arresters, Communication Devices (Power-Line Carrier) and Line Trap.

08 Hours

PART – B

Module-3

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:
Transformers - Sectional Views Of Single And Three Phase Core And Shell Type Transformers.

08 Hours

Module-4

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:

D.C. Machine - Sectional Views of Yoke with Poles, Armature and Commutator dealt separately

08 Hours

Module-5

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both:

Alternator – Sectional Views of Stator and Rotor dealt separately

08 Hours

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Drawings, Part Modeling.
02	VI	Electrical Machine Design	Transformer, Alternator and DC machines.

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Industrial drawings and design of various components concern to electrical system.
02	Model creation for analysis.
03	Plant layout, Substation layout drawings with various components.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Learning of assembly & winding practices.
02	NPTEL Videos & Models	Assembly of machine parts & its Applications.

8.0 Books Used and Recommended to Students

Reference Books
1.A course in Electrical Machine design A. K. SawhneyDhanpat Rai 6thEdition, 2013 2 .Electrical Engineering DrawingK. L. NarangSatya Prakashan2014
Additional Study material & e-Books
1. A Text Book of Computer Aided Electrical Drawing", S F Devalapur 2 Manuals of Auto – CAD

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) WWW. autodesk .com, 2) WWW. autodesk.in

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Manuals of Auto – CAD	http:// Auto-CAD

11.0 Examination Note

Internal Assessment: 20Marks(15 Marks Internal Assessment + 5 Marks Assignment) :
Internal Assessment is conducted for 25 Marks and is scaled down to 15 Marks
Scheme of Evaluation for Internal Assessment (25 Marks)
Student has to answer two full questions as per the format shown below.

Q.1 a	13	Q.3 a	12
b		b	
OR		OR	
Q.2 a	13	Q.4 a	12
b		b	

SCHEME OF MAIN EXAMINATION: 80 Marks

Question paper pattern:

- The question paper will have two parts, PART –A and PART –B.
- Each part is for 40 marks
- **Part A** is for Modules 1 and 2
- Questions 1 and 2 of PART -A will be only on DC windings or only on AC windings. Students have to answer any one of them. The marks prescribed is 25.
  Question 3 of PART –A covering module 2 is compulsory. The marks prescribed is 15.
- **Part B** is for Modules 3, 4 and 5.
- Questions 4 and 5 will cover any two modules of modules 3, 4 and 5. Students have to answer any one of them. The marks prescribed is 40.

INSTRUCTION FOR COMPUTER AIDED ELECTRICAL DRAWING (15EE651) EXAMINATION

1. No restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. Winding calculation & table is to be done in sketch book of all the solutions before computerization.
3. Drawing printout should be submitted at the end.

12.0 Course Delivery Plan

Unit No.	Lecture No.	Content of Lecture	% of Portion
MODULE -1	1	Study of different Auto-CAD commands which are useful to draw the windings, electrical machines and electrical sketches.	20%
	2	Developed winding diagrams of D.C machines simplex single layer using Auto-CAD.	
	3	Developed winding diagrams of D.C machines simplex double layer using Auto-CAD.	
	4	Developed winding diagrams of D.C machines duplex single layer using Auto-CAD.	
	5	Developed winding diagrams of D.C machines duplex double layer using Auto-CAD.	
	6	Developed winding diagrams of AC machines, integral slot double layer lap winding using Auto-CAD.	
	7	Developed winding diagrams of AC machines, integral slot double layer wave winding using Auto-CAD.	
	8	Developed winding diagrams of AC machines, fractional slot double layer lap winding using Auto-CAD.	
	9	Developed winding diagrams of AC machines, fractional slot double layer wave winding using Auto-CAD.	
	10	Un-bifurcated single layer, 2 and 3 tier winding	
	11	Mush windings	
	12	Bifurcated single layer, 2 and 3 tier winding.	
MODULE-2	1	Single line diagram of generating stations of Hydral plant High head plant, medium head, low head plants.	20%
	2	Single line diagram of thermal power generating station.	
	3	Single line diagram of Nuclear power plant.	
	4	Single line diagram of MUSS plant.	
	5	Single line diagram of substations.(110KV/33KV/11KV)	
	6	Single line diagram of generating stations.(11KV/110KV/220KV)	
MODULE-3, 4 & 5	1	Draw the sectional views (front view & top view) of single phase core type transformer from the given data.	60%
	2	Draw the sectional views (front view & top view) of single phase shell type transformer from the given dissembled parts.	
	3	Draw the sectional views (front view & top view) of single phase core type transformer from the given from given dissembled figure.	
	4	Draw the sectional views (front view & top view) of single phase shell type transformer from the given data.	
	5	Draw the sectional views (front view & top view) of three phase core type transformer from the given dissembled parts of the transformer figure.	
	6	Draw the sectional views (front view & top view) of three phase core type transformer from the given data.	
	7	Sectional views of a Yoke, field system of the D.C machine drawn separately.	
	8	Sectional views of a armature & commutator system of the D.C machine drawn separately.	
	9	Sectional views of a stator & rotor of the alternator drawn separately.	

13.0 Assignments

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on DC windings Lap and wave with	Students able to write winding calculation and winding table. Get practice to solve	Unit 1 of the syllabus	2&3	Individual Activity. Printed solution is expected.	Book 1, 2 of the reference list.

	different slots.	university questions.				
2	Assignment 2: University Questions on Single line diagram of generating station and substations.	Students study the Topics and write the Answers & able to analyze and understand the Single line diagrams.	Unit 1, Part-2 of the syllabus	4	Individual Activity. Printed solution is expected.	Book 1, 2 of the reference list.
3	Assignment 3: University Questions on DC Machine parts and assembly.	Students study the Topics and write the Answers. Get practice to solve university questions.	Unit 2 of the syllabus	6	Individual Activity. Printed solution is expected.	Book 1, 2 of the reference list.
4	Assignment 4: University Questions Transformer assembly	Students are able to draw the different types of transformers by the given data.	Unit 2 of the syllabus	8	Individual Activity. Printed solution is expected.	Book 1, 2 of the reference list.
5	Assignment 5: University Questions on Assembly Drawings Alternators	Students are able to draw the different types of transformers by the given data.	Unit 2 of the syllabus	10	Individual Activity. Printed solution is expected.	Book 1, 2 of the reference list.

14.0 QUESTION BANK

Unit No. 1:

1 Draw the developed winding diagram having 2 coil side per slot, 4-pole, 19 slots. The type of winding is duplex, progressive lap winding. Show the positions of the brush, direction of EMF. Draw the sequence diagram (28-05-2016).
2 Draw the developed winding diagram for a 4-pole,wave winding progressive, for an alternator with 34 conductors accommodated in 17 slots show the position of brush, direction of EMF.
(26-05-2016,2.30 to5.30 pm)
3 Develop a double layer, progressive, lap winding for a DC machine having 16 slots, 4-poles. Draw the sequence diagram. Indicate the position of the brushes, show the direction of induced EMF and equalizer connection.(26-05-2016, 11.30 to 2.30pm)
4 Design and Draw a duplex winding diagram for a DC machine with 16 slots, double layer, 4-pole, progressive lap winding. Draw the sequence diagram. (26-05-2015. 11.30 to 5.30 pm)
5 Draw the developed winding diagram of an 3-phase induction motor, which have 18 slots,
2 poles, winding is chorded by 2 slots, double layer lap delta connection. (26-05-2015. 11.30 to 5.30 pm).
6 Draw the developed winding diagram of an 3-phase induction motor, which have 18 slots, 6-poles, 2-coilsides/ slot, full pitch, star connected lap winding using Auto-CAD Commands.

Unit No. 2:

1 Single line diagram of thermal power generating stations.
2 Single line diagram of Hydal power plant(Medium and High Head)
3 Single line diagram of nuclear power generating stations.
4 Single diagrams of sub-stations like: 110KV/ 11KV, 33KV / 11KV
5 Single diagrams of generating stations like: 11KV / 110KV or 11KV / 220KV
6 Single diagrams of sub-stations like: MUSS.

Unit No. 3:

1 Draw the sectional views like front view & top view of single phase core type transformer from the given data or from the dissembled parts.
2 Draw the sectional views like front view & top view of single phase shell type transformer from the given data or from the dissembled parts.
3 Draw the sectional views like front view & top view of three phase core type transformer from the given data or from the dissembled parts.
4 Draw the sectional views of a Yoke, field system of the D.C machine drawn separately from the given data or from the dissembled parts.
5 Draw the sectional views of a armature and commutator of the D.C machine drawn separately from given data or from the dissembled parts.

Course Plan 20187-19 even – Semester-6th
Electrical & Electronics Engineering

15.0 University Result

Examination	Number of students appeared	Number of students passed	% Passing
June-2018	47	47	100

Prepared by	Checked by		
8/1/2019		1/2/19	
Prof. S B PATIL	Prof. S.G.Huddar	HOD	Principal

Subject Title	Sensors and Transducers		
Subject Code	15EE662	**IA Marks**	20
Number of Lecture Hrs /	03	**Exam Marks**	80
Total Number of Lecture	40	**Exam Hours**	03

FACULTY DETAILS:		
Name: Prof. O. B. Heddurshetti	**Designation:** Asst. Professor	**Experience:**13
No. of times course taught:02	**Specialization:** Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronic Engg	III	Electrical and Electronics Measurement
02	Electrical & Electronic Engg	I/II	Basic Electrical Engineering

2.0 Course Objectives

- To discuss the need of transducers, their classification, advantages and disadvantages.
- To discuss the working of different types of transducers and sensors.
- To discuss recent trends in sensor technology and their selection.
- To discuss the basics of signal conditioning and signal conditioning equipment.
- To discuss configuration of Data Acquisition System and data conversion.
- To discuss the basics of Data transmission and telemetry.
- To explain measurement of various non electrical quantities.

3.0 Course Outcomes

At the end of the course the student will be able to:

	Course Outcome	Cognitive	POs
CO 324.1	Discuss the working of various transducers and sensors.	U	PO1
CO 324.2	Discuss basics of signal conditioning and signal conditioning equipment.	U	PO1
CO 324.3	Discuss configuration of Data Acquisition System and data conversion.	U	PO1
CO 324.4	Explain data transmission and telemetry.	U	PO1
CO 324.5	Explain measurement of non electrical quantities -temperature, flow, speed, force, torque, power and viscosity.	U	PO1
Total Hours of instruction		**40**	

4.0 Course Content

Module-1

Sensors and Transducers: Introduction, Classification of Transducers**,** Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers. 08 Hours

Module-2

Sensors and Transducers (continued): Stain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems. 08Hours

Module-3

Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers.

Data Acquisition Systems and Conversion: Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion. 08Hours

Module-4

Data Transmission and Telemetry: Data/Signal Transmission, Telemetry.

Measurement of Non – Electrical Quantities: Pressure Measurement. 08Hours

Module-5

Measurement of Non – Electrical Quantities (continued): Temperature Measurement, Flow Measurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Metes, and Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level, Measurement of Viscosity.

08Hours

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Students can apply the knowledge of different type's Sensors & transducers working principle to implement their projects.
02	VIII	Seminar work	Students can utilize the basic knowledge of different types of sensors & transducers during seminar preparation.

6.0 Relevance to Real World

Sl.No	Real World Mapping
01	Students can utilize the knowledge of the subject while working in industries as various industries use different types of sensors and transducers in the operation.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Power Point Presentation and Videos	PPTs and videos of working of different sensors and transducers in industrial operations are shown to the students.

8.0 Books Used and Recommended to Students

Text Books
➢ Electrical and Electronic Measurements and instrumentation by R.K Rajput 3rd Edition, 2013 S. Chand.
Reference Books
➢ A Course in Electronics and Electrical Measurements and Instruments by J.B. Gupta 13th Edition, 2008 Katson Books. ➢ A Course in Electrical and Electronic Measurements and Instrumentation by A. K. Sawheny 2015 Dhanpat Rai.
Additional Study material & e-Books
➢ Electrical & Electronic measurements by P.M.Chandrashekar.

9.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) https://books.google.co.in/books?isbn=125902959X 2) http://NPTEL.com/ 3) www.electrical4u.com

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	IEEE Instrumentation & measurement magazine	ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5289
2	Electrical & Electronic industry trade publications journals magazines	www.industrymart.com › Industrial Publications
3	IEEE journals & magazines	https://www.ieee.org › Publications

11.0 Examination Note

Internal Assessment: 20 Marks (15 Marks for IA Test+05 Marks for Assignment)
IA Test: Three Internal Assessment tests are conducted for 25 marks each. Best of the two tests average marks are finalized. Then the average IA marks is scaled down to a value out of 15 which is the final IA marks.
There are four main questions of 13 or 12 Marks.
Students have to answer any two full questions by selecting one question from Q. No.1 or Q. No. 2 and one question from Q. No. 3 or Q. No. 4.

Assignment: Five assignments are given on five modules. Each assignment carries 25 marks. Average marks of five assignments is calculated and scaled down to a value out of 05.

SCHEME OF EXAMINATION:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

12.0 Course Delivery Plan

MODULE	Lecture No.	Content of Lecture	% of Portion
1	1.	**Sensors and Transducers:** Introduction,	20%
	2.	Classification of Transducers**,** Advantages and Disadvantages of Electrical Transducers,	
	3.	Transducers Actuating Mechanisms, Resistance Transducers,	
	4.	Variable Inductance Transducers, Capacitive Transducers	
	5.	Piezoelectric Transducers,	
	6.	Hall Effect Transducers	
	7.	Thermoelectric Transducers,	
	8.	Photoelectric Transducers	
2	9.	Stain Gages, Load Cells, Proximity Sensors	20%
	10.	Pneumatic Sensors, Light Sensors, Tactile Sensors,	
	11.	Fiber Optic Transducers, Digital Transducers	
	12.	Recent Trends – Smart Pressure Transmitters,	
	13.	Selection of Sensors,	
	14.	Rotary – Variable Differential Transformer,	
	15.	Synchros and Resolvers, Induction Potentiometers	
	16.	Micro Electromechanical Systems	
3	17.	**Signal Condition:** Introduction	
	18.	Functions of Signal Conditioning Equipment	
	19.	Amplification, Types of Amplifiers	
	20.	Mechanical Amplifiers, Fluid Amplifiers	

	21.	Optical Amplifiers, Electrical and electronic Amplifiers.	20%
	22	**Data Acquisition Systems and Conversion:** Introduction,	
	23	Objectives and Configuration of Data Acquisition System,	
	24	Data Acquisition Systems, Data Conversion	
4	25	**Data Transmission and Telemetry:**	
	26	Data/Signal Transmission, Telemetry.	
	27	**Measurement of Non – Electrical Quantities**	
	28	Pressure Measurement	
5	29	Temperature Measurement, Flow Measurement – Introduction,	20%
	30	Electromagnetic Flow meters, Ultrasonic Flow Meters,	
	31	Thermal Metes, Wire Anemometers	
	32	Measurement of Displacement, Measurement of Velocity/ Speed	
	33	Measurement of Acceleration,	
	34	Measurement of Force, Measurement of Torque,	
	35	Measurement of Shaft Power, Measurement of Liquid Level,	
	36	Measurement of Viscosity	

13.0 Assignments, Pop Quiz, Mini Project, Seminars

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on Sensors and transducers	Students are capable to explain working of different sensors & transducers.	Module 1	2	Individual Activity. Written solution expected.	Book 1 of the text book list. Website of the Reference list
2	Assignment 2: University Questions on sensors & transducers (continued)	Students are capable to explain working of different sensors & transducers.	Module 2	4	Individual Activity. Written solution expected.	Book 1 of the text book list. Website of the Reference list
3	Assignment 3: University Questions on signal condition, Data acquisition systems & conversion	Students are capable to explain the Data acquisition systems & conversion.	Module 3	6	Individual Activity. Written solution expected.	Book 1 of the text book list. Website of the Reference list
4	Assignment 4: University Questions on data transmission & telemetry	Students are capable to explain data transmission and telemetry.	Module 4	8	Individual Activity. Written solution expected.	Book 1 of the text book list. Website of the Reference list
5	Assignment 5: University Questions on Measurement of non electrical quantites.	Students are capable to elaborate measurement of non-electrical quantites.	Module 5	10	Individual Activity. Written solution expected.	Book 1 of the text book list. Website of the Reference list

14.0 QUESTION BANK

MODULE-1

1. Explain the classification of transducers?
2. Mention advantages & disadvantages of Electrical transducers?
3. Explain the working of Resistance & Capacitance transducer?
4. Write a note on piezoelectric transducers?
5. Explain the working of photoelectric transducer?
6. With neat sketch explain the operation of Hall Effect transducers?
7. Explain the operation of thermoelectric transducers?
8. Explain the operation of variable inductance transducer?

MODULE-2

1. Explain the operation of Proximity sensors?
2. Explain the operation of Light & tactile sensors?
3. Write a note on selection of transducers?
4. Explain Micro Electromechanical systems?
5. Explain the operation of Pneumatic sensors?
6. Write a note on rotary –Variable differential transformer?
7. Explain the operation of light cells?
8. Explain the operation of Fiber optic transducer?

MODULE-3

1. Explain the operation of Fluid & Mechanical transducer?
2. Mention functions of signal conditioning equipment?
3. Explain Electrical & Electronic transducers?
4. Write a note on types of Amplifiers?
5. Explain the configuration of Data acquisition system?
6. Write a note on Data acquisition systems?
7. Define Amplification?
8. Explain Data Conversion?

MODULE-4

1. Explain data/Signal transmission?
2. Write a note on Telemetry?
3. Explain how pressure measurement can be performed?
4. Write a note on measurement of Non-electrical quantities?

MODULE-5

1. Explain temperature & flow measurement?
2. Write a note on electromagnetic flow meters?
3. Explain the measurement of displacement & acceleration?
4. Write a note on thermal meters?
5. Explain the measurement of force & torque?
6. Explain the measurement of shaft power, liquid level & Viscosity?

13.0 University Results

Sl.No	Students Appeared	No of Students Passed	Percentage of Passing
1	47	47	100%

Prepared by	Checked by		
31/01/19		31.1.19	
Shri. O. B. Heddurshetti	Shri. V. B. Dhere	HOD	Principal

Subject Title	**CONTROL SYSTEM LABORATORY**		
Subject Code	15EEL67	**IA Marks**	20
No of Practical Hrs / Week	03	**Exam Marks**	80
Total No of Practical Hrs	42	**Exam Hours**	03
			CREDITS – 02

FACULTY DETAILS:		
Name: Shri. O B Heddurshetti	**Designation:** Asst. Professor	**Experience:** 13 Years
No. of times course taught: 02 Time	**Specialization:** Power Electronics	

FACULTY DETAILS:		
Name: Shri. K B Negalur	**Designation:** Asst. Professor	**Experience:** 6 Years
No. of times course taught: 05 Times	**Specialization:** Industrial Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	I/II	Basic Electrical Engineering
02	Electrical & Electronics Engineering	IV	Electric Motors
03	Electrical & Electronics Engineering	VI	Control System

2.0 Course Objectives

- To determine the time and frequency domain reposes of a given second order system using software package or discrete components.
- To design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
- To draw the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair.
- To simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
- To write a script files to plot root locus, Bode plot, Nyquist plots to study the stability of the system using a software package.

3.0 Course Outcomes

The student, after successful completion of the course, will be able to

CO	Course Outcome	Cognitive Level	POs
CO328.1	Use software package or discrete components in assessing the time and frequency domain responses of a given second order system.	L1,L2,L3	1,2,5,9,10
CO328.2	Design and analyze Lead, Lag and Lag – Lead compensators for given specifications.	L1,L2,L3,L4, L5,L6	1,2,9,10
CO328.3	Determine the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair used in control systems .	L1,L2,L3,L4, L5	1,2,9,10
CO328.4	Take part in simulation of DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.	L1,L2,L3,L4	1,2,5,9,10
CO328.5	Develop script files to plot root locus, Bode plot, Nyquist plots to study the stability of the system using a software package.	L1,L2,L3,L4, L5	1,2,5,9,10
CO328.6	Discuss with a small team to carryout experiments and prepare reports that present lab work.	L1,L2,L3,L4, L5,L6	1,2,5,9,10
Total Hours of instruction		**42**	

4.0 Course Content

Experiments

1. Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor
2. Experiment to draw synchro pair characteristics
3. Experiment to determine frequency response of a second order system
4. (a)To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response.
   (b) To determine experimentally the transfer function of the lead compensating network.
5. (a)To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response.
   (b) To determine experimentally the transfer function of the lag compensating network
6. Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.

Experiments 7 to 11 must be done using MATLAB/SCILAB only.

7. (a) To simulate a typical second order system and determine step response and evaluate time response specifications.
   (b) To evaluate the effect of additional poles and zeros on time response of second order system.

(c) To evaluate the effect of pole location on stability
(d) To evaluate the effect of loop gain of a negative feedback system on stability.

8. To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.
9. (a) To simulate a D.C. Position control system and obtain its step response.
(b) To verify the effect of input waveform, loop gain and system type on steady state errors.
(c) To perform trade-off study for lead compensator.
(d) To design PI controller and study its effect on steady state error.
10 (a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response
(b) To study the effect of open loop gain on transient response of closed loop system using root locus.
11 (a) To study the effect of open loop poles and zeros on root locus contour
(b) To estimate the effect of open loop gain on the transient response of closed loop system using root locus.
(c) Comparative study of Bode, Nyquist and root locus with respect to stability.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VII	Advanced Control Systems	Stability of systems
02	VIII	Project work	System Control Applications

6.0 Relevance to Real World

SL. No	Real World Mapping
01	State-of-the-art actuators and sensors in feedback control systems may be used in any system, including biological propulsion; locomotion; robotics; material handling; biomedical, surgical, and endoscopic; aeronautics; marine; and the defense and space industries.

7.0 Books Used and Recommended to Students

Text Books

1. Control Systems by Anand Kumar.

Reference Books

1. Automatic Control Systems by Farid Golnaraghi, Benjamin C. Kuo, Wiley , 9th Edition, 2010.
2. Control Systems Engineering by Norman S. Nise, 4th Edition, 2004.
3. Modern Control Systems by Richard C Dorf et al, Pearson, 11th Edition, 2008.
4. Control Systems, Principles and Design by M.Gopal , McGaw Hill, 4th Edition, 2012.
5. Control Systems Engineering by S. Salivahanan et al, Pearson, 1st Edition, 2015.

Additional Study material & e-Books

1. Control Engineering by Ganesh Rao and Chennavenkatesh, Pearson.

8.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1) www.VSSUT.ac.in
2) www.Smartzworld.com
3) www.Scribd.com

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	IEEE Xplore: IEEE Control Systems Magazine	www.ieeexplore.ieee.org
2	Journal of Control Theory and Applications, Journal of Real-Time Image Processing etc	www.Springer.com

10.0 Examination Note

Internal Assessment:
Question can appear on any of experiment.
Scheme of Evaluation for Internal Assessment (20 Marks)
Internal Assessment test in the same pattern as that of the main examination.

Write up	1.5 Marks
Conduction	7 Marks
Viva – Voce	1.5 Marks
Journal	10 Marks
	20 Marks

SCHEME OF EXAMINATION:
One question can be set on any of the experiment

Write up	12 Marks
Conduction	56 Marks
Viva – Voce	12 Marks
	80 Marks

11.0 Course Delivery Plan

Expt No	Lecture / Pract No	Name of the Experiment	% Of Portion
1	1	Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor	8.33%
2	2	Experiment to draw synchro pair characteristics	8.33%
3	3	Experiment to determine frequency response of a second order system	8.33%
4	4	a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lead compensating network.	8.33%
5	5	(a)To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lag compensating network	8.33%
6	6	Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function..	8.33%
7	7	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. (b) To evaluate the effect of additional poles and zeros on time response of second order system. (c) To evaluate the effect of pole location on stability (d) To evaluate the effect of loop gain of a negative feedback system on stability.	8.33%
8	8	To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.	8.33%
9	9	(a) To simulate a D.C. Position control system and obtain its step response. (b) To verify the effect of input waveform, loop gain and system type on steady state errors. (c) To perform trade-off study for lead compensator. (d) To design PI controller and study its effect on steady state error.	8.33%
10	10	(a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response (b) To study the effect of open loop gain on transient response of closed loop system using root locus.	8.33%
11	11	(a) To study the effect of open loop poles and zeros on root locus contour (b) To estimate the effect of open loop gain on the transient response of closed loop system using root locus. (c) Comparative study of Bode, Nyquist and root locus with respect to stability.	8.33%

12.0 QUESTION BANK

1. What is control System?
2. What is open loop control system?
3. What is open loop control system?
4. Differentiate between open and closed loop control system.
5. What is lead compensating network?
6. What is lag compensating network?
7. What is lead- lag compensating network?
8. What is Servo motor?
9. What are the features does Servo Motors possess?
10. What is the difference between AC servomotor and two phase induction motors?
11. Compare AC servo motor and DC servo motors?
12. Some Applications where Servo motors are used?
13. What is Synchro?
14. What is Synchro pair?
15. What are the applications of Synchro pair?
16. What is Proportional Controller? Advantages and Disadvantages?
17. What is Integral Controller? Advantages and Disadvantages?
18. Why Derivative Controller is not used in isolation like Proportional and Integral?
19. For reducing Steady State error which type of controller is used?
20. What is Reset rate?
21. Which type of controller anticipates the error?
22. What is Order of the system?
23. What is Time response of the control system?
24. How Time response of the system is divided?
25. What are Test signals and their significance?
26. What is Pole of the system?
27. What is Zero of the system?
28. What is gain margin in bode plot?
29. Define phase margin in bode plot.
30. Define state , state space, State variable.

13.0 University Results

Sl.No	Students Appeared	No of Students Passed	Percentage of Passing
1	47	46	97.87%

Prepared by	Checked by		
31/1		31.1.19	
Shri. Keshav B Negalur	Shri. O B Heddurshetti	HOD	Principal

Subject Title	**DIGITAL SIGNAL PROCESSING LABORATORY**		
Subject Code	15EEL68	**IA Marks**	20
No of Practical Hrs / Week	03	**Exam Marks**	80
Total No of Practical Hrs	42	**Exam Hours**	03
			CREDITS – 02

FACULTY DETAILS:		
Name: Prof. Pramod Murari	**Designation:** Asst. Professor	**Experience:** 08 Years
No. of times course taught: 01 Time	**Specialization:** Power System and Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	IV	Operation amplifiers and linear IC's
02	Electrical & Electronics Engineering	V	Signals and systems

2.0 Course Objectives

- To explain the use of MATLAB software in evaluating the DFT and IDFT of given sequence
- To verify the convolution property of the DFT
- To design and implementation of IIR and FIR filters for given frequency specifications.
- To realize IIR and FIR filters.
- To help the students in developing software skills

3.0 Course Outcomes

The student, after successful completion of the course, will be able to

CO	Course Outcome	Cognitive Level	Pos
CO329.1	Show the physical interpretation of sampling theorem in time and frequency domains.	L1,L2,L3,L4,L5	1,2,9,10
CO329.2	Evaluate the impulse response of a system.	L1,L2,L3,L4,L5	1,2,9,10
CO329.3	Perform convolution of given sequences to evaluate the response of a system	L1,L2,L3,L4,L5	1,2,9,10
CO329.4	Compute DFT and IDFT of a given sequence using the basic definition and/or fast methods.	L1,L2,L3,L4,L5	1,2,9,10
CO329.5	Provide a solution for a given difference equation.	L1,L2,L3,L4,L5	1,2,9,10
CO329.6	Design and implement IIR and FIR filters	L1,L2,L3,L4,L5	1,2,9,10
Total Hours of instruction		**42**	

4.0 Course Content

Experiments

1. Verification of Sampling Theorem both in time and frequency domains
2. Evaluation of impulse response of a system
3. To perform linear convolution of given sequences
4. To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.
5. Computation of N – point DFT and to plot the magnitude and phase spectrum

6. Linear and circular convolution by DFT and IDFT method
7. Solution of a given difference equation.
8. Calculation of DFT and IDFT by FFT
9. Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject Filters)
10. Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions
11. Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique
12. Realization of IIR and FIR filters

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work	Automation

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Digital photo camera,MP3 players to automobiles.
02	Speech processing, Image processing.
03	Application of audio processing.

7.0 Books Used and Recommended to Students

Text Books
1. Introduction to Digital Signal Processing, Johnny R. Johnson, Pearson, 1st Edition, 2016.
Reference Books
1."Digital Signal Processing – Principles, Algorithms, and Applications, Jhon G. Proakis, Dimitris G. Manolakis Pearson 4th Edition, 2007. 2. Digital Signal Processing A.NagoorKani McGraw Hill, 2nd Edition, 2012. 3. Digital Signal Processing, Shaila D. Apte, Wiley ,2nd Edition, 2009, 4. Digital Signal Processing, Ashok Amberdar, Cengage, 1stEdition, 2007
Additional Study material & e-Books

8.0 Relevant Websites (Reputed Universities and Others) for Notes/Animation/Videos Recommended

Website and Internet Contents References
1. http://freevideolectures.com/Course/2339/Digital-Signal-Processing-IITKharagpur
2. https://www.youtube.com/playlist?list=PLaJppqXMef2ZHIKM4vpwHIAWyRmw3TtSf
3. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/

9.0 Magazines/Journals Used and Recommended to Students

SL.No	Magazines/Journals	Website
1	Elsevier Journal	https://www.journals.elsevier.com/digital-signal-processing/
2	ICGST Journal of Digital signal processing	http://www.icgst.com/journals/journal.aspx?subid=45
3	InternationalJournal of Advancements in Digital Signal Processing	http://journals.theired.org/ijdsp.html
4	**Science Direct**	http://www.sciencedirect.com/science/journal/10512004

10.0 Examination Note

Internal Assessment:
Theoretical aspects as well as relevant circuits should be drawn neatly for questions asked in Internal Assessments

Scheme of Evaluation for Internal Assessment (20 Marks)
(a) Internal Assessment test in the same pattern as that of the main examination: 10marks.
(b) Continuous Assessment: 10marks

SCHEME OF EXAMINATION:
One question to be set from list of experiments for 10 Marks
Write up- 3 marks
Conduction and Result- 5 marks
Viva Voce- 2 marks
Continuous assessment/ Journal Writing- 10 marks

11.0 Course Delivery Plan

Expt No	Lecture / Pract No	Name of the Experiment	% Of Portion
1	1	Verification of Sampling Theorem both in time and frequency domains.	8.33%
2	2	Evaluation of impulse response of a system.	8.33%
3	3	To perform linear convolution of given sequences.	8.33%
4	4	To perform circular convolution of given sequences using (a) the convolution summation formula (b) the matrix method and (c) Linear convolution from circular convolution with zero padding.	8.33%
5	5	Computation of N – point DFT and to plot the magnitude and phase spectrum.	8.33%
6	6	Linear and circular convolution by DFT and IDFT method.	8.33%
7	7	Solution of a given difference equation.	8.33%
8	8	Calculation of DFT and IDFT by FFT	8.33%
9	9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject Filters)	8.33%
10	10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions	8.33%
11	11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.	8.33%
12	12	Realization of IIR and FIR filters.	8.33%

12.0 QUESTION BANK

1. What is MATLAB?
2. What are the applications of MATLAB?
3. State sampling theorem.
4. What is meant by Nyquist rate and Nyquist criteria?
5. Explain scaling and superposition properties of a system.
6. What is meant by linearity of a system and how it is related to scaling and superposition?
7. What is impulse function?
8. What is meant by impulse response?
9. What is energy signal? How to calculate energy of a signal?
10. What is power signal? How to calculate power of a signal?
11. Differentiate between even and odd signals.
12. Explain time invariance property of a system with an example.
13. What is memory less system?
14. When a system is said to have memory?
15. What is meant by causality?

16. Explain linear convolution and circular convolution.
17. What is the length of linear and circular convolutions if the two sequences are having the length n1 and n2?
18. What are Fourier series and Fourier transform?
19. What are the advantages and special applications of Fourier transform, Fourier series, Z transform and Laplace transform?
20. Differentiate between DTFT and DFT. Why it is advantageous to use DFT in computers rather than DTFT?
21. What is cross-correlation?
22. What are the advantages of using autocorrelation and cross correlation properties in signal processing fields?
23. How auto-correlation can be used to detect the presence of noise?
24. Differentiate between IIR filters and FIR filters.
25. What is the procedure to design a digital Butterworth filter?
26. What is the difference between Butterworth, Chebyshev I and Chebyshev II filters?
27. What are difference equations and differential equations?
28. What is non real time processing?
29. What is a Digital Signal Processor (DSP)?
30. What is meant by real time processing?

Examination	Appeared	Passed	% Passing
May/June 2018	47	46	97.87

Prepared by	Checked by		
31.1.19	31/1/19	31.1.19	
Prof. Pramod Murari	Prof. M.P.Yanagimath	HOD	Principal