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
	17MAT31- Engineering Mathamatics-III-M-3 17EE32-Electric Circuit Analysis-ECA 17EE33-Transformers & Generators-T&G 17EE34-Analog Electronic Circuits-AEC 17EE35- Digital System Design-DSD 17EE36-Electrical & Electronic Measurements -EEM **Laboratory – Course Plan and Viva Questions** 17EEL37-Electrical Machine's Laboratory-IM/C Lab-1 17EEL38-Electronics Lab- EC Lab 17KL/CPH39/49-Kannada, Constitution of India Professional ethics and human rights

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

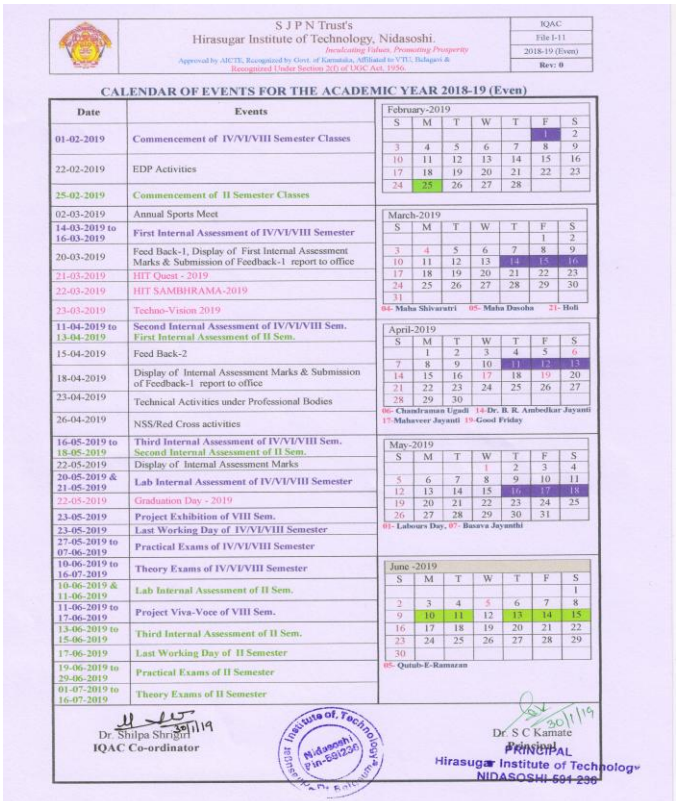
SN	Name of the Laboratory	Carpet Area (Sq.mt)	Total investment till date
1.	Electronics Lab	92	576516.80
2.	Operational Amplifiers & Linear IC Lab	72	111537.00
3.	Power Electronics Lab	92	770111.00
4. Microcontroller Lab 5. DSP Lab		72	582174.00
6.	Control System Lab	72	212755.00
7.	Electrical Machines 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
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17	18	19	20	21	22	23
24	25	26	27	28		

March-2019

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24	25	26	27	28	29	30
31						

04- Maha Shivaratri 05- Maha Dasoha 21- Holi

April-2019

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21	22	23	24	25	26	27
28	29	30				

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

May-2019

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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

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23	24	25	26	27	28	29
30						

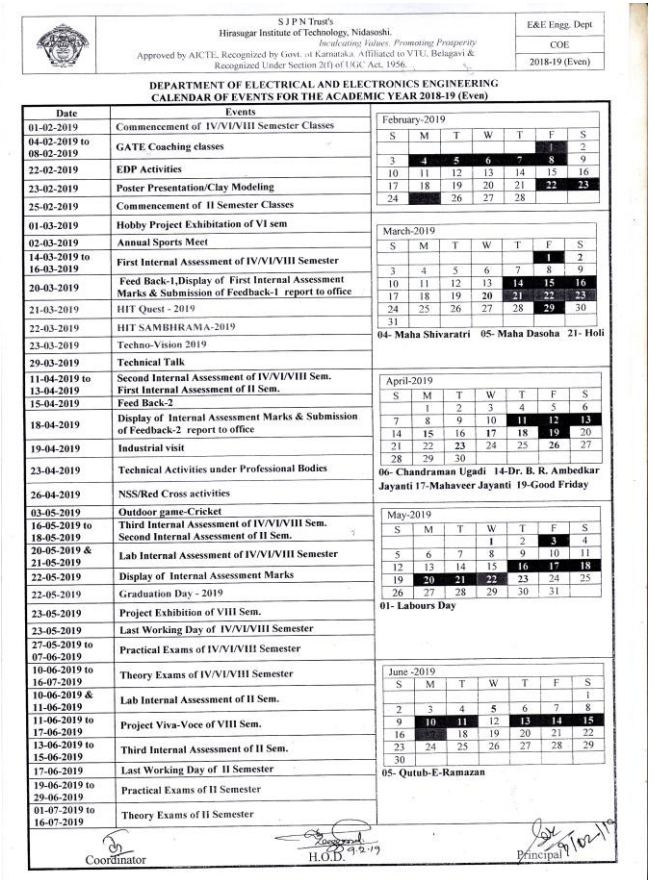
05- Qutub-E-Ramazan

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

Dr. S C Kamate
Principal
30/1/19

PRINCIPAL
Hirasugar Institute of Technology
NIDASOSHI 591 236

5.0 Department Academic calendar



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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		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		18	19	20	21	22
23	24	25	26	27	28	29
30						

05- Qutub-E-Ramazan

Coordinator H.O.D. 27.2.19 Principal 27/2/19

5.1 Scheme of Teaching & Examination

IV SEMESTER

Sl. No	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT41	Engineering Mathematics-IV (Core)	Mathematics	04		03	60	40	100	4
2	17EE42	Power Generation and Economics (Core)	EEE	04		03	60	40	100	4
3	17EE43	Transmission and Distribution (Core)	EEE	04		03	60	40	100	4
4	17EE44	Electric Motors (Core)	EEE	04		03	60	40	100	4
5	17EE45	Electromagnetic Field Theory (Core)	EEE	04		03	60	40	100	4
6	17EE46	Operational Amplifiers and Linear ICs (Foundation course)	EEE	03		03	60	40	100	3
7	17EEL47	Electrical Machines Laboratory -2	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17EEL48	Op- amp and Linear ICs Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
			TOTAL	**Theory: 24hours Practical: 06 hours**		**25**	**510**	**340**	**850**	**28**

1. Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2.Audit Course:
(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – II, which is 03 contact hours per week.

Subject Title	Engineering Mathematics-IV		
Subject Code	17MAT41	IA Marks	40
Number of Lecture Hrs / Week	04	Exam Marks	60
Total Number of Lecture Hrs	50	Exam Hours	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. S. I. Shivamoggimath	**Designation:** Asst.Professor	**Experience:** 6.5
No. of times course taught: 04	**Specialization:** Mathematics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	III	Engineering Mathematics-III

2.0 Course Objectives

The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.

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	POs
CO1	Use appropriate single step and multi-step numerical methods to solve first and second order ordinary differential equations arising in flow data design problems.	1,2,,312
CO2	Explain the idea of analyticity, potential fields residues and poles of complex potentials in field theory and electromagnetic theory.	1,2,3,12
CO3	Employ Bessel's functions and Legendre's polynomials for tackling problems arising in continuum mechanics, hydrodynamics and heat conduction.	1,2,3,12
CO4	Describe random variables and probability distributions using rigorous statistical methods toanalyze problems associated with optimization of digital circuits, information, coding theory and stability analysis of systems.	1,2,3,12
CO5	Apply the knowledge of joint probability distributions and Markov chains in attempting engineering problems for feasible random events.	1,2,3,12
Total Hours of instruction		**50**

4.0 Course Content

MODULE-I

Numerical Methods: Numerical solution of ordinary differential equations of first order and first degree, Taylor's series method, modified Euler's method, Runge - Kutta method of fourth order. Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae). (10 Hours)

MODULE-II

Numerical Methods: Numerical solution of second order ordinary differential equations, Runge-Kutta method and Milne's method.

Special Functions:. Series solution of Bessel's differential equation leading to Jn(x)-Bessel's function, Bessel orthogonality. Series solution of Legendre's differential equation leading to Pn(x)-Legendre polynomials. Rodrigue's formula, problems (10Hours)

MODULE-III

Complex Variables: Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula.

Residue, poles, Cauchy's Residue theorem (without proof) and problems.

Transformations: Conformal transformations, discussion of transformations: $w = z^2$, $w = e^z$, $w = z + 1/z$ and bilinear transformations-problems. (10 Hours)

MODULE-IV

Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.

MODULE-V

Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

Stochastic process:

Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability simple problems. (10 Hours)

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	Common to all	Common to all engineering Subjects	Signal and Analysis, Field Theory, Thermodynamics, Fluid Dynamics etc

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Numerical methods are used to solve engineering problems. For examples will be drawn from a variety of engineering problems, including heat transfer, vibrations, dynamics, fluid mechanics, etc.
02	Special functions are used to wave propagation and scattering, fiber optics, heat conduction in solids, and vibration phenomena.
03	In signal processing, sampling is the reduction of a continuous signal to a discrete signal. A common example is the conversion of a sound wave (a continuous signal) to a sequence of samples (a discrete-time signal).

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Topic: Sampling Theory

8.0 Books Used and Recommended to Students

Text Books
'1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015. 2. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.
Reference Books
1. N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers,7th Ed., 2010. 2. B.V.Ramana: "Higher Engineering M athematics" Tata McGraw-Hill, 2006. 3. H. K. Dass and Er. RajnishVerma: "Higher Engineerig Mathematics", S. Chand publishing, 1st edition, 2011.
Additional Study material & e-Books
1. N.P.Bali & Manish.Goyal, A Text book of Engineering Mathematics, 7th edition, Laxmi Publications.

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

Website and Internet Contents References
1. http://nptel.ac.in/courses.php?disciplineID=111 2. http://wwww.khanacademy.org/ 3. http://www.class-central.com/subject/math

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	+ Plus Magazine	https://plus.maths.org/issue44.
2	Mathematics Magazine	www.mathematicsmagazine.com

11.0 Examination Note

Internal Assessment: 20 Marks
Theoretical aspects as well as relevant sketches should be drawn neatly.
Scheme of Evaluation for Internal Assessment (20 Marks)
(a) Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests): 15 Marks.
(b) Assignments: 05 Marks

SCHEME OF EXAMINATION:
Question paper pattern:
□ □ □The question paper will have **ten** full questions carrying equal marks.

2. Each full question consisting of **16** marks.
3. There will be **two** full questions (with a **maximum** of **four** sub questions) from each module.
4. Each full question will have sub question covering all the topics under a module.
5. The students will have to answer **five** full questions, selecting **one** full question from each module.

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
MODULE 1	1	Numerical solution of ordinary differential equations of first order & first degree	20
	2	Taylor's series method & Problems.	
	3	Modified Euler's method	
	4	Problems	
	5	Runge -Kutta method of fourth order	
	6	Problems	
	7	Milne's predictor and corrector method	
	8	Problems	
	9	Adams-Bashforth predictor and corrector method	
	10	Problems.	
MODULE 2	11	Numerical solution of second order ordinary differential equations	20
	12	Runge -Kutta method	
	13	Milne's method	
	14	Problems.	
	15	Series solution of Bessel's differential equation leading to Jn(x)	
	16	Properties of Bessel's functions.	
	17	$J_{\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}}\sin x$ & $J_{-\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}}\cos x$	
	18	Orthogonality of Bessel's functions.	
	19	Series solution of Legendre differential equation leading to Jn(x)-Legendre polynomials	
	20	Rodrigue's formula, problems	
MODULE 3	21	Review of a function of a complex variable, limits, continuity, differentiability	20
	22	Analytic functions-Cauchy-Riemann equation in Cartesian form	
	23	Cauchy-Riemann equation in Polar form	
	24	Properties and construction of analytic functions	
	25	Complex line integrals-Cauchy's theorem	
	26	Cauchy's integral formula	
	27	Residue, poles, Cauchy's Residue theorem	
	28	Conformal Transformations and discussion of transformations of $w = z^2$, $w = e^z$	
	29	Discussion of Transformations: $w = z + (1 / z)$.	
	30	Bilinear transformations & Problems	
MODULE 4	31	Random variables (discrete and continuous)	20
	32	Probability mass/density functions	
	33	Binomial distribution.	
	34	Poisson distribution.	
	35	Exponential distribution.	
	36	Normal distributions.	
	37	Problems.	
	38	Joint Probability distribution for two discrete random variables	
	39	Expectation, covariance.	
	40	Correlation coefficient	
MODULE 5	41	Sampling & Sampling distributions	
	42	standard error, test of hypothesis for means and proportions	
	43	confidence limits for means	
	44	student's t-distribution	
	45	Chi-square distribution as a test of goodness of fit.	
	46	Stochastic processes, probability vector	

	47	stochastic matrices, fixed points,	20
	48	regular stochastic matrices	
	49	Markov chains	
	50	higher transition probability simple problems	

14.0 QUESTION BANK

MODULE-1: NUMERICAL METHODS

1. Solve $dy/dx = x^2y-1$ with $y(0)=1$ using Taylor's series method and find $y(0.1)$ consider upto 4th degree terms.
2. Use Runge Kutta fourth order method to solve $dy/dx= y^2-x^2/y^2+x^2$ with $y(0)=1$ and find y for $x=0.2$ and 0.4 take $h=0.2$
3. Given $dy/dx = xy+ y^2$, $y(0)=1$, $y(0.1)=1.1169$,$y(0.2)=1.2773$, $y(0.3)=1.5049$ find $y(0.4)$ accurate upto three decimal places using Milne's predictour corrector method.
4. Applying R-K method to find an approximate value of y for $x=0.2$ in steps of 0.1 of $dy/dx= x+ y^2$ given that $y=1$ when $x=0$.
5. Given $dy/dx= x^2(1+ y)$ & $y(1)=1$,$y(1.1)=1.233$, $y(1.2)=1.548$,$y(1.3)=1.979$. Evaluate $y(1.4)$ by Adams Bash Fourth method
6. Employ Taylor's series method to find an approximate solution correct to fourth decimal places for the following initial value problem at $x=0.1$ & 0.2 $dy/dx=2y+3e^x$, $y(0)=0$.
7. Applying R-K method to find the approximate value of y for $x=0.2$ in step of $x=0.1$ given that $dy/dx= x+y^2$ with $y(0)=1$.
8. Using Milne's predictour corrector method find y where $x=0.8$ given $dy/dx= x-y^2$, $y(0)=0$, $y(0.2)=0.02$, $y(0.4)=0.0795$, $y(0.6)=0.1762$.Applying corrector formula twice.
9. Employ R-K method of 4rth order to solve the equation $dy/dx = 3x+y/2$, $y(0)=1$ at $x=0.2$ taking step lengthh=0.1
10. Solve the differential equation $dy/dx = x^2+y^2$ given $y(0)=1$ to find the value of $y(0.1)$ by using Taylor's series method of order.
11. Using modified Euler's method ,solve the equation $dy/dx = 1/x+y$, $y(0)=1$ in steps of 0.5 at $x=1$
12. Using Adams Bash fourth predictor correct method find y when $x=0.8$ given $dy/dx = x- y^2$, $y(0)=0$, $y(0.2)=0.02$, $y(0.4)=0.0795$, $y(0.6)=0.1762$. Apply correct formula twice.
13. Using Taylor's series method to find y at the point $x=0.1$& $x=0.2$ given that $dy/dx= x^2+y^2$,$y(0)=1$
14. From the data given below find y at $x=1.4$ using Milne's predictour corrector method $y'= x^2+y/2$

x	1	1.1	1.2	1.3
y	2	2.2156	2.4649	2.7514

MODULE-2: NUMERICAL METHODS AND SPECIAL FUNCTIONS

1. Use R- K method to solve $xy'^2 - y^2$ for x = 0.2 correct to 4 decimal places. $= 1 \& y'(0) = 0$
2. Given $y'' + xy' + y = 0$, $y(0)=1$, $y'(0)=0$, obtain y for x=o(0.1)0.3Milne's method & calculate $y(0.4)$.
3. Obtain the series solution of Bessel's differential equation $\frac{d^2y}{dx^2} + x\frac{dy}{dx} + (x^2 - n^2)y = 0$ in the form of $AJ_n(x) + BJ_{-n}(x)$
4. If α β are two distict roots of $) = 0$, then prove that $J_n(\alpha x)J_n(\beta x)\,dx = 0$ if $\alpha \neq \beta$.
5. Using R-K method of order four, solve $y'' = y+xy'$, $y(0) = 1$, $y'(0)$ to find $y(0.2)$ & $y'(0.2)$.
6. S.T. i) $J_{1/2} = \sqrt{2/\pi x}\ \sin x$, ii) $J_{-1/2} = \sqrt{2/\pi x}\ \cos x$.
7. Express $f(x) = x^4+3x^3-x^2+5x-2$ in terms of Legendary's polynomials.
8. Obtain the series solution of Bessel's differential equation in the form $y = AJn(x) + BJn(x)$
9. Establish the Rodirgue's formula for Legendre polynomials. S.T. i) $Pn(1)=1$, ii) $Pn(-1) = (-1)^n$
10. Express $f(x) = x^3+2x^2-x-3$ in terms of Legendre polynomials

MODULE-3: COMPLEX VARIABLES AND TRANSFORMATIONS

1. Derive Cauchy-Riemann equations in the Cartesian form.
2. Derive Cauchy-Riemann equations in the Polar form.

3. P.T if f(z)= u+iv is an analytic then the family of curves u(x,y)=C1 , v(x,y)= C2, C1 & C2 being Constants, intersect each other orthogonally
4. S.T w = log z ,$z \neq 0$ is analytic & find dw/dz.
5. S.T f(z) = z^n , where n is a positive is analytic & hence find its derivative.
6. Find the analytic function f(z)= u+iv given u-v= e^x(cosy-siny)
7. Find the analytic function f(z) as a function of z given that the sum of its real & imaginary parts is $x^3-y^3+3xy(x-y)$
8. Discuss the conformal transformation of $w=z^2$
9. Discuss the conformal transformation of $w=e^z$
10. Find the bilinear transformation which map the points z= 1, i, -i under this transformation find the image of |z| <1.
11. Find the bilinear transformation which maps z = ∞,i,0 into w=-1,-i,1. Also find the pts of transformation
12. State & prove Cauchy integral Theorem.
13. Verify Cauchy's theorem for the function f(z)= z^2 where c is the square having vertices (0,0) ,(1,0),(1,1) & (0,1)
14. Evaluate $\int e^z / z+i\pi$ dz over each of the following contours C, a) |z| =2π , b) |z| =π/2 , c) |z-1|=1
15. Evaluate $\int e^{2z} /(z+1)(z-2)$ dz where c is the circle |z|=3 using Residue Thm.

MODULE-4: PROBABILITY DISTRIBUTIONS AND JOINT PROBABILITY DISTRIBUTIONS

1. Find the mean & variance of Binomial distribution.
2. The marks of 1000 students in an examination follows in a normal distribution with mean 70 & SD 5. Find the number of students whose marks will be i) less than 65 , ii) more than 75 & iii) between 65 & 75.
3. The probability mass function of a variate X is

$X = x_i$	-2	-1	0	1	2	3
p(x)	0.1	K	0.2	2k	0.3	k

4. Find i) The value of K, ii) ≤ 0), iii) > 1) iv) $2 < x \leq 1$)
5. If 10% of the rivets produced by a machine are defective, find the probability that, out of 12 rivets chosen at random.
6. S.T mean & standard deviation of exponential distribution are equal.
7. In a test of 2000 electric bulbs, it was found that the life of a bulb is a normal variable with average life of 2040 hours & standard deviation of 60 hours. Estimate the number of bulbs to burn for i) More than 2150 hours , ii) less than 1950 hours , Given that p[$0 \leq z \leq 1.83$] = 0.4664 & p[$0 \leq z \leq 1.33$] = 0.4082.
8. 2% of the fusion manufactured by a firm are found to be defective .Find the probability that a box containing 200 fuses contains i) no defective fuse , ii) 3 or more defective fuses.
9. In length of a telephone conversation is an exponential vitiate with mean 3 minutes. Find the probability that call i) ends in less than 3 minutes , ii) takes between 3 to 5 minutes.
10. Suppose that the student IQ scores form a normal distribution with average 100 & standard deviation 20. Find the percentage of students whose (i) score less than 80 (ii) score more than 120 (iii) score falls between 80 & 120 (G T P(1)=0.3413)
11. In a certain town the duration of a shower is exponentially distributed with mean 5 minutes what is the probability that a shower will least for i) 10 minutes or more, ii) less than 10 minutes, iii) betn 10 min & 12 min
12. The joint probability distribution for two random variables X and Y is as given below.

Y / X	-2	-1	4	5
1	0.1	0.2	0	0.3

2	0.2	0.1	0.1	0

Find the marginal distributions of X, Y. Also find the covariance of X and Y.

13. The Joint probability distribution of two random variables X and Y is as follows

X \ Y	-4	2	7
1	1/8	1/4	1/8
5	1/4	1/8	1/8

14. Determine (i) Marginal distribution of X & Y (ii) E(X) , E(Y) and E(XY) (iii) Cov (XY) (iv) .
15. A fair coin is tossed 4 times. Let X denotes the number of heads occurring and let Y denotes the longest string of heads occurring. Find the joint distribution function of X and Y.

MODULE-5: SAMPLING THEORY AND STOCHASTIC PROCESS

1. Explain the following terms i) Null hypothesis , ii) Level of significance , iii) Type I & II errors , iv) Confidence limits.
2. A sample of 100 days is taken from meteorological records of certain districts & 10 of them are found to be fussy. Find the 99.73 % confidence interval of the % of fussy days in the distinct.
3. A certain stimulus administered to each of the 12 patients resulted in the following blood pressure 5,2,8,-1,3,0,6,-2,1,5,0,4, can it be calculated that stimulus will increase the blood pressure ?

   [t 0.05 for 11d.f= 2.201]
4. A die was thrown 9000 times & a throw of 5 or 6 was obtained 3240 times. On the assumption of random throwing, do the data abdicate that the die is biased?
5. A random sample of 100 records deaths in past year showed an average life span of 71.8 years. Assuming a population standard deviation of 8.9 years, does the data indicated that average life span today is greater than 70 years? Use a 0.05 level of significance.
6. In 324 throws of a six faced die, an odd number turned up 181 times. Is it reasonable to think that the die is an unbiased one?
7. Four coins are tossed 100 times & the following results were obtained

No. of Heads	0	1	2	3	4
Frequencies	5	29	36	25	5

   Fit a Binomial distribution for the data & test the goodness of fit given
   $\chi^2_{0.05} = 9.49$ for 4 d.f
8. Find the student's 't' for the following variable values in a sample of eight -4,-2,-2,0,2,2,3,3 taking the mean of the universe to be zero.
9. A coin was tossed 400 times & the head turned up 216 times. Test the hypotheses that the coin is in biased at 5% level significance.

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EEE Engg. Dept.
Academic
Course Plan
Even sem (2018-19)

10. A die was thrown 1200 times & the number 6 was obtained 236 times. Can the die be considered fair at level of significance?

11. Explain i) Random sample ii) Sample mean iii) Population mean

12. Find the fixed probability vector of the regular stochastic matrix $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1/2 & 1/2 & 0 \end{bmatrix}$

13. Explain i) Transient state ii) Recurrent state iii) absorbing state of Markov chain

14. Each year a man trades his car for a new car in 3 brands of the popular company Maruti Udyuog Limited. If he has a 'standard' he trades it for 'zen'. If he has a 'zen' he trades it for a 'Esteem'. If he has a 'Esteem' is just as likely to trade it for a new 'Esteem' or for a 'zen' or a 'standard'. In 1996 he bought his first car which was 'Esteem'. Find the probability that he has (i) 1999 Esteem (ii)1998 Standard (iii)1999 Zen

15. Define stochastic matrix. Find the unique fixed probability vector for the regular stochastic matrix

$$\begin{bmatrix} 0 & 1 & 0 \\ 1/2 & 0 & 1/2 \\ 1/2 & 1/4 & 1/4 \end{bmatrix}$$

16. Find the fixed probability vector of the regular stochastic matrix $A=\begin{bmatrix} 0.5 & 0.25 & 0.25 \\ 0.5 & 0 & 0.5 \\ 0 & 1 & 0 \end{bmatrix}$

16.0 University Result

Examination	S+	S	A	B	C	D	E	% Passing
January 2018	0	3	7	16	9	9	0	81.48

Prepared by	Checked by		
Prof. S. I. Shivamoggimath	Prof. S. L. Patil	HOD	Principal

Page 8

Subject Title	**POWER GENERATION AND ECONOMICS**		
Subject Code	17EE42	**IA Marks**	40
Number of Lecture Hrs / Week	04	**Exam Marks**	60
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof.Sujata.G.Huddar	**Designation:** Asst.Professor	**Experience:**05
No. of times course taught:03	**Specialization:** Power System Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & electronics engineering	I/II	BEE.
02	Electrical & electronics engineering	III	T&G.
03	Mechanical Engineering	I/II	Basics of Mechanical Engineering.
04	Applied Science	I/II	Engineering Physics.

2.0 Course Objectives

- Explain the arrangement and operation of hydroelectric, steam, diesel, gas turbine and nuclear Power plants and working of major equipment in the plants.
- Classification of substation and explain the operation of different substation equipment.
- Explain the importance of grounding and different grounding methods used in practice.
- Explain the economics of power generation and importance of power factor.

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
CO210.1	Describe the working of hydroelectric, power plant and state functions of major equipment of the power plant.	U	PO1,PO2, PO6, PO7
CO210.2	Describe the working of steam power plant and state functions of major equipment of power plant.	U	PO1,PO2, PO6, PO7
CO210.3	Describe the working of Nuclear power plant and explain classification of Nuclear reactors.	U	PO1,PO2, PO6, PO7
CO210.4	Classify various substations and explain the importance of grounding	U,A	PO1,PO2, PO6, PO7
CO210.5	Understand the economic aspects of power system operation, its effects and importance of power factor improvement.	U,A	PO1,PO2, PO6, PO7
Total Hours of instruction		**50**	

4.0 Course Content

Module-1

Hydroelectric Power Plants: Hydrology, Run off and stream flow, Hydrograph, Flow duration curve, Mass curve, Reservoir capacity, Dam storage. Hydrological cycle, Merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, Elements of the plant, Classification of the plants based on water flow regulation, Water head and type of load the plant has to supply. Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines governing of turbines, Selection of water turbines. Underground, Small hydro and pumped storage plants. Choice of size and number of units, Plant layout and auxiliaries. 10 Hours

Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding

Module-2

Steam Power Plants: Introduction, Efficiency of steam plants, Merits and demerits of plants, Selection of site. Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling, Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control, Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, Plant auxiliaries.

Diesel Power Plant: Introduction, Merits and demerits, Selection site, Elements of diesel power plant, Applications.

Gas Turbine Power Plant: Introduction Merits and demerits, Selection site, Fuels for gas turbines, Elements of simple gas turbine power plant, Methods of improving thermal efficiency of a simple steam power plant, closed cycle gas turbine power plants. Comparison of gas power plant with steam and diesel power plants. 10Hours

Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding

Nuclear Power Plants: Introduction, Economics of nuclear plants, Merits and demerits, selection of site, Nuclear reaction, Nuclear fission process, Nuclear chain reaction, Nuclear energy, Nuclear fuels, Nuclear plant and layout, Nuclear reactor and its control, Classification of reactors, Power reactors in use, Effects of nuclear plants, Disposal of nuclear waste and effluent, Shielding. 10Hours

Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding

Module-4

Substations: Introduction to Substation equipment; Transformers, High Voltage Fuses, High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters, High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors, Measuring Instruments and power line carrier communication equipment. Classification of substations – indoor and outdoor, Selection of site for substation, Busbar arrangement schemes and single line diagrams of substations. Interconnection of power stations. Introduction to gas insulated substation, Advantages and economics of Gas insulated substation.

Grounding: Introduction, Difference between grounded and ungrounded system. System grounding – ungrounded, Solid grounding, Resistance grounding, Reactance grounding and resonant grounding. Earthing transformer. Neutral grounding and neutral grounding transformer. 10Hours

Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding

Module-5

Economics: Introduction, Effect of variable load on power system, classification of costs, Cost analysis. Interest and Depreciation, Methods of determination of depreciation, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants. Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, Disadvantages and causes of low power factor, Methods of improving power factor, Economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment. 10Hours

Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.

5.0 Relevance to future subjects

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

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Economics of Nuclear power plants.
02	Basic knowledge of single line diagram of substations & usage of different types of protective devices.
03	Basic Knowledge of Site selection for different types of power plants construction.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Industrial Visit	To Meet Industry/Profession Requirements For Effective Learning Of Practical Operation Of The Generating Stations (Diesel ,Thermal ,Hydroelectric Power Plants) through Industrial Visit.
02	NPTEL&conducting Extra Classes.	Awareness towards to the Importance of High Load Factor.

8.0 Books Used and Recommended to Students

Text Books

- A Course in Power Systems by J.B. Gupta Katson 2008.
- Generation of Electrical Energy by B.R.Gupta S. Chand 2015.
- Electrical power Generation, Transmission and Distribution by S.N. Singh PHI 2nd Edition, 2009.
- Power Plant Engineering by P.K. Nag Mc Graw Hill 4th Edition, 2014.
- Electrical Power Distribution Systems by V. Kamaraju Mc Graw Hill 1st Edition, 2009.

Reference Books

- Electrical Distribution Engineering Anthony by J.Pansini CRC Press 3rd Edition, 2006.
- Electrical Distribution Systems by Dale R Patrick Et al CRC Press 2nd Edition, 2009.
- A Text Book on Power System Engineering by A.Chakrabarti, et al Dhanpath Rai 2nd Edition, 2010.

Additional Study material & e-Books

- M V Deshpande, Elements Of Electrical Power Station Design, Phi
- P.S. Pabla, Electric Power Distribution, Tata Mcgraw Hill
- D P Kothari And I J Nagrath , Power System Engineering:, Tata Mcgraw Hil
- S N Singh, Electric Power Generation, Transmission And Distribution, Phi Reference Books.

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

Website and Internet Contents References

1) libguides.library.qut.edu.au/energy/powereng
2) http://NPTEL.com/
3) www.electrical4u.com

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Power Magazine Business & Technology for the Global Generation Industry Since 1882	www.powermag.com
2	Renewable energy Journal Elseiver.	https://www.journals.elsevier.com/renewable-energy/
3	IEEE xplore:IEEE power & Energy Magazine	ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8014

11.0 Examination Note

Internal Assessment: 30 Marks
There are four main questions of 15 Marks
Students have to answer any two full questions of each 15Marks selecting from Q.No 1 & Q.No 2.
Scheme of Evaluation for Internal Assessment (30 Marks)
(a) Internal Assessment test will be done in the same pattern as that of the main examination

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 No	Lecture No.	Content of Lecturer	% of Portion
		PART - A	
Module 1	1	**Hydroelectric Power Plants:** Hydrology, Run off and stream flow.	20%
	2	Hydrograph Flow duration curve, Mass curve, Reservoir capacity, Dam storage.	
	3	Hydrological cycle, Merits and demerits of hydroelectric power plants, Selection of site.	
	4	General arrangement of hydel plant, Elements of the plant.	
	5	Classification of the plants based on water flow regulation, Water head and type of load the plant has to supply.	
	6	Water turbines – Pelton wheel, Francis.	
	7	Kaplan and propeller turbines.	
	8	Characteristic of water turbines Governing of turbines, Selection of water turbines.	
	9	Underground, Small hydro and pumped storage plants.	
	10	Choice of size and number of units, Plant layout and auxiliaries.	
Module 2	11	**Steam Power Plants:** Introduction, Efficiency of steam plants, Merits and demerits of plants, Selection of site.	20%
	12	Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling.	
	13	Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control.	
	14	Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, Plant auxiliaries.	
	15	**Diesel Power Plant:** Introduction, Merits and demerits.	
	16	Selection site, Elements of diesel power plant, Applications.	
	17	**Gas Turbine Power Plant**: Introduction, Merits and demerits.	
	18	Selection site, Fuels for gas turbines, Elements of simple gas turbine power plant.	

	19	Methods of improving thermal efficiency of a simple steam power plant, Closed cycle gas turbine power plants.	
	20	Comparison of gas power plant with steam and diesel power plants.	
Module 3	21	**Nuclear Power Plants:** Introduction, Economics of nuclear plants.	20%
	22	Merits and demerits, selection of site.	
	23	Nuclear reaction, Nuclear fission process, Nuclear chain reaction.	
	24	Nuclear energy, Nuclear fuels.	
	25	Nuclear plant and layout, Nuclear reactor and its control.	
	26	Classification of reactors, Power reactors in use.	
	27	Effects of nuclear plants.	
	28	Disposal of nuclear waste and effluent, Shielding.	
Module 4	29	**Substations:** Introduction to Substation equipment; Transformers, High Voltage Fuses.	20%
	30	High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters	
	31	High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors.	
	32	Measuring Instruments and power line carrier communication equipment.	
	33	Classification of substations – indoor and outdoor, Selection of site for substation, Bus bar arrangement schemes and single line diagrams of substations.	
	34	Interconnection of power stations. Introduction to gas insulated substation, Advantages and economics of Gas insulated substation.	
	35	**Grounding:** Introduction, Difference between grounded and ungrounded system.	
	36	System grounding – ungrounded, Solid grounding, Resistance grounding, Reactance grounding and resonant grounding.	
	37	Earthing transformer. Neutral grounding and neutral grounding transformer.	
Module 5	38	**Economics:** Introduction, Effect of variable load on power system,	
	39	Classification of costs, Cost analysis.	20%
	40	Interest and Depreciation, Methods of determination of depreciation,	
	41	Economics of Power generation, different terms considered for power plants and their significance, load sharing.	
	42	Choice of size and number of generating plants. Tariffs, objective.	
	43	Factors affecting the tariff, types. Types of consumers and their tariff.	
	44	Power factor, Disadvantages and causes of low power factor, Methods of improving power factor.	
	45	Economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment.	

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 Hydroelectric power plants	Students are capable to identify different types of water turbines & understand the working of different hydro power plants.	Module 1	2	Individual Activity. Written solution expected.	Book 1, 3, 4 of the text book list. Website of the Reference list
2	Assignment 2: University Questions on Steam power plants, Diesel power plant, Gas turbine power plant.	Students understand the working of steam & diesel power plants.	Module 2	4	Individual Activity. Written solution expected.	Book 1, 3, 4 of the text book list. Website of the Reference list
3	Assignment 3: University Questions on Nuclear power plants.	Students explain the operation of Nuclear power plant & Nuclear fission process.	Module 3	6	Individual Activity. Written solution expected.	Book 1, 3, 4 of the text book list. Website of the Reference list
4	Assignment 4:	Students are capable to	Module 4	8	Individual Activity.	Book 1, 3, 4 of

	University Questions on Substations.	identify different types of protective devices & lightning arresters.			Written solution expected.	the text book list. Website of the Reference list
5	Assignment 5: University Questions on Economics.	Students are capable to elaborate causes of low power factor & different power factor improvement methods.	Module 5	10	Individual Activity. Written solution expected.	Book 1, 3, 4 of the text book list. Website of the Reference list

14.0 QUESTION BANK

MODULE 1: HYDROELECTRIC POWER PLANTS

1. Explain the factors to be considered for the selection of site for hydroelectric power plant?
2. Mention the classification of hydel power plants?
3. Define Flow duration curve & Mass curve?
4. Explain merits & demerits of hydroelectric power plants?
5. With neat sketch explain the working of Francis, Kaplan and propeller turbine?
6. Write a note on selection of water turbines?
7. Explain small hydro power plant?
8. Define hydrology, run off & stream flow?
9. Define i) hydrograph ii) flow duration curve and mass curve?
10. Explain the essential elements of hydro power plant with neat schematic diagram?
11. Explain the governing mechanism of hydraulic impulse turbine and reaction turbine with neat sketches?
12. Explain the classification of hydroelectric power plant based on water head?
13. Explain the components of high head hydroelectric power plant with its schematic arrangement?

MODULE 2: STEAM POWER PLANTS, DIESEL & GAS TURBINE POWER PLANT

1. Write a note on merits & demerits of steam power plant?
2. Explain the selection of site for steam power plant?
3. With neat sketch explain the working of steam plant?
4. Write a note on steam turbines?
5. Write a note on merits & demerits of Diesel power plant?
1. Mention the elements of diesel power plant & applications?
2. Mention merits & demerits of Gas turbine power plant?
3. Explain the methods of improving thermal efficiency of a simple steam power plant?
4. Explain Closed cycle gas turbine power plant?
5. Write comparison of gas power plant with steam & diesel power plant?
6. Explain the techniques of dust collection in thermal power station?
7. Explain the function of air-preheater and economizer in thermal plant?
8. Mention the application of Diesel power plant?
9. With neat sketch explain the working of a gas turbine plant?
10. Mention the application of Diesel power plant?
11. Mention the classification of stokers?

MODULE 3: NUCLEAR POWER PLANTS

1. What are the Economics of Nuclear power plants?
2. Mention merits & demerits of Nuclear power plant?
3. Explain site selection procedure for Nuclear power plant?
4. Write a note on Nuclear reaction & Nuclear chain reaction?
5. Explain Nuclear fission process?
6. Explain Nuclear reactor & its control?
7. Write a note classification of reactors?
8. Explain effects of Nuclear plants?
9. Explain how disposal of Nuclear waste and effluent is performed?
10. Describe construction and working of a Pressurized water reactor?
11. Explain the working operation of Nuclear power plant with neat sketch?
12. Give the various classifications of Nuclear reactor and explain each?
13. Explain the function of moderator, control rod, coolant in nuclear power plant?
14. Write briefly about Nuclear waste disposal?

15. Explain the Boiling water reactor with diagram?

MODULE 4: SUBSTATIONS, GROUNDING

1. Write a note on
   - High voltage fuses
   - High voltage circuit breakers
   - Lightning arresters
   - High voltage insulators & conductors.
2. Explain Measuring instruments & power line carrier communication equipments used in substations?
3. Explain indoor and outdoor substations?
4. With neat sketch explain Gas insulated substation?
5. Mention advantages & economics of Gas insulated substation?
6. Write a note on site selection procedure for substation?
7. Differentiate between grounded and ungrounded system?
8. Explain resistance grounding and reactance grounding?
9. Explain Neutral grounding transformer?
10. Write a note on earthing transformer?
11. Explain resonant grounding with a neat diagram?
12. Explain the function of transformer, high voltage circuit breaker & high voltage insulator in substation?
13. Draw a neat single line diagram of substation & explain it?
14. Define substation & mention different types of substations?
15. Explain double bus without sectionlisation?
16. With neat sketch explain the single bus bar system?
17. Explain the interconnection of power station with its advantages and disadvantages?

MODULE 5: ECONOMICS

1. Explain the effect of variable load on power system?
2. Explain the classification of cost, cost analysis?
3. Write a note on Interest and Depreciation?
4. Explain different methods for determination of Depreciation?
5. Write a note on economics of power generation?
6. Define Tariff, explain types of Tariffs?
7. Define power factor and mention disadvantages & causes of low power factor?
8. Explain the methods of improving power factor?
9. Write a note on Economics of power factor improvement?
10. Explain the comparison of different methods of improving the power factor?
11. Define the fallowing terms i)Load factor ii)diversity factor iii)plant use factor ?
12. Explain the factors affecting tariff?
13. Calculate the annual energy cost of an industrial consumer who takes a load of 2KW for 1 hour per day, 150KW for and 50KW for 8hours/day. The tariff in force is Rs.20per kilowatt of maximum demand and 10paise per KWH. Assume 6 working days in a weak?
14. A generating station has 3*50MW units. The station output is 876*10^6 KWH per annum. The maximum demand is 120MW calculate
    - I. Average load on the station
    - II. Annual load factor
    - III. Annual capacity factor
15. Mention the measures by which low power factor can be avoided?
16. Discuss the Economics of power factor correction?
17. What are the main objectives in framing a Tariff?
18. Explain the types of consumers and write the general form of Tariff?

15.0 University Result

Examination	FCD	FC	SC	%passing
July 2018	--	--	--	92.59%
July 2017	12	16	39	98.53%

Prepared by	Checked by		
		31.1.19	KW per
Smt. S. G. Huddar	Shri. P. M. Murari	HOD	Principal

Subject Title	**TRANSMISSION AND DISTRIBUTION**		
Subject Code	17EE43	**IA Marks**	40
Number of Lecture Hrs /	04	**Exam Marks**	60
Total Number of Lecture Hrs	50	**Exam Hours**	03
Credits 04			

FACULTY DETAILS:		
Name: Dr. B. V. Madiggond	**Designation:** Professor & HOD	**Experience: 25**
No. of times course taught: 02	**Specialization:** Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	III	EPG
02	First Year	I/II	BEE

2.0 Course Objectives

1. To understand the concepts of various methods of generation of power.
2. To understand the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
3. To design insulators for a given voltage level.
4. To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
5. To study underground cables for power transmission and evaluate different types of distribution systems.

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
C211.1	Explain the concepts of various methods of generation of power.	L1,L2	PO1, PO2,
C211.2	Explain the importance of HVAC, EHVAC, UHVAC and HVDC transmission.	L1,L2,L3	PO1, PO2 PO7
C211.3	Design and analyze overhead transmission system for a given voltage level.	L1,L2,L3,L4	PO1, PO2, PO6
C211.4	Calculate the parameters of the transmission line for different configurations and assess the performance of the line.	L1,L2,L3,L4	PO1, PO2 PO3
C211.5	Explain the use of underground cables and evaluate different types of distribution systems.	L1,L2,L3,L4 ,L6	PO1, PO2, PO4, PO5
Total Hours		**50**	

4.0 Course Content

Module-1

Introduction to power system: Structure of electric power system: Generation, Transmission and distribution. Advantages of high voltage transmission: HVAC, EHVAC, UHVAC and HVDC. Interconnection. Feeders, Distributors and service mains. **Overhead transmission lines:** A brief introduction to types of supporting structures and line conductors-Conventional conductors; Aluminium Conductor steel reinforced (ACSR), All –aluminium alloy conductor (AAAC) and All –aluminium conductor (AAC). High temperature conductors; Thermal resistant aluminium alloy (ATI),Super thermal resistant aluminium alloy (ZTAI), Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR), Gap type super thermal resistant aluminium alloy conductor steel reinforced (GZTACSR). Bundle conductor and its advantages. Importance of sag, Sag calculation – supports at same and different levels, Effect of wind and ice. Line vibration and vibration dampers. Overhead line protection against lightening; ground wires.

Overhead line Insulators: A brief introduction to types of insulators, Material used porcelain, toughened glass and polymer (composite). Potential distribution over a string of suspension insulators. String efficiency, Methods of increasing string efficiency. Arcing horns. **10 Hours.**

Revised Bloom's Taxonomy Level L1 – Remembering, L2 – Understanding.

Module-2

Line parameters: Introduction to line parameters- Resistance, Inductance and capacitance. Calculation of inductance of single phase and three phase lines with equilateral spacing, Unsymmetrical spacing, Double circuit and transposed lines. Inductance of composite – conductors, Geometric mean radius (GMR) and geometric mean distance (GMD). Calculation of capacitance of single phase and three phase lines with equilateral spacing, Unsymmetrical spacing, Double circuit and transposed lines. Capacitance of composite – conductor, Geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines. **10 Hours.**

Revised Bloom's Taxonomy Level L1 – Remembering, L2 – Understanding. L3 – Applying.

Module-3

Performance of transmission lines: Classification of lines – Short, Medium and Long lines. Current and voltage relations, Line regulation and Ferranti effect in short length lines, Medium length lines considering Nominal T and nominal π circuits, and long lines considering hyperbolic form equations. Equivalent circuit of a long line. ABCD constants in all cases. **10 Hours.**

Revised Bloom's Taxonomy Level L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing.

Module-4

Corona: Phenomena, Disruptive and visual critical voltages, Corona loss. Advantages and disadvantages of corona. Methods of reducing corona.

Underground cable: Types of cables, Constructional features, Insulation resistance, Thermal rating, Charging current, Grading of cables – capacitance and inter-sheath. Dielectric loss. Comparison between ac and dc cables. Limitations of cables. Specification of power cables. **10 Hours.**

Revised Bloom's Taxonomy Level L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing.

Module-5

Distribution: Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system. Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution, AC distributors with concentrated and uniform loads. Effect of disconnection of neutral in a 3 phase four wire system.

Reliability and Quality of Distribution system: Introduction, Definition of reliability, failure, Probability concepts, Limitation of distribution systems, Power quality, Reliability aids. **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	VI	Power system analysis and stability	All
01	VII	Computer techniques in power system analysis	All
02	VII	Electric Design Estimating & Costing	6 and 7

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Design and erection of transmission lines and electric power transmission and distribution
02	Describe Substation and Fault analysis of power system by software tools.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical	Obtaining ABCD parameters of TL's using MATLAB program.

8.0 Books Used and Recommended to Students

Text Books
1. A Course in Electrical Power Soni Gupta and Bhatnagar Dhanpat Rai 2. Power System Analysis and Design J. Duncan Glover at el Cengage Learning 4th Edition 2008 3. Principles of Power System V.K. Mehta Rohit Mehta S. Chand Publishers 1st Edition 2013 4. Electrical power Generation, Transmission and Distribution S.N. Singh PHI 2nd Edition,2009 5. Electrical Power S.L.Uppal Khanna Publication
Reference Books
1. Electrical power systems C. L. Wadhwa New Age International 5th Edition, 2009

2. Electrical power systems Ashfaq Hussain CBS Publication 3. Electric Power Distribution A.S. Pabla Mc Graw-Hill 6th Edition,2011
Additional Study material & e-Books
1. For High temperature conductors refer www.jpowers.co.jp/english/product/pdf/gap_c1.pdf and Power System Analysis and Design, J. Duncan Glover at el
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. https://energy.gov/oe/downloads/electricity-transmission-primer 2. https://energy.gov/oe/downloads/draft-chapter-4-transmission-adequacy 3. https://www.youtube.com/watch?v=Yg6XsepGCKY&list=PLD4ED2FAF3C155625 4. https://www.youtube.com/watch?v=lr1jgbR5ca8&index=10&list=PLD4ED2FAF3C155625 5. https://www.youtube.com/watch?v=y_UJvHMEun0&index=11&list=PLD4ED2FAF3C155625 6. https://www.youtube.com/watch?v=OsgIo5z-0EA&index=12&list=PLD4ED2FAF3C155625

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	IEEE transactions on power delivery	http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=61
4	Power and Energy technology systems journal	http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=6687318

11.0 Examination Note

Internal Assessment: 40 Marks (30 Marks Internal Assessment + 10 Marks Assignment) :
Internal Assessment is conducted for 30 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	15	Q.3 a	15
b		b	
OR		OR	
Q.2 a	15	Q.4 a	15
b		b	

SCHEME OF EXAMINATION (100 Marks Scaled down to 60 Marks):

1. The question paper will have ten questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
4. Each full question with sub questions will cover the contents under a module.
5. Students will have to answer any 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.	**Introduction to power system:** Structure of electric power system: Generation, Transmission and distribution.	20
	2.	Advantages of high voltage transmission: HVAC, EHVAC, UHVAC and HVDC. Interconnection. Feeders, Distributors and service mains.	

	3.	**Overhead transmission lines:** A brief introduction to types of supporting structures and line conductors-Conventional conductors; Aluminium Conductor steel reinforced (ACSR),	
	4.	All –aluminium alloy conductor (AAAC) and All –aluminium conductor (AAC). High temperature conductors; Thermal resistant aluminium alloy (ATI),Super thermal resistant aluminium alloy (ZTAI),	
	5.	Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR), Gap type super thermal resistant aluminium alloy conductor steel reinforced (GZTACSR). Bundle conductor and its advantages.	
	6.	Importance of sag, Sag calculation – supports at same and different levels, Effect of wind and ice. Line vibration and vibration dampers. Overhead line protection against lightening; ground wires.	
	7.	**Overhead line Insulators:** A brief introduction to types of insulators, Material usedporcelain, toughened glass and polymer (composite).	
	8.	Potential distribution over a string of suspension insulators. String efficiency, Methods of increasing string efficiency. Arcing horns.	
	9.	Numerical	
	10.	Numerical	
2	11.	**Line parameters:** Introduction to line parameters- Resistance, Inductance and capacitance.	**20**
	12.	Calculation of inductance of single phase and three phase lines with equilateral spacing, Unsymmetrical spacing, Double circuit and transposed lines.	
	13.	Inductance of composite – conductors, Geometric mean radius (GMR) and geometric mean distance (GMD).	
	14.	Calculation of capacitance of single phase and three phase lines with equilateral spacing,	
	15.	Unsymmetrical spacing, Double circuit and transposed lines.	
	16.	Capacitance of composite – conductor, Geometric mean radius (GMR) and geometric mean distance (GMD).	
	17.	Advantages of single circuit and double circuit lines.	
	18.	Numerical	
	19.	Numerical	
	20.	Numerical	
3	21.	**Performance of transmission lines:** Classification of lines – Short, Medium and Long lines.	**20**
	22.	Current and voltage relations,	
	23.	Line regulation and Ferranti effect in short length lines,	
	24.	Medium length lines considering Nominal T and nominal _ circuits,	
	25.	and long lines considering hyperbolic form equations. Equivalent circuit of a long line.	
	26.	ABCD constants in all cases.	
	27.	Numerical	
	28.	Numerical	
	29.	Numerical	
	30.	Numerical	
4	31.	**Corona:** Phenomena, Disruptive and visual critical voltages,	**20**
	32.	Corona loss. Advantages and disadvantages of corona. Methods of reducing corona.	
	33.	**Underground cable:** Types of cables, Constructional features,	
	34.	Insulation resistance, Thermal rating, Charging current,	
	35.	Grading of cables – capacitance and inter-sheath.	
	36.	Dielectric loss. Comparison between ac and dc cables.	
	37.	Limitations of cables. Specification of power cables.	
	38.	Numerical	
	39.	Numerical	
	40.	Numerical	
5	41.	**Distribution:** Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system.	**20**
	42.	Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution,	
	43.	AC distributors with concentrated and uniform loads.	
	44.	Effect of disconnection of neutral in a 3 phase four wire system.	
	45.	**Reliability and Quality of Distribution system:** Introduction, Definition of reliability,	

		failure,	
	46.	Probability concepts, Limitation of distribution systems, Power quality, Reliability aids.	
	47.	Numerical	
	48.	Numerical	
	49.	Numerical	
	50.	Numerical	

13 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 Introduction to PS, OH lines & insulators	Students understand PS & get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity. Written solution expected.	Book 3,4 of the text book list. & reference 1,2
2	Assignment 2: University Questions on Line parameters	Students understand line parameters get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity. Written solution expected.	Book 3,4 of the text book list. & reference 1,2
3	Assignment 3: University Questions on Performance of TL	Students understand TL's get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity. Written solution expected.	Book 3,4 of the text book list. & reference 1,2
4	Assignment 4: University Questions on Corona & UG cables	Students know Corona & UG cables & get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity. Written solution expected.	Book 3,4 of the text book list. & reference 1,2
5	Assignment 5: University Questions on Distribution and its reliability and quality	Students study & get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity. Written solution expected.	Book 3,4 of the text book list. & reference 1,2 & additional reference 1,2

14.0 QUESTION BANK

Module 1

Q1.Name three types of line vibrators and explain Aeoline vibrators.
Q2.Explain with the help of neat line diagram a typical transmission and distribution system scheme indicating standard voltages.
Q3.What are the advantages of High voltage transmission? Explain.
Q4.Write a short note on HVDC transmission, feeder, distribution and service mains along with a neat sketch.
Q5.Explain sag and what are the factors affecting sag? Derive the expression for sag when the supports are at unequal heights.
Q6.A transmission line conductor at a river crossing is supported form two towers of heights 50mts and 80mts above water level. The horizontal distance between the towers is 500mts. If the tension in the conductor is 3000kgs. Find the minimum clearance between the conductor and water. Weight of the conductor per meter is 0.844kg.
Q7.Explain with a neat diagram, the pin type of insulator.
Q8.Define string efficiency. Explain the methods of improving string efficiency.
Q9.A 33kv overhead line, there are three units in the string of insulators. If the capacitance between each insulator pin and earth is 11% of the self capacitance of each insulator, find, the distribution of voltage over three insulators and string efficiency.
Q10.An OH TL at a river crossing is supported from two towers at heights of 40m and 90m above water level, the horizontal distance between the towers being 400m. if the maximum allowable tension is 2000kg. Find the clearance between the conductor and water at appoint midway between the towers. Weight of conductor is 1kg/m.
Q11.Explain stringing charts.
Q12.Write on effect of high voltage on TL.
Q13.Compare AC and distribution systems with respect to bulk power generation, transmission voltage levels, line charging current and power conversion.

Q14.Show that increase in transmission voltage causes reduction in copper losses and reduced weight of conductor material.
Q15.Discuss the necessity of sag and tension calculation in erection of OH lines.
Q16. Obtain an expression for sag of a line conductor suspended between two equal supports. Assume parabolic configuration.
Q17. Explain the different methods to equalize the potential across a string of suspension insulators.
Q18. An insulator for 66kV is provided with 5 discs. The capacitance between the each joint and tower is $1/6^{th}$ of the self capacitance of each disc. Find the voltage across each disc and also string efficiency.
Q19. A transmission line has a span of 275m with diameter 19.5mm and weight 0.844 kg/m has a ultimate breaking strength of 7950kg. Each conductor has a radial covering of ice 9.53mm thick and is subjected to a horizontal wind pressure of $40kg/m^2$ of the ice covered projected area. If the factor of safety(FOS) is 2, calculate the deflected sag and vertical component of the sag. Given one cubic meter of ice weighs 913.5kg.
Q20. What are the limitations of increasing the transmission voltage level to high volume?
Q21. State the effect of high voltage used in transmission on volume of copper required, line efficiency and line voltage drop.
Q22. Explain the following components of distribution i)substation ii)distribution substation iii)feeder iv)service mains v)distributors.
Q23. The two towers of height 95m and 70m respectively support the line conductor at a river crossing. The horizontal distance between the towers is 400m. If the tension in the conductor is 1100kg and its weight is 0.8kg/m, calculate i)sag at lower support ii)sag at upper support iii)clearance of lowest point on trajectory from water level. Assume bases of towers to be at the same level.
Q24. Explain different types of insulators. Explain any one of them with neat figure.
Q25. Each line of a three phase system is suspended by a string of three similar insulators. If the voltage across the line is 20kV, calculate the line to neutral voltage and the string efficiency. Assume that the shunt capacitance between each insulator and earthed metal work of tower to be $1/10^{th}$ the capacitance of the insulator.
Q26. Mention the different methods of increasing string efficiency. Explain any one method in brief.
Q27. Write a short note on testing of insulators briefly explain different tests.
Q28. Derive the relevant equations for demonstrating the effect of the ice deposition and wind loading on sagging of a transmission line.
Q29 Write a short note on vibration of conductors.
Q30 Define string efficiency. Derive an expression for the string efficiency for 4 disc string.
Q31 With a neat diagram, explain feeders, distributors and service mains of a distribution system.

Module 2
Q1.Find the inductance/ph/km of double circuit three phase line shown in fig. The line is completely transposed. Use GM method. The radius of the conductor is 9mm.
Q2.Write on transposition of transmission lines.
Q3. Derive an expression for inductance per phase for a 3phase OH TL when conductors are asymmetrically placed but the line is completely transposed.
Q4. Calculate the loop inductance per km of a single phase TL consisting of two parallel conductors 1.5m apart and 1.5cm in diameter. Calculate also the reactance of the transmission line if it is operating at a frequency of 50Hz.
Q5. A three phase transmission line 100km ling has its conductors of 0.6cm diameter spaced at the corners of an equilateral d triangle of 100cm side. The arrangement is shown in fig. find the inductance per phase of the system.
Q6. Derive an expression for capacitance of a three phase line with equilateral spacing.
Q7. Derive an expression for inductance due to internal flux linkage, inductance due to external flux linkage, inductance of a 1-phase two wire line.
Q8. Determine the loop inductance and reactance per km of a single phase 50Hz transmission line consisting of two parallel conductors spaced 1m apart and 1.25cm diameter.
Q9. Obtain an expression for capacitance of a three phase symmetrically spaced TL.
Q10. Describe composite conductors and discuss their advantages.
Q11.Derive the expression for capacitance of a transposed three phase line with unsymmetrical spacing.
Q12. A single phase OH line 30km long consists of 2 parallel wires each 5mm in diameter and 1.5m apart. If the line voltage is 50kV at 50Hz, calculate charging current with line open-circuited.
Q13. Obtain self GMD and mutual GMD and hence calculate inductance/km of each conductor in a three phase three wire system. Conductors are arranged at the vertices of a triangle of sides 2.5m, 3m and 5m. These are transposed at regular intervals. Diameter of each conductor is 1.5cm.
Q14. Explain the terms self GMD and mutual GMD
Q15. The three conductors of a 3-phase line are arranged at the corners of a triangle of sides 2m, 2.5m and 4.5m.calculate the inductance per km of the line when the conductors are regularly transposed. The diameter of each conductor is 1.24cm.
Q16. Derive an expression for the inductance of a single phase two wire line.
Q17. A three phase, 50Hz, 132kV OH line has conductor placed in a horizontal plane 4 meter apart. Conductor diameter is 2cm. If the line length is 100km. Calculate the charging current per phase. Assume complete transposition.

Q18. Derive an expression for the capacitance of a three phase oh line for symmetrical spacing and unsymmetrical spacing.

Module 3

Q1.Derive an expression for ABCD constants of a long transmission line using Rigorous method of analysis.
A three phase line delivers 5000kW at 22kV and at a p.f of 0.8 lagging to a load. Determine sending end voltage, percentage regulation and transmission efficiency. The resistance and reactance of each conductor is 4 ohm and 6 ohm respectively.
Q2.A three phase, 50Hz, 16km long OH line supplies 1000kW at 11kV, 0.8p.f lagging. The resistance is 0.03 ohm per phase per km and inductance is 0.7mH per phase per km. calculate the sending end voltage, percentage voltage regulation and efficiency of transmission.
Q3 Write on ABCD constants of TL.
Q4. Write a short notes on bundled conductors and skin effect.
Q5. Deduce an expression for transmission efficiency and regulation for medium transmission line using nominal T method.
Q6 A 110kV, 50Hz, three phase TL delivers a load of 40MW at 0.85 lagging p.f at the receiving end. The generalized constants of the TL are. A=D=0.95 angle 1.4 degree, B=96 angle 78 degree ohm, C=0.0015 angle 90 degree mho. Find the regulation of the line and charging current use nominal T-method.
Q7. Explain Ferranti effect in long transmission lines, with the help of a phasor diagram.
Q8. Obtain expression for sending end voltage and current in terms of ABCD constants and receiving end voltage and current for a nominal Pi model of a transmission line. Also draw the phasor diagram.
Q9. A three phase, 50Hz OH TL has the following distributed constants: R=28 ohm, X_L=63ohm, T =$4*10^{-4}$ mho.
Q10. A three phase short TL delivers 3MW at a p.f of 0.8 lagging to a load. If the sending end voltage is 33kV, determine i)Receiving end voltage ii)Line current iii)Transmission efficiency iv)Regulation. The resistance and reactance of each conductor are 5 ohm and 8 ohm respectively.
Q11. Discuss the nominal T method of a medium TL with appropriate circuit diagram and phasor diagram and hence obtain the expressions for regulation and ABCD constants for the same.
Q12. Two transmission lines having generalized circuit constants A1,B1,C1,D1 and A2,B2,C2,D2 are connected in series. Develop expressions for the overall constants ABCD of the combination in terms of A1,B1,C1,D1 and A2,B2,C2,D2.

Module 4

Q1.Write the factors affecting corona. Derive the expressions for critical disruptive voltage and visual critical voltage and power loss in corona.
Q2.State the advantages of using UG cables for power distribution.
Q3.What is meant by grading of cable? Explain capacitance grading.
Q4.A single core lead sheathed cable has a conductor diameter of 3cm, the diameter of the cable being 5cm. The cable is graded by using two dielectrics of relative permittivity 5 and 4 respectively with corresponding safe working stresses of 30kV/cm and 20kV/cm. calculate the radial thickness of each insulation and the safe working voltage of the cable.
Q5.Write a note on insulating materials for cables.
Q6. Explain the phenomenon of corona in OH TL's.
Q7. Show that in a single core cable the ratio of maximum to minimum stress g_{max}/g_{min}=R/gamma, where R=sheath radius, gamma=core radius.
Q8. A 33kV, three phase UG cable, 4km long, uses three single cables. Each of the conductor has a diameter of 2.5cm and the radial thickness of insulation 0.5cm. the relative permittivity of the dielectric is 3. Find capacitance of the cable/phase, charging current/phase, total charging kVAR.
Q9. For the most economical diameter of a single core cable to be used on 66kV, three phase system. If the peak permissible stress is not to exeed 50kV/cm. also find the overall diameter.
Q10. Determine the critical disruptive voltage and the critical visual voltage for a three phase, 50Hz, 132kV line situates in a temperature of 30 degree Celsius and at a barometric pressure of 74cm. the conductor diameter is 1.5cm while the equilateral spacing between the conductors is 2.75m. the surface irregularity factor is 0.9 while m=0.75.
Q11. Discuss the factors affecting corona power loss.
Q12. Briefly explain Laying of UG cable.
Q13. Explain the methods of reducing corona effect.
Q14. What are the merits and demerits of corona?
Q15. Derive an expression for potential gradient.
Q16. A single core cable has a conductor diameter of 1cm and insulation thickness of 0.4cm. If the specific resistance of the insulation is 5*10^14 ohm cm. Calculate the insulation resistance of a 2km length of the cable.

Module 5

Q1. Mention the different schemes of distribution system and explain radial distribution system.
Q2. Explain the requirements of a distribution system.
Q3. Explain radial and ring main distribution system. What are the advantages and disadvantages of radial distribution?
Q4. Write a note on feeders, distributors and service mains.

Course Plan 2018-19 Even – Semester -4th
Electrical and Electronics Engineering

Q5. A single phase, distribution 2km long supplies a load of 120A at 0.8pf lag at its far end and a load of 80A at 0.9 pf lag at its midpoint. Both the power factors are referred to the voltage at far end. The resistance and reactance per km(go and return) are 0.05ohm and 0.1ohm respectively. If the voltage at the far end is maintained at 230V and calculate voltage at the sending end, phase angle between voltages at the two ends.

Q6. A two wire distributor 1000m long is loaded as shown in fig. B is the mid point. The power factors at the two load points refer to the voltage at C. The impedance of each line is 0.15+0.2 ohm. Calculate the sending end voltage and voltage, current and power factor. The voltage at point C is 220V

Q7. Explain radial feeders for AC distribution system. Mention the characteristics of radial feeders.

Q8. A 3phase,4-Wire system supplies power at 440V and lighting at 230V. If the lamps in the main are 60, 40 and 30 A in each of the three lines. What should be the current in the neutral wire? If a 3-phase motor is now taking 200A from the lines at a pf of 0.8 lagging. What should be the total current in each line and the neutral wire? Find the total power supplied to the lamps and the motor.

Q9. Explain 3-phase four wire star connected unbalanced loads for AC distribution system.

Q10. A single phase AC distributor AB 300 meter long is fed from end A and is loaded as under. i)100A at 0.707pf lagging, 200m from point A. ii)80A at 0.8pf lagging, 300m from point A.

The load resistance and reactance of the distributor is 0.2 ohm and 0.1 ohm per kilometers. Calculate the total voltage drop in the distributor. The power factors refer to the voltage at the far end.

15:0 University Result

Examination	No. of students appeared	No. of students passed	%Passing
May/June 2018	54	47	87.04

Prepared by		Checked by	
Dr B. V. Madiggond		Mr. Pramod Murari	
HOD		Principal	

Subject Title	**ELECTRIC MOTORS**		
Subject Code	17EE44	**IA Marks**	20
Number of Lecture Hrs /	4	**Exam Marks**	80
Total Number of Lecture Hrs	50	**Exam Hours**	03
CREDITS – 04			

FACULTY DETAILS:		
Name: Prof. S B PATIL	**Designation:** Asst. Professor	**Experience:**33
No. of times course taught:01	**Specialization:** Power and Energy System	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	I/II	Basic Electrical Engineering
02	Electrical & Electronics Engineering	III	Transformer & Generator

2.0 Course Objectives

1. To explain the operation and characteristics of D.C motor and selection of a suitable drive for specific application.
2. To explain the constructional features of Three Phase and Single phase induction Motors.
3. To explain direct and indirect test to be conducted for the assessment of the performance of DC machines and Induction motors.
4. To explain controlling the speed of DC and induction motors.
5. To explain the construction and operation of Synchronous motor and special motors.

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
C212.1	Explain the constructional features, characteristics and speed control of DC Motors and selection of a suitable drive for specific application.	L1,L2,L3	PO1, PO2 ,PO3, PO4
C212.2	Determine the performance of DC machines from the pre-determined and determined test data	L1,L2,L3,L4	PO1, PO2 ,PO3, PO4
C212.3	Explain the performance of Three Phase induction motor.	L1,L2,L3,L4	PO1, PO2 ,PO3, PO4
C212.4	Explain starting methods and speed control of induction motor by a suitable method& Explain the construction and operation of single phase induction & Motors.	L1,L2,L3,L4	PO1, PO2 ,PO3, PO4
C212.5	Explain the construction, operation and performance of synchronous motor. Discuss construction and operation of special motors; Universal motor, AC servomotor, Linear induction motor and stepper motor.	L1,L2,L3,L4	PO1, PO2 ,PO3, PO4
Total Hours of instruction		**50**	

4.0 Course Content

MODULE I

DC Motors: Classification, Back emf, Torque equation, and significance of back emf, Characteristics of shunt, Series & Compound motors. Speed control of shunt, Series and Compound motors. Application of motors. DC motor starters – 3 point and 4 point.

Losses and efficiency- Losses in DC motors, Power flow diagram, Efficiency, Condition for maximum efficiency. **(10Hours)**

MODULE II

Testing of dc motors: Direct & indirect methods of testing of DC motors-Brake test, Swinburne's test, Retardation test, Hopkinson's test, Field's test, Merits and demerits of tests.
Three phase Induction motors: Review of concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring (No question shall be set from the review portion). Slip, Torque equation, Torque-slip characteristic covering motoring, Generating and braking regions of operation. Maximum torque, Significance of slip. (**10Hours)**

MODULE III
Performance of three-phase Induction Motor: Phasor diagram of induction motor on no-load and on load, Equivalent circuit, Losses, Efficiency, No-load and blocked rotor tests. Performance of the motor from the circle diagram and equivalent circuit. Cogging and crawling.
High torque rotors-double cage and deep rotor bars. Equivalent circuit and performance Evaluation of double cage induction motor. Induction motor working as induction generator; Standalone operation and grid connected operation**. (10Hours)**

MODULE IV
Starting and speed Control of Three-phase Induction Motors: Need for starter. Direct online, Star-Delta and autotransformer starting. Rotor resistance starting. Speed control by voltage, Frequency and rotor resistance methods
Single-phase Induction Motor: Double revolving field theory and principle of operation. Construction and operation of split-phase, Capacitor start, Capacitor run, and shaded pole motors. Comparison of single phase motors and applications. (**10Hours)**

MODULE V
Synchronous motor: Principle of operation, Phasor diagrams, Torque and torque angle, Blondel diagram, Effect of change in load, Effect of change in excitation, V and inverted V curves. Synchronous condenser, Hunting and damping. Methods of starting synchronous motors.
Other motors: Construction and operation of Universal motor, AC servomotor, Linear induction motor and stepper motor. (**10Hours)**

5.0 Relevance to future subjects

S No	Semester	Subject	Topics
01	VIII	Project work	Designing machine
02	-	Electrical machine Design	-
03	-	Industrial Drives and applications	-

6.0 Relevance to Real World

S No	Real World Mapping
01	Motors for industrial applications
02	Special motors for control system applications

7.0 Gap Analysis and Mitigation

S No	Delivery Type	Details
01	Lab / industry visit.	Familiarization of real machine parts and its constructional features.
02	NPTEL	Video lecture on electric motors.
03	PPT	Animation slides demonstrating the working of various machines

8.0 Books Used and Recommended to Students

Text Books
1. Electric Machines', D. P. Kothari,I. J. Nagrath Mc Graw Hill 4th edition, 2011 2.Electrical Machines M.V. Deshpande PHI Learning 2013 3.Electric Machines R.K. Srivastava Cengage Learning 2nd Edition,2013
Reference Books
1.Principles of Electric Machines and power Electronics P.C.Sen Wiley 2nd Edition, 2013 2. Electrical Machines, Drives and Power systemsTheodore Wildi Pearson 6th Edition, 2014. 3.Electric Machinery and Transformers Bhag S Guru at el Oxford University Press 3rd Edition, 2012 4.Theory of Alternating Current Machines Alexander Langsdorf Mc Graw Hill 2nd Edition, 2001

Additional Study material & e-Books
1. Electric machines by godse & bakshi 2. Principles Of Electrical Machines, V.K. Mehta Rohit Mehta

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. https://en.wikipedia.org/wiki/**DC_motor** 4. www.electrical4u.com/**testing-of-dc**-machine/ 5. http://www.electrical4u.com/working-principle-of-three-phase-induction-motor/ 6. www.ijset.net/journal/68.pdf 7. www.electrical4u.com/**speed-control-of-three-phase-induction-motor** 8. www.electrical4u.com/**single-phase-induction-motor** 9. www.electricaleasy.com/.../**synchronous-motor** 10. http://eeeinterviewtips.blogspot.in/2011/09/discuss-different-types-of-motors-their.html

10.0 Magazines/Journals Used and Recommended to Students

S. No	Magazines/Journals	website
1	EC&M Magazines	http://ecmweb.com/ops-maintenance/motors
2	Oil & gas journal	https://www.sub-forms.com/dragon/init.do?site=PNW23_OGogpenew
3	IPT Magazine	https://www.intelligent-power-today.com/
4	Electric apparatus magazine	https://electricalapparatus.wordpress.com/2016/06/30/electric-motors-up-and-running/
5	E drive magazine	http://www.e-driveonline.com/main/
6	Motor magazine	https://www.motor.com/newsletters/20110410/WebFiles/ID1_IonizingAmerica.html

11.0 Examination Note

Internal Assessment: 20 Marks(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 b OR	13	Q.3 a b OR	12
Q.2 a b	13	Q.4 a b	12

SCHEME OF EXAMINATION (80 Marks):

1. The question paper will have ten questions.
2. Each full question is for 16 marks.
3. There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
4. Each full question with sub questions will cover the contents under a module.
5. 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 Lecturer	% of Portion
	1.	**DC Motors:** Classification, Back emf & significance of back emf.	
	2.	Torque equation and problems.	
	3.	Characteristics of shunt, Series & Compound motors.	
	4.	Speed control of shunt motor & problems.	
	5.	Speed control of series motor & problems.	

1	6.	Speed control of Compound motors & Application of motors.	20
	7.	DC motor starters – 3 point and 4 point.	
	8.	**Losses and efficiency**: Losses in DC motors & Problems.	
	9.	Efficiency & Problems.	
	10.	Power flow diagram & Condition for maximum efficiency.	
2	11.	**Testing of dc motors:** Direct testing of DC motors(Brake test) & Problems	20
	12.	Indirect methods of testing of DC motors (Swinburne's test) & Problems.	
	13.	Indirect methods of testing of DC motors (Retardation test) & Problems	
	14.	Indirect methods of testing of DC motors (Hopkinson's test) & Problems	
	15.	Indirect methods of testing of DC motors (Field's test) & Problems	
	16.	Merits and demerits of all above tests.	
	17.	**Three phase Induction motors:** Review portion	
	18.	Torque equation & Maximum torque & problems.	
	19.	Torque-slip characteristic motoring, Generating and braking regions.	
	20.	Slip, Significance of slip & Problems.	
3	21.	**Performance of three-phase Induction Motor:** Phasor diagram of induction motor on no load and on load,	20
	22.	Cogging and crawling.	
	23.	Equivalent circuit & Problem.	
	24.	Losses, Efficiency & Problem.	
	25.	No-load and blocked rotor tests & problem.	
	26.	Performance from the circle diagram and equivalent circuit & problem.	
	27.	High torque rotors-double cage and deep rotor bars.	
	28.	Equivalent circuit and performance Evaluation of double cage induction motor & problem.	
	29.	Induction motor working as induction generator;	
	30.	Standalone operation and grid connected operation**.**	
4	31.	**Starting and speed Control of Three-phase Induction Motors:** Need for starter. Direct on line.	20
	32.	Star-Delta and autotransformer starting. Rotor resistance starting.	
	33.	Problems on above starters.	
	34.	Speed control by voltage, Frequency and rotor resistance methods.	
	35.	**Single-phase Induction Motor:** Double revolving field theory and principle of operation.	
	36.	Construction and operation of split-phase.	
	37.	Capacitor start, Capacitor run	
	38.	Shaded pole.	
	39.	Numerical on above types.	
	40.	Comparison of single phase motors and applications.	
5	41.	**Synchronous motor:** Principle of operation, Phasor diagrams.	20
	42.	Torque and torque angle & problem.	
	43.	Blondel diagram	
	44.	Effect of change in load & Effect of change in excitation	
	45.	V and inverted Curves. Synchronous condenser, Hunting and damping.	
	46.	Methods of starting synchronous motors.	
	47.	Numerical.	
	48.	**Other motors:** Construction and operation of Universal motor,	
	49.	AC servomotor,	
	50.	Linear induction motor and stepper motor.	

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 DC motor an losses and efficiency	Students will be able to explain characteristics speed control and torque equation of DC motor	Module 1 of the syllabus	2	Individual Activity.	Book 2, 3 of the reference list.

2	Assignment 2: University Questions on Testing of dc motor and three phase Induction motor	Students will able to explain testing of DC Machine and behavior of 3 phase IM and torque equation of IM.	Module 2 of the syllabus	4	Individual Activity.	Book 2, 3 of the reference list.
3	Assignment 3: University Questions on Performance on three phase induction motor	Students will able to explain working, behavior, condition for maximum power output and tests on induction motor	Module 3 of the syllabus	6	Individual Activity.	Book 2, 3 of the reference list.
4	Assignment 4: University Questions on starting and speed control on 3 phase IM , Single phase induction motor	Students will able to explain starting and speed control on 3 phase IM and working principle& application of Single phase induction motor	Module 4 of the syllabus	8	Individual Activity.	Book 2, 3 of the reference list.
5	Assignment 5: University Questions on Synchronous motor and other motor	Students will able to explain construction & operation of Synchronous motor and other motor.	Module 5 of the syllabus	10	Individual Activity.	Book 2, 3 of the reference list.

14.0 QUESTION BANK

Module-1

1. A series motor should never be started on no-load" justify the above statement With proper reasoning. '
2. Explain the method of speed control of DC shunt machine by ward Leonard method. '
3. Derive the standard torque equation for DC Motor.
4. A dc motor takes an armature current of 110A at 480V. The armature circuit resistance is 0.2 ohm. The machine has 6 poles and the armature is lap connected with 864 conductors. The flux per pole is 0.05wb. Calculate (a) speed and (b) gross torque developed by the motor.
5. What is back? Explain the significance of back emf.
6. Explain the working and performance, characteristic, advantage, disadvantage And application magnet DC motor.
7. Give the characteristic of DC shunt, series and compound motor.
8. Discuss the speed of dc shunt and series motor.

Module-2

1. Explain the Swinburne's test to predetermine the efficiency of d.c machine by computing mechanical losses and discuss merit and demerit of it.
2. With neat circuit diagram Explain the procedure to conduct Hopkinson's test. Show how the efficiency of motor and generator are calculated. What are advantage and disadvantage of this test?
3. Explain the principle of retardation test and how moment of inertia of dc machine can be' estimated and eliminated.
4. Briefly describe the field test applied to two similar dc series motor.
5. Mention the various methods of testing a DC machine and discuss on the limitations of each method.
6. With 3- ø flux wave diagram & vector diagram explain how you obtain rotating magnetic field in a 3- ø IM & also explain the production of torque.
7. What are different types of induction motors? Explain their uses.
8. Derive the equation for torque developed by an IM taking stator impedance into account. Draw a typical torque slip curve & deduce the condition for max torque.
9. Draw & explain the phasor diagram & equivalent circuit of a 3 ø JM.
10. Draw the complete torque slip characteristics of a 3- ø IM indicating all the regions & explain
11. Explain the torque-slip characteristics of 3- ø IM under the condition of variable frequency, constant V/F ratio.
12. The no load test on 60HP, 220V DC shunt motor gave the following results on no load test. Input current =13.25 amps, Field current=2.55 amps, Resistance of armature=0.032 ohm, Brush drop =2 Volts. Find the full load current and full load efficiency.
13. A retardation test is carried out on a 1000 rpm dc machine. The time taken for speed to fall from 1030 rpm to 970rpm is a) 40 Sec with no excitation ii) 20 sec with full excitation c) 9 sec with full excitation and armature supplying an extra load of 10A at 225V. Calculate i) moment of inertia ii) Iron losses iii) Mechanical losses.
14. The following results were obtained during Hopkinson's test on two similar 230V machines, armature currents 37 A and 30A, field currents 0.85 A and 0.8A of motor and generator respectively .Calculate the efficiencies of machines if each has armature resistance of 0.33 ohm.
15. A 6 pole, 3 phase induction motor develops a maximum torque of 30 Nm at 960 rpm. Determine the torque exerted by motor at 5 % slip. The rotor resistance per phase is 0.6 ohm.
16. A 6 pole , 3 phase induction motor develops a maximum torque of 30 Nm at 960 rpm. Determine the torque exerted by motor at 5 % slip. The rotor resistance per phase is 0.6 ohm.

Course Plan 2018-19 odd – Semester- 4th
Electrical & Electronics Engineering

Module-3

1. Explain the phenomenon of cogging & crawling in a 3- phase IM.
2. Discuss the working of deep bar & double cage IM
3. With neat circuit diagram, explain no load & blocked rotor test conducted on 3- phase IM to construct circle diagram.
4. Develop the approximate equivalent circuit of induction motor.
5. Derive condition for maximum power output of induction motor.
6. Discuss the no load and blocked rotor test of induction motor.
7. Draw a circle diagram for 20Hp, 50Hz, 3 phase star connected induction With following data motor: No load test :400V, 9A, 0.2 p.f lag…Blocked rotor Test :200V,50A,0.4 p.f .Determine line current.
8. A 440V, 3phase,8 pole , 40Kw ,star connected three phase IM has the following parameters: Stator resistance (R_1)=0.1 ohm, Stator reactance (X_1)=0.4 ohm, Equivalent rotor resistance referred to stator(R_2')=0.15 ohm , Equivalent rotor reactance referred to stator(X_2')=0.44 ohm . The stator core loss is 1250 Watt while the mechanical loss is 1000W. It draws a no load current of 20A at a power factor of 0.09 lagging. While running at speed of 727.5 rpm. Calculate i) Input line current and power factor ii) Torque developed iii) Output power. Use approximate equivalent circuit.
9. The cages of double cage IM have a standstill impedance of (3.5+1.5j) ohm and (0.6+7j) ohm. Full load slip is 6%.Find starting torque in terms of full load torque. Neglect stator impedance and magnetizing current.

Module-4

1. Explain any three important methods, with suitable circuits, how speed control can be achieved in 3- ø IM.
2. With neat sketches, explain the construction working principle & application of
   i. Split phase
   ii.Capacitor start 1- ø IM
3. Explain the electronic starters for 3- ø IM
4. Why starter is necessary to start IM? Explain in detail auto - transformer method of starting a cage IM.
5. An 18650W,4pole,50HZ,3-ø IM has friction & windage losses of 2.5% of the output .The FL slip is 4% compute for FL
   i. the rotor copper loss
   ii. the rotor input
   iii. the shaft torque
6. Explain double revolving field theory of 1-ø IM & prove that starting torque is zero.

Module-5

1. Describe the working principle of synchronous motor and why it is not self starting.
2. Write note on V and inverted V curve of synchronous motor.
3. Explain the phenomenon of hunting in synchronous machine and method of reducing the same.
4. Explain how two or more alternators are made to share the load in propagation to their rating.
5. An alternator is supplying constant load. With suitable vector diagram and explain the effect of variation on excitation on armature current and power factor.
6. Write a note on synchronous condenser.

15.0 University Result

Examination	Number of students appeared	Number of students passed	% passing
July 2017	62	52	84
July 2018	52	48	92

Prepared by	Checked by		
31/1/19		31.1.19	
Prof. S B PATIL	Prof. A. U. Neshti	HOD	Principal

Subject Title	**ELECTROMAGNETIC FIELD THEORY**		
Subject Code	17EE45	**IA Marks**	40
Number of Lecture Hrs / Week	05	**Exam Marks**	60
Total Number of Lecture Hrs	65	**Exam Hours**	03
			CREDITS – 04

FACULTY DETAILS:		
Name: Prof. A.U.Neshti	**Designation:** Assistant Professor	**Experience:** 10
No. of times course taught:01	**Specialization:** Digital Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Engineering Mathematics	I/II	Vector Algebra
02	Engineering Mathematics	III/(10+2)	Trigonometry, Calculus

2.0 Course Objectives

1. To study different coordinate systems for understanding the concept of gradient, divergence and curl of a vector.
2. To study the application of Coulomb's Law and Gauss Law for electric fields produced by different charge configurations.
3. To evaluate the energy and potential due to a system of charges.
4. To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
5. To study the magnetic fields and magnetic materials.
6. To study the time varying fields and propagation of waves in different media

3.0 Course Outcomes

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

	Course Outcome	Cognitive	POs
CO213.1	Use different coordinate systems to explain the concept of gradient, divergence and curl of a given vector	L2	PO1
CO213.2	Use Coulomb's Law and Gauss Law for the evaluation of electric fields produced by different charge configurations.	L2	PO 1, PO 2, PO 3
CO213.3	Calculate the energy and potential due to a system of charges.	L2	PO 2, PO 3
CO213.4	Explain the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.	L2	PO 2, PO 3
CO213.5	Explain the behavior of magnetic fields and magnetic materials.	L2	PO 2, PO 3
CO213.6	Assess time varying fields and propagation of waves in different media.	L2	PO 2, PO 3, PO 7
Total Hours of instruction		**50**	

4.0 Course Content

MODULE-1:

Vector Analysis: Scalars and Vectors**,** Vector algebra, Cartesian co-ordinate system,Vector components and unit vectors. Scalar field and Vector field. Dot product and Cross product, Gradient of a scalar field. Divergence and Curl of a vector field. Co – ordinate systems: cylindrical and spherical, Relation between different coordinate systems. Expression for gradient, Divergence and curl in rectangular, Cylindrical and spherical coordinate systems. Problems.

Electrostatics: Coulomb's law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications. Maxwell's first equation (Electrostatics). Divergence theorem. Problems. **10 HOURS**

MODULE-2:

Energy and Potential: Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient. The dipole. Energy density in the electrostatic field. Problems.

Conductor and Dielectrics: Current and current density. Continuity of current. Metallic conductors, Conductor's properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Capacitance of two wire line. Problems. **10 HOURS**

MODULE-3:

Poisson's and Laplace equations: Derivations and problems, Uniqueness theorem.

Steady magnetic fields: Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials. Problems. **10 HOURS**

MODULE-4:

Magnetic forces: Force on a moving charge and differential current element. Force between differential current elements. Force and torque on a closed circuit. Problems.

Magnetic materials and magnetism: Nature of magnetic materials, Magnetisation and permeability. Magnetic boundary conditions. Magnetic circuit, Inductance and mutual inductance. Problems. **10 HOURS**

MODULE-5:

Time varying fields and Maxwell's equations: Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Problems.

Uniform plane wave: Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Problems. **10 HOURS**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VII	High voltage Engineering	Time varying fields, Maxwell's equations
02	V	Transmission & distribution	Gauss law, electric flux, Electric field, Magnetic field.

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Communication Systems
02	Radars, Magneto hydrodynamic generators, motors, generators, Cathode Ray Tubes, Ink jet printer Electrostatic generator,Electrostatic voltmeter, Magnetic separator, Magnetic deflection, Cyclotron, Mass spectrometer,Hall effect

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Tutorial	Assignment problems will be solved in the tutorial classes to clear the concepts usage of appropriate formulas.
02	NPTEL	Explained with Video Lectures will be used to clear the concepts

8.0 Books Used and Recommended to Students

Text Books/Reference Books

1. Engineering Electromagnetics William H Hayt et al Mc Graw Hill 8thEdition, 2014
2. Principles of Electromagnetics Matthew N. O. Sadiku Oxford University Press 6th Edition, 2015
3. Fundamentals of Engineering Electromagnetics David K. Cheng Pearson 2014
4. Electromagnetism - Theory (Volume -1) -Applications (Volume-2) Ashutosh Pramanik PHI Learning 2014
5. Electromagnetic Field Theory Fundamentals Bhag Guru et al Cambridge University press 2005
6. Electromagnetic Field Theory Rohit Khurana Vikas Publishing 1st Edition,2014
7. Electromagnetics J. A. Edminister Mc Graw Hill 3rd Edition, 2010
8. Electromagnetic Field Theory and Transmission Lines Gottapu Sasibhushana Rao Wiley 1st Edition, 2013

Additional Study material & e-Books

1. VTU Question papers

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

Website and Internet Contents References
1. NPTEL Videos 2. www.wikipedia.com

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	**Journal of Electromagnetic Analysis and Applications**	http://www.scirp.org/journal/JEMAA/
		https://www.physicsforums.com

11.0 Examination Note

Internal Assessment: 30 Marks:

Scheme of Evaluation for Internal Assessment (30 Marks)

Student has to answer two full questions as per the format shown below.

Q.1 a	**15**	**Q.2 a**	**15**
OR **b**		OR **b**	
c	**15**	**c**	**15**
Q.2 d		**Q.3 d**	

SCHEME OF EXAMINATION (100 Marks):

1. The question paper will have ten questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
4. Each full question with sub questions will cover the contents under a module.
5. Students will have to answer 5 full questions, selecting one full question from each module

12.0 Course Delivery Plan

MODULE-1	1	**Vector Analysis:** Scalars and Vectors**,** Vector algebra, Vector components and unit vectors, Scalar field and Vector field,Dot product and Cross product	20
	2,3	Co – ordinate systems: Cartesian co-ordinate system, cylindrical and spherical, Relation between different coordinate systems.	
	4,5	Gradient of a scalar field. Divergence and Curl of a vector field, problems.	
	6,7	Electrostatics: Coulomb's law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions.	
	8	Problems on Coulombs law & Electric field Intensity	
	9	Electric flux density, Gauss law and its applications. Maxwell's first equation (Electrostatics).	
	10	Divergence theorem. Problems.	
MODULE-2	11	**Energy and Potential:** Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential.	20
	12	Problems on work done	
	13	The potential field of a point charge and of a system of charges. Potential gradient. The dipole.	
	14,15	Energy density in the electrostatic field. Problems.	
	16	**Conductor and Dielectrics:** Current and current density. Continuity of current. Metallic conductors, Conductor's properties	

	17	Boundary conditions. Perfect dielectric materials problems	
	18,19	capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates	
	20	Capacitance of two wire line. Problems.	
MODULE-3	21	**Poisson's and Laplace equations:** Derivations and problems, Uniqueness theorem.	20
	22,23	Problems	
	24,25	**Steady magnetic fields:** Biot - Savart's law problems, Ampere's circuital law.	
	26,27	The Curl. Stokes theorem, problems	
	28	Magnetic flux and flux density. Scalar and vector magnetic potentials.	
	29,30	Problems	
MODULE-4	31	**Magnetic forces:** Force on a moving charge and differential current element Force between differential current elements	20
	32	Force and torque on a closed circuit	
	33,34	Problems.	
	35	Nature of magnetic materials, Magnetization and permeability.	
	36,37	Magnetic boundary conditions, Problems	
	38	Magnetic circuit, Inductance and mutual inductance. Problems.	
	39,40	Problems.	
MODULE-5	41	**Time varying fields and Maxwell's equations:** Faraday's law, Displacement current.	20
	42	Maxwell's equations in point form and integral form.	
	43,44	Problems.	
	45,46	**Uniform plane wave:** Wave propagation in free space and in dielectrics.	
	47	Pointing vector and power considerations.	
	48	Propagation in good conductors, skin effect.	
	49,50	Problems.	

13.0 Assignments, Quiz

Sl. No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference : book/website /Paper
1	Assignment-I: Questions on Coordinate geometry, Coulomb's Law, Gauss law & Divergence	Student will be able to understand coordinate geometry, divergence, curl & apply to solve the problems on various charges.	Module-1	4	Individual	1,2 & 7
2	Assignment-II: Problems on Energy & potential, Conductors & Dielectrics.	Understand the concept of Energy & potential ,Conductors & dielectrics & solve the problems	Module-2	6	Individual	1,2 & 7
3	Assignment-III: Problems on Poisson's & Laplace equations , Steady magnetic fields.	Student will be able to solve the problems on potential distribution using Poisson's & Laplace equations, understand the concept steady magnetic field & solve the problems.	Module-3	9	Individual	1,2 & 7
4	Assignment-IV: Problems on Magnetic forces, Magnetic	Student will be able to solve the problems on magnetic force,materials,	Module-4	12	Individual	1,2 & 7

	materials and magnetism	boundary conditions & magnetic circuits				
5	Assignment-V: Problems on Time varying fields & wave propagations.	Student will be able to numerical on time varying magnetic fields & wave propagations in different mediums.	Module-5	15	Individual	1,2 & 7

14.0 Assignment Questions

Assignment No	Questions	Marks
I	1) Find the angle between $A=10a_y+2a_z$ and $B=-4a_y+0.5a_z$ using both the dot product & the cross product. 2) Find the curl of $P=xya_x+yza_y+zxa_z$ 3) Find the force on a charge of 30µc at (0,0,5)m,due to a 4mt squre in the Z =0 plane between X=±2m and Y=±2m with a total charge of 500µc distributed uniformly. 4) A sheet charge of $20x10^{-9}$ nc/m² is at x=2m in free space & a line Charge of 20nc/m is located at x=1mt & z=4mt. Find $\lvert\bar{E}\rvert$ at a) origin b)(4,5,6) c) What is the force per unit on the line charge. 5) Given $D'=30e^{-r}a_r$ C/M^2 in cylindrical co-ordinate system. Evaluate both sides of divergence theorem for the volume enclosed by r=2mt,Z=5mt	5 Marks each
II	1) Given $E'=-8xy\ a_x-4x^2\ a_y+a_z$ V/M. Determine the work done in carrying a charge of 6C from (1,8,5) to (2,8,6) along the path i) direct straight line ii) $Y=3x^2+z$ and z=x+4. 2) Find the potential at 'P' which is centre of a square of side 1M. The square has a point Q1=10µC at the upper left corner, a point charge of Q2=-10pC at the lower left corner and a line charge density $P_e=10^{-11}$ C/M along the right edge. 3) Find the current in the circular wire of radius 2mm.The current density is $J=(15(1-e^{-100r})a_z$ Amp./M^2 4) The EFI in region x<0 is $E=10a_x+5a_y-6a_z$ V/mt.& $€_r$ =5 Find i) electric field in the region in the region x>0 assuming $€_r$ =8 ii) the angle between the electric field intensity & interface iii) The angle between the electric field & the normal drawn to the interface. Assume the interface is at x=0. 5) A parallel plate capacitor of 8 nF has an area of 1.51 m^2 & separation of 10mm. What separation would be required to obtain the same capacitance with free space between the plates.	5 Marks each
III	1) Obtain the electric potential and electric field intensity at point between the two cylindrical surfaces having radius 5mt and 10 mt kept at potential 10 Volts and 80 Volts respectively. 2) In Cylindrical coordinate system $H'=(2r-r^2)a_Ø$ A/mt:0<r<1 i) Find J as a function of r ii) Find current passing through the surface Z=0,0<r<1 along Z-axis. 3) If the field of a region is given by i)$E=5\cos t\ a_z+5\cos y\ a_x$ ii) $v=3x^2-2y^2-4z^2$ Volts is the region free of charge. 4) Find the magnetic field intensity at the centre of a squqre of radius 4mt & carrying a current 10 Amps. 5) Evaluate both sides of stokes theorem for the field $H=10\sin Θa_ø$ A/M& the surface at r=3mt $0≤Θ≤90^0$, $0≤ø≤90^0$. Let the surface have the r direction.	5 Marks each
IV	1) Find the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60 cm and diameter of 6 cm. Given that the medium is air. Derive the expression used. 2) A point charge of Q=-1.2µc has velocity $v=5a_x+2a_y-3a_z$ m/s Find the magnitude of the force exerted on the charge if i)$E=-18a_x+5a_y-10a_z$ V/m ii)$B=-4a_x+4a_y-10a_z$ Tesla iii) When both are present. 3)Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical type of length 60 Cm & diameter 6 cm.Given that the medium is air. Derive the	5 Marks each

	expression used. 4)The Z=0 marks the boundary between two magnetic materials. For region1(Z>0),μ_1=4,μH & region 2.(Z<0), μ_2=6μH.The surface current density at the boundary is given as K=12a_y A/M,find H_2 if H_1=40a_x+50a_y+12a_z A/m. 5) Derive an expression for the force on a differential current element placed in a magnetic field. Find the force per meter length between two long parallel wires separated by 10 Cm in air carrying a current of 10A in the same direction.	
V	1)Select the value of K ,so that the following pair of equations satisfy the Maxwell's equation in free space & σ=0,μ=0.25H/mt ,ϵ=.01F/mt: E=(Kx-100t)a_y v/m, H=(x+20t)a_z A/mt 2)What is intrinsic impedance? A wet marshy soil is characterized by σ = 10^{-2} ℧ /mt ϵ_r =15 & μ_r=1. AT WHAT FREQUENCY 60Hz, 1Mhz, 100Mhz, 10GHz, find whether the soil may be considered as conductor or dielectric. 3) Do the fields E=$E_m$sinx sint a_y V/m & H=$\frac{E_m}{\mu_0}$ cosx sint a_z satisfy the Maxwell's equation in free space. 4)Given E=E_0Sin(wt-βZ)a_y V/m in free space.Find i)D ii) B iii) H. Sketch E & H at t=0. 5) A 300MHz uniform plane wave propogates through fresh water for which σ =0 , μ_r=1 & ϵ_r =78. Calculate i) Attenuation constant ii) Phase constant iii) Wave length iv) Intrinsic Impedance. Assume lossless medium.	5 Marks each

15.0 QUESTION BANK

MODULE-1

1. Define i) vector ii) Scalar iii) Unit vector.
2. Define Dot product & cross product. List their properties.
3. What is divergence & curl of a vector?
4. Obtain the expression for incremental length, surface & volume in rectangular coordinate system.
5. Obtain the expression for incremental length, surface & volume in cylindrical coordinate system.
6. Obtain the expression for incremental length, surface & volume in spherical coordinate system.
7. Derive the relationship between i) Rectangular & cylindrical Coordinates ii) Rectangular & Spherical Coordinate system.
8. Define gradient of a scalar field? List the expression for gradient in rectangular, cylindrical & spherical Coordinate system.
9. Define divergence of a vector field. Derive an expression for divergence of a vector field in rectangular, cylindrical & spherical coordinate system.
10. Explain the physical significance of divergence of a vector field.
11. What is curl of a vector field? Derive an expression for 'curl' of a vector field in rectangular, cylindrical & spherical coordinate system.
12. State and explain coulombs law in vector form. Derive an expression for the electric field intensity due to 'n' no. of charges.July-2009,July-2006,Jan-2004,Aug.2003,Mar.-2001,Jan-2015
13. State and explain coulombs law in vector form. Mention the units of each terms involved.July-2008.
14. State and explain inverse square law for electric field in the vector form. Mention the unit of each term involved.
15. Derive an expression for EFI due to an infinite line charge of linear charge density. Dec-2004,Jan-2016,July-2008.
16. Define EFI due to point charge in vector form. With usual notation, derive the expression for field due to many charges -- Dec-2009,Jan-2016,Jan-2013,June-2012.
17. Find EFI at (0,ϕ, h) in cylindrical co-ordinates due to uniformly charged disk for r=a, z=0. Dec-2009.
18. Consider a uniform ring charge of radius 'a'. Derive the general expression for filed electric field vector 'E' at a height 'h' mt (h<a), along the axis of the ring charge and normal to its plane.Jan-2007.
19. Charge is uniformly distributed along an∞ straight line with constant density ρl. develop the expression for E at the general point P.
20. Use Gauss law to determine the EFI due to infinite line charge. Jan-2016.

21. Derive Maxwell's first equation in electrostatics.Jan-2016.
22. What is divergence of a vector field? Obtain the point form of Gauss law.June-2012.
23. What is divergence of a vector field? What do positive & negative divergence represent?June-2010.
24. Derive an expression for EFI due to an infinite line charge density using Gauss Law.
25. State and prove divergence theorem or Maxwell's divergence theorem.
26. State and represent Gauss law in mathematical form for the charge enclosed by a sphere.
27. Write the expressions for div D in three co-ordinate systems. What is the physical significance of divergence?
28. State and prove Gauss law applied to an electric field.Jan-2016,Jan-2009,Jul-2015.
29. State and prove Gauss law. How are the Gaussian surfaces chosen?Jan-2008,Feb-2002,Aug.-2001.
30. State Gauss theorem. Mention the nature of Gaussian surface. July-2007.
31. From Gauss law prove $\nabla . D=\rho_v$July-2008.
32. Using Gauss law, determine EFI everywhere due to a hollow sphere of charge.July-2009.
33. State and explain Gauss law, obtain the relation between D& E. Indicate the nature of Gaussian surface.
34. State Gauss law, using Gauss law obtain an expression for electric field intensity E due to a uniformly charged infinite plane sheet. July-2008.
35. Obtain an expression for EFI due to solid sphere of charge.
36. State and prove Gauss's law in point form.
37. Define a) electric flux, b) Electric flux density, mention their units.
38. There exists a spherical volume charge of radius 'a' with uniform charge density ρ_v, obtain the electric field intensity E and sketch it as a function of r. verify the divergence theorem for r<a.
39. Explain the terms i) Electric field intensity ii) Electric potential. Also bring out the relation between them.July-2006.
40. State & explain the Gauss Divergence theorem. Aug.-2005,Jan-2004,Jan-2013,Jun.-2013.

MODULE- 2

1. Explain the concept of work& potential as applied to an electric field & hence obtain the an expression for the potential difference between two points in an electric field produced by a point charge. July-2006
2. Explain the concept of work & potential as applied to an electric field & charge & hence derive a quantified form of work done from the first principle. July-2002.
3. State & explain the point form of Ohm's law, in the presence of an electric field; also find the current density vector.July-2002.
4. Obtain the point form of continuity equation for current. Comment on the result that free charge cannot remain within a conductor, instead is distributed evenly over the conductor surface.July-2005.
5. Explain the idea of continuity of current equation& hence obtain the an expression for the field equivalent of Kirchhoff's law current law.Aug-2002.
6. Show that the energy required to assemble n number of charges is $W_E=(1/2)\Sigma Q_m V_m$ & hence derive expression for energy in electric field in terms of field quantities $\vec{D}$ & $\vec{E}$ Jan-2016,June-2010
7. Derive an expression for electric potential due to infinite line charges using Gauss law.March-2001, Jan-2016.
8. Derive boundary conditions for conductor & Dielectric interface.Jan-2016,June-2012,Feb-2004.
9. Derive an equation for energy stored in terms of $\vec{D}$ & $\vec{E}$.Feb-2004.
10. Show that the electric field intensity $\vec{E}$ can be expressed as a negative gradient of scalar potential. June-2012.
11. Show that $\vec{E}= -\nabla V$ Feb-2004,July-2003,Aug-2001.
12. Derive an expression for energy expended in moving a point charge in an electric field. June-2012,Jan-2009.
13. Discuss the boundary conditions between two perfect dielectrics. July-2008,July2013.
14. Obtain boundary conditions for dielectric-dielectric boundary July-2009.
15. Obtain the conditions on the tangential & normal components of field intensity & electric flux density at the boundary between two dielectric media.Aug.2001.
16. Derive an expression for the potential of co-axial cable in the dielectric space between inner & outer conductor.March-2001.

17. Discuss with relevant equations the potential of a system of charges & obtain the potential field of a ring of a ring of a uniform line charge density. July 2013.
18. Discuss the current & current density & derive the expression for continuity equation. July2013.
19. D**e**rive an expression relating convection current density , volume charge density & velocity of the charge element.Jan-2009.
20. Show that the electric field at any point is given by the negative of the gradient of potential at the point. July 2013.
21. With usual notations prove $\nabla .J=-\delta\rho_v/\delta t$ Jul.2007,Jul-2008,July-2002.
22. Define & explain the following terms i) Electric field intensity ii) Electric flux density

    iii) Gaussian surface July-2003.
23. Explain the concept of capacitance/capacity of a dielectric medium separated by conducting zones & hence obtain the expression energy stored in a capacitor with the usual notations $W=(1/2)CV^2$.
24. Derive Poisson's & Laplace equations – Dec 2009,July-2013.
25. State & prove uniqueness theorem – Dec 2009, july-2009,Jan-2013,July-2013,Dec-2010,Jan2010,Jan-2008.

MODULE- 3:

1. Derive Poisson's & Laplace equations starting from point form of Gauss's law.-Dec 2007.
2. Using Laplace equation, derive the expression for potential & electric filed distributions for a parallel plate capacitor. Apply proper boundary conditions.
3. Starting from Gauss's law in integral form , derive Laplace & Poisson's equations. Write Laplace's equation in all the coordinate systems.June-2012,Jan-2010
4. Starting with deduce Poisson's & Laplace equation. - Aug-2003,
5. Obtain Poisson's & Laplace equation from Maxwell's first equation.Jan-2013.
6. Obtain Poisson's & Laplace equation; write Laplace equation in explicit form in Cartesian cylindrical & Spherical co-ordinate system. Jan- 2010, July-2006
7. Using Laplace equation derive an expression for the capacitance of a concentric spherical capacitor-Jan-2010
8. Using Laplace equation derive an expression for capacitance of co-axial cable.Jan-2013
9. Write expression for Laplace equation in rectangular, Cylindrical & Spherical coordinate system.Jan-2015.
10. A large spherical cloud of radius b has a uniform volume charge distribution of ρ_v C/m^3, find the potential distribution & electric field intensity at any point in space using Laplace equation, Jan-2013
11. Use Laplace's equation; determine the distribution of potential & electric field intensity between two spherical conductors separated by a dielectric. The inner conductor is at potential V_0 while the outer conductor is grounded.
12. Using Laplace equation, derive an expression for the capacitance of a concentric spherical capacitor. Jan-201
13. State and prove Biot-savart Law. Mention the unit of each quantity involved.
14. Obtain an expression for magnetic field intensity at any point on the axis of a circular coil.
15. State and Prove Stokes theorem.
16. Co axial cable with radius of inner conductor 'a' meter, inner radius of outer conductor 'b' meter and outer radius 'c' meter carries a current of 'I' ampere at inner conductor and –I at outer conductor. Determine and sketch variation of 'H' against 'r' for
    a) r < a b) a< r <b c) b< r <c d) r > c
17. State and Explain amperes circuital law. Write in point form.
18. Derive the Gauss Law for magnetic field in point form. Hence show that scalar magnetic potential follows Laplace equation
19. Explain the concept of vector magnetic potential.
20. Using Biot-savrt Law find an expression for magnetic field of a straight filamentary conductor carrying current I in the Z- direction.

21. Clearly differentiate between scalar and vector magnetic potential.
22. Obtain an expression for vector magnetic potential.
23. State and prove Ampere's Circuit Law and apply it to a infinite long conductor to calculate magnetic field intensity.
24. Find vector magnetic potential 'A' at a point due to a straight current carrying conductor of length 2l meter and hence find flux density

MODULE-4:

1. With usual notations, derive the equation for magnetic force between two differential current elements (force between two loop current circuit)
2. Define self inductance and mutual inductance with suitable formulae.
3. Find the expression from the force on differential current carrying elements.
4. Derive an expression for self inductance of a co-axial cables.
5. Obtain an expression of magnetic force between two current elements and hence for current loops.
6. Discuss the boundary conditions to apply B& H at the interface between two different magnetic materials.
7. Define self and mutual inductance of coil.
8. Derive the equation for energy density in a magnetic field.
9. Obtain the Lorenz force equation for force on an electric charge moving in a uniform magnetic field.
10. Derive an expression for the force on a differential current element placed in magnetic field.
11. Derive an expression for force between two circular current carrying conductors
12. Derive the expression for the inductance of toroidal ring with N turns and carrying I amp current.
13. Derive an expression for force between two current loops.
14. Derive an expression for force between two parallel conductors.
15.
16. Derive the boundary conditions on H & B.
    OR. Discuss the boundary conditions at the interface between two media of different

MODULE -5:

1. Derive the Maxwell's equation from Ampere's law.July-2005
2. State and explain Faraday's laws for emf when a closed conductor single loop circuit is placed in time varying magnetic field.
3. Write Maxwell's equations for free space in point and integral form.July-2009
4. Write a short note on retarded potential. Derive the expressions for the same.
5. List he Maxwell's equations in differential and integral form as applied to time varying fields.July-2014
6. Explain the transformer and motional induced emf's.Aug-2001,June-2009
7. Write the Maxwell's equations in point form for static fields and in integral form for time varying fields.
8. Obtain the expression for emf induced in Faraday's disc generator. Indicate the type of emf induced.
9. Show that the conduction current in the wire is equal to the displacement current in the dielectric of a capacitor subjected to a time varying filed.Feb-2004,Dec-2010
10. What is meant by displacement current? Show that for a harmonically varying electric field, the conduction and displacement currents are in time phase quadrature.
11. Write the Maxwell's equations in integral form derived from Ampere's law & Gauss Law for good conductor medium and for free space.
12. What is the inconsistency of Ampere's law with the equation of continuity? Derive the modified form of Ampere's law of Maxwell.July-2009
13. Explain Faraday's laws applied to i) Stationary path changing field, ii) Steady field moving circuit.
14. Write a note on retarded potential.July-2014
15. Develop from first principles the four Maxwell's equations in both point & integral form. July-2002
16. Enumerate the Maxwell's equations for time varying electric & Magnetic fields.Aug-2003,Feb-2004
17. Prove that $\nabla \times E = -\delta B/\delta t$Dec-2010.
18. Explain the interpretation of Faraday's law applicable to time-varying magnetic field & derive the expression for Transformer emf& motional emf.July-2011
19. State the integral forms of Maxwell's equations applicable to time-varying magnetic fields.Give the wordy description of each statement also. June-2011
20. Derive the continuity equation from Maxwell's equation.June-2010

Course Plan 2018-19 Even – Semester -IV
Electrical & Electronics Engineering

21. Obtain the relation between electric filed intensity (E) and magnetic field intensity (H) in a perfect dielectric medium.
22. State & prove Poynting theorem July-2008
23. Define depth of penetration. Show that depth of penetration of wave in a conductor decreases with increase in frequency
24. Derive electromagnetic wave equation for a homogeneous medium
25. What do you mean by depth of penetration?
26. Explain electromagnetic wave propagation in perfect dielectric.
27. Prove that $E/H = \sqrt{(\mu/\varepsilon)}$
28. Starting from Maxwell's equation, derive the wave equations for a uniform plane wave traveling in free space.
29. Obtain wave equation of E & H.
30. Discuss the uniform plane wave propagation in good conducting medium.
31. With usual notation, derive equation for infinite impedance for lossy medium.
32. What is uniform plane wave? Derive wave equations for free space in terms of E &H .
33. Define wave equation? Derive wave equation in a general medium.July-2009
34. Show that uniform plane electromagnetic wave is transverse in nature.
35. Show that at any point in a space the cross product of electric and magnetic field intensity vector is a measure of rate of energy flow per unit area at that point.
36. Derive the general expression for EM wave; modify it to suit for i) good conductor, ii) Lossy dielectric, iii) perfect dielectric.
37. For an electromagnetic wave propagating in free space , prove that i) $|E|/|H|=I]$ ii)E & H are mutually perpendicular.July-2009

16.0 University Result

Examination	FCD	FC	SC	% Passing
July 2017	--	--	--	56.60
July 2016	3	06	45	88.42
July 2015	--	02	21	34.92

Prepared by	Checked by		
31/1/19		31.1.19	
Prof.A.U.Neshti	Prof. O B Heddurashetti	HOD	Principal

Subject Title	**OPERATIONAL AMPLIFIERS AND LINEAR ICs**		
Subject Code	17EE46	**IA Marks**	40
Number of Lecture Hrs /	03	**Exam Marks**	60
Total Number of Lecture Hrs	40	**Exam Hours**	03
			CREDITS – 03

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

1.0 Prerequisite Subjects:

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

2.0 Course Objectives

1. To understand the basics of Linear ICs such as Op-amp, Regulator, Timer & PLL.
2. To learn the designing of various circuits using linear ICs.
3. To use these linear ICs for specific applications.
4. To understand the concept and various types of converters.
5. To use these ICs, in Hardware projects.

3.0 Course Outcomes

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

	Course Outcome	Cognitive Level	POs
C214.1	Describe the characteristics of ideal and practical operational `amplifier.	L2	PO1,PO3,PO4
C214.2	Design filters and voltage regulators using Op-amp.	L5	PO1,PO3,PO4
C214.3	Explain wave shape generator, comparator and converter circuits.	L2	PO1,PO3,PO4
C214.4	Design signal processing circuits, ADC and DAC's using Op-amp.	L5	PO1,PO3,PO4
C214.5	Discuss PLL and 555 timers.	L1	PO1,PO3,PO4
Total Hours of instruction		**50**	

4.0 Course Content

Module-1

Operational amplifiers: Introduction, Block diagram representation of a typical Op-amp, Schematic symbol, Characteristics of an Op-amp, Ideal op-amp, Equivalent circuit, Ideal voltage transfer curve, Open loop configuration, Differential amplifier, Inverting & non – inverting amplifier, Op-amp with negative feedback(excluding derivations).

General Linear Applications: A.C amplifiers, Summing, Scaling & averaging amplifier, Inverting and non-inverting configuration, Differential configuration, Instrumentation amplifier.

08 Hours

Module-2

Active Filters: First & Second order high pass & low pass Butterworth filters, higher order filters Band pass filters, Band reject filters & all pass filters.

DC Voltage Regulators: Voltage regulator basics, Voltage follower regulator, Adjustable output regulator, M317 & LM337 Integrated circuit regulators.

08 Hours

Module-3

Signal generators: Triangular / rectangular wave generator, Phase shift oscillator, saw tooth oscillator**.**
Comparators & Converters: Basic comparator, Zero crossing detector, Inverting & non-inverting Schmitt trigger circuit, Voltage to current converter with grounded load, Current to voltage converter and basics of voltage to frequency and frequency to voltage converters.

08 Hours

Module-4

Signal processing circuits: Precision half wave & full wave rectifiers.
A/D & D/A Converters: Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, Linear ramp ADC.

08Hours

Module-5

Phase Locked Loop (PLL): Basic PLL, Components, Performance factor.
Timer: Internal architecture of 555 timer, Mono stable, Astable multivibrators and applications.

08 Hours

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VI	Digital Signal Processing	Filters [LPF, HPF, BPF]
02	VIII	VLSI Circuits	PLL

6.0 Relevance to Real World

Sl No	Real World Mapping
01	Design of various components like voltage regulator, oscillators etc.
02	Conduct investigations of complex Problems using basics of Op-amp parameters.
03	Development of prototype models.

7.0 Gap Analysis and Mitigation

Sl No	Delivery Type	Details
01	Tutorial	Topic: Basic of op amp, transistor amplifiers, oscillators.
02	NPTEL	DC voltage regulators

8.0 Books Used and Recommended to Students

Text Books

1. 'Op-Amps and Linear Integrated Circuits', Ramakant A Gayakwad Published by Pearson 4th Edition 2015.
2. 'Linear Integrated Circuits', S. Salivahanan, Published by Mc Graw Hill 2nd Edition, 2014.
3.

Reference Books

1. "Linear Integrated Circuits", Muhammad H Rashid, Cengage Learning 1st Edition, 2014.
2. "Operational Amplifiers and Linear ICs', David A. Bell, Oxford University Press 3rd Edition 2011.
3. 'Operational Amplifiers & Linear Integrated Circuits', K. Lal Kishore, Published by Pearson 1st Edition, 2012.

Additional Study material & e-Books

1. Operational Amplifiers: Theory and Practice Second Edition Version 1.8.1 James K. Roberge Kent H. Lundberg Massachusetts Institute of Technology April 19, 2007

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

Website and Internet Contents References

1. https://en.wikipedia.org/wiki/Operational_amplifier
2. https://en.wikipedia.org/wiki/Voltage_regulators
3. https://en.wikipedia.org/wiki/Analog-to-digital_converter
4. https://en.wikipedia.org/wiki/Phase-locked_loop

10.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	Website
1	AEÜ - International Journal of Electronics and Communications	www.journals.elsevier.com/aeu

11.0 Examination Note

Internal Assessment: 40 Marks(30 Marks Internal Assessment +10 Marks Assignment) :
Internal Assessment is conducted for 30 Marks .
Scheme of Evaluation for Internal Assessment (30 Marks)
Student has to answer two full questions as per the format shown below.

Q.1 a	15	Q.3 a	15
b		b	
OR		OR	
Q.2 a	15	Q.4 a	15
b		b	

SCHEME OF EXAMINATION (60 Marks):

1. The question paper will have ten questions.
2. Each full question is for 15 marks.
3. There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
4. Each full question with sub questions will cover the contents under a module.
5. 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 Lecturer	% of Portion
1	1	Introduction, Block diagram representation of a typical Op-amp, Schematic symbol, Characteristics of an Op-amp, Ideal op-amp	20
	2	Equivalent circuit, Ideal voltage transfer curve, Open loop configuration	
	3	Differential amplifier, Inverting & non – inverting amplifier	
	4	Op-amp with negative feedback	
	5	A.C amplifiers , Summing amplifiers	
	6	Scaling & averaging amplifier	
	7	Inverting and non-inverting configuration	
	8	Instrumentation amplifier	
2	09	First order high pass/low pass Butterworth filters	20
	10	Second order high pass/ low pass Butterworth filters	
	11	Band pass filters , all pass filters	
	12	Voltage regulator basics	
	13	Voltage follower regulator	
	14	Adjustable output regulator	
	15	LM317 Integrated circuit regulators	
	16	LM337 Integrated circuit regulators	
3	17	Triangular / rectangular wave generator	20
	18	Phase shift oscillator, Saw tooth oscillator	
	19	Basic comparator, Zero crossing detector	
	20	Inverting & non-inverting Schmitt trigger circuit	
	21	Voltage to current converter with grounded load	
	22	Current to voltage converter	
	23	basics of voltage to frequency converters	
	24	frequency to voltage converters	
4	25	Precision half wave rectifiers	20
	26	Precision Full wave rectifiers	

	27	A/D Converters basics	
	28	D/A Converters	
	29	R–2R D/A Converter	
	30	Integrated circuit 8-bit D/A	
	31	successive approximation ADC	
	32	, Linear ramp ADC	
5	33	Basic PLL	20
	34	Components.	
	35	Performance factors.	
	36	Applications of PLL IC 565	
	37	Internal architecture of 555 timer	
	38	Internal architecture of 555 timer	
	39	Mono stable multivibrators	
	40	Mono stable multivibrators & applications	

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 basics of Op-amp, parameters, as amplifier.	Module 1 of the syllabus	3	Individual Activity.	David Bell R Gayakwad
2	Assignment 2: Questions on module 2	Students study the voltage regulators and filter design process.	Module 2 of the syllabus	5	Individual Activity.	David Bell R Gayakwad
3	Assignment 3: Questions on module 3	Practice design of various circuits as well as comparators.	Module 3 of the syllabus	8	Individual Activity.	David Bell R Gayakwad
4	Assignment 4: Questions on module 4	Designing different signal processing circuits and converters	Module 4 of the syllabus	10	Individual Activity.	David Bell R Gayakwad
5	Assignment 5: Questions on module 5	Students Study PLL and Timer operation.	Module 5 of the syllabus	12	Individual Activity.	S Salivahan R Gayakwad

14.0 QUESTION BANK

MODULE 1

1. Sketch a basic operational amplifier voltage follower circuit connected as a voltage follower. Explain the operation.
2. Sketch an op-amp inverting amplifier circuit. Also sketch a basic op-amp circuit connected to function as an inverting amplifier. Derive an equation for its voltage gain.
3. An op-amp voltage follower is to operate with a minimum input signal of 200mV. If the error in the output voltage due to amplifier gain is not to exceed 0.005%, determine the minimum voltage gain required for the op-amp.
4. An op-amp non-inverting amplifier has resistors of R2= 22KΩ, and R3= 120Ω, Calculate the output voltage produced by a 75mV input.
5. An op-amp inverting amplifier is to have a voltage gain of 150. If R2 is 33KΩ, determine a suitable resistance value of R1.
6. Explain the need for uninterrupted current paths at each input terminal of an IC op-amp.
7. Write equations for input impedance, output impedance and voltage gain for an inverting amplifier.
8. Sketch an op-amp difference amplifier circuit. Explain the operation of the circuit and derive an equation for the output voltage.
9. Two signals which each range from 0.1 V to 1 V are to be summed. Using a 741 op-amp, design a suitable inverting summing circuit.
10. An inverting amplifier with a +/- 12 V supply is to produce maximum possible output voltage and is to have a voltage gain of 33. Using 741 op-amps, design a suitable circuit.

MODULE 2

1. Draw an all pass phase lag circuit. Sketch the input and output waveforms and the typical frequency response, and explain the circuit operation.

2. Write the equation for the voltage gain of a first order low pass active filter, and briefly discuss the circuit design procedure.
3. Sketch the circuit of a second order active high-pass filter. Briefly explain its operation.
4. Design a first order active low pass filter circuit with a cutoff frequency of 3 kHz.
5. Design a second order high pass filter circuit to have a cutoff frequency of 7 kHz. Estimate the highest signal that can be passed.

6. Briefly explain the action of a dc voltage regulator. Write the equations for line regulation, load regulation a ripple rejection.
7. Briefly discuss the design procedure for a voltage follower regulator.
8. Sketch a regulator circuit using an LM317 IC voltage regulator. Explain the circuit operation, write the equati for output voltage, and discuss the required supply voltage.
9. A voltage regulator circuit has Vs= 25V, Rs= 20Ω, R1= 470Ω, V_z= 15V, Z_z= 10Ω and $I_{L\ (max)}$ = 75mA. Analy the circuit to determine the line regulation, load regulation and ripple rejection. [refer ckt of voltage regulator]
10. With a neat sketch explain the operation of adjustable voltage regulator.

MODULE 3

1. Sketch the circuit of a triangular/ rectangular waveform generator. Draw the output waveforms from the circuit showing their phase relationship and explain the circuit operation.
2. Discuss the design procedure for a triangular/ rectangular waveform generator and write the equations for calculating the component values.
3. Sketch the circuit of a phase shift oscillator that uses diodes for output amplitude stabilization. Explain how the amplitude stabilization circuit operates and show how a distortion control may be included.
4. Design a triangular/ rectangular waveform generator to have an output frequency of 1kHz, a triangular output amplitude of +/- 6 , and a square wave output amplitude of approximately +/ - 10 V.
5. Sketch the circuit of an op-amp employed as a non-inverting ZCD. Also sketch typical input output waveforms. Explain briefly.
6. Draw an op-amp inverting Schmitt trigger circuit. Sketch typical input output waveforms. Explain the circuit operation and the shape of the waveforms.
7. Discuss the design process for an op-amp inverting Schmitt trigger circuit, and write equations for calculating each component value.
8. Using op-amp with a +/- 15 V supply, design a non-inverting Schmitt trigger circuit to have UTP= 1V and LTP 1.5 V.
9. A voltage level detector is to switch its output between approximately -13 V and +13 V when the input exceeds 1.5 V. design a suitable circuit using a 741 op-amp.

MODULE 4

1. Sketch the circuit of a saturating type half wave precision rectifier. Draw the input and output waveforms a explain the circuit operation.
2. Draw the circuit of a high input impedance full wave precision rectifier. Draw the voltage waveforms through the circuit and write the appropriate equations to shoe that full wave rectification is performed.
3. Sketch an op-amp precision clamping circuit, draw the input and output waveforms, and explain the circ operation. Show how the output voltage can be biased to any desired level.
4. A precision full wave rectifier has a signal with 1.5 V peak amplitude. The output peak voltage is to be adjus from 1.5 V to 4.5 V. design a suitable circuit using op-amp.
5. A 3.3 kHz, +/- 2V square wave with a 600Ω source resistance is to have its negative peak clamped at grou level. Design a suitable precision clamping circuit. The tilt on the output is not to exceed 2%.
6. With a neat circuit diagram explain the operation of R-2R DAC.
7. Draw internal architecture of Integrated circuit 8-bit D/A and explain the operation in brief.
8. Explain successive approximation ADC with a neat sketch.
9. Discuss Dual slope ADC with a neat sketch.
10. Sketch a circuit for Digital ramp ADC, explain brief.

MODULE 5

1. What is PLL? Discuss a basic Phase Locked Loop.
2. List the various performance factors of PLL.
3. Discuss the applications of IC 565 [PLL].
4. Discuss the components used to build a phase locked loop.
5. Draw the internal architecture of 555 timers.
6. Discuss the operation of 555 timers as a monostable multivibrator with a neat sketch.

15.0 University Result

Examination	No. of students appeared	No. of students passed	%Passing
May/June 2018	54	37	68.52
May/June 2017	65	48	73.84

Subject Title	**ELECTRICAL MACHINE-II LAB**		
Subject Code	17EEL47	**IA Marks**	20
No of Lecture Hrs + Practical Hrs /	01+02	**Exam Marks**	80
Total No of Lecture + Practical Hrs	42	**Exam Hours**	03
			CREDITS – 02

FACULTY DETAILS:		
Name: Prof. A.U. Neshti	**Designation:** Asst. Professor	**Experience: 9** Years
No. of times course taught: 01 Times		**Specialization:** Digital electronics
Name: Prof. S.B. Patil	**Designation:** Asst. Professor	**Experience: 33** Years
No. of times course taught: 01 Times		**Specialization:** Power and Energy system

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	I	Basic Electrical Engineering
02	Electrical & Electronics Engineering	III	Transformer and generator

2.0 Course Objectives

- To perform tests on dc machines to determine their characteristics.
- To control the speed of dc motor
- To conduct test for pre-determination of the performance characteristics of dc machines
- To conduct load test on single phase and three phase induction motor.
- To conduct test on induction motor to determine the performance characteristics
- To conduct test on synchronous motor to draw the performance curves.

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	POs
C215.1	Test dc machines to determine their characteristics.	L3,L4,L5,L6	PO1, PO2, PO4, PO5
C215.2	Control the speed of dc motor	L3,L4,L5,L6	PO1, PO2, PO4, PO5
C215.3	Pre-determine the performance characteristics of dc machines by conducting suitable tests.	L3,L4,L5,L6	PO1, PO2, PO4, PO5
C215.4	Perform load test on single phase and three phase induction motor to assess its performance.	L3,L4,L5,L6	PO1, PO2, PO4, PO5
C215.5	Conduct test on induction motor to pre-determine the performance characteristics	L3,L4,L5,L6	PO1, PO2, PO4, PO5
C215.6	Conduct test on synchronous motor to draw the performance curves.	L3,L4,L5,L6	PO1, PO2, PO4, PO5
Total Hours of instruction		**42**	

4.0 Course Content

PART A

1. Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics
2. Field Test on dc series machines.
3. Speed control of dc shunt motor by armature and field control.
4. Swinburne's Test on dc motor.
5. Retardation test on dc shunt motor.
6. Regenerative test on dc shunt machines.
7. Load test on three phase induction motor.
8. No load and Blocked rotor test on three phase induction motor to draw (i) equivalent circuit and (ii) circle diagram. Determination of performance parameters at different load conditions from (i) and (ii).
9. Load test on induction generator.

10. Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.
11. Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.
12. Conduct an experiment to draw V and Λ curves of synchronous motor at no load and load.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work	Generation of components for project

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Off-highway Sector, Automotive Marine, Pump Drives
02	Energy Regeneration Material Handling Oil and Gas Mining and Drilling Industry (Hazardous Environment)

7.0 Books Used and Recommended to Students

Text Books
1. Electric Machines', D. P. Kothari,I. J. Nagrath Mc Graw Hill 4th edition, 2011 2.Electrical Machines M.V. Deshpande PHI Learning 2013 3.Electric Machines R.K. Srivastava Cengage Learning 2nd Edition,2013
Reference Books
1.Principles of Electric Machines and power Electronics P.C.Sen Wiley 2nd Edition, 2013
Additional Study material & e-Books
1.Electric machines by godse & bakshi

8.0 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. https://en.wikipedia.org/wiki/DC_motor 4. https://www.youtube.com/watch?v=LAtPHANEfQo 5. www.electrical4u.com/testing-of-dc-machine/ 6. http://www.electrical4u.com/working-principle-of-three-phase-induction-motor/ 7. www.ijset.net/journal/68.pdf 8. www.electrical4u.com/speed-control-of-three-phase-induction-motor 9. www.electrical4u.com/single-phase-induction-motor 10. www.electricaleasy.com/.../synchronous-motor

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	EC&M Magazines	http://ecmweb.com/ops-maintenance/motors
2	Oil & gas journal	https://www.sub-forms.com/dragon/init.do?site=PNW23_OGogpenew
3	IPT Magazine	https://www.intelligent-power-today.com/
4	Electric apparatus magazine	https://electricalapparatus.wordpress.com/2016/06/30/electric-motors-up-and-running/
5	E drive magazine	http://www.e-driveonline.com/main/
6	Motor magazine	https://www.motor.com/newsletters/20110410/WebFiles/ID1_IonizingAmerica.html

10.0 Examination Note

Scheme of Evaluation for Internal Assessment (40 Marks)
a. Internal Assessment test in the same pattern as that of the main examination: 10marks.
b. Continuous Assessment: 30marks

11.0 Course Delivery Plan

Expt No	Practical No	Name of the experiment	% of portion
1	1	Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics	8.33%
2	2	Field Test on dc series machines.	8.33%
3	3	Speed control of dc shunt motor by armature and field control.	8.33%
4	4	Swinburne's Test on dc motor.	8.33%
5	5	Retardation test on dc shunt motor.	8.33%
6	6	Regenerative test on dc shunt machines.	8.33%
7	7	Load test on three phase induction motor.	8.33%
8	8	No load and Blocked rotor test on three phase induction motor to draw (i) equivalent circuit and (ii) circle diagram. Determination of performance parameters at different load conditions from (i) and (ii).	8.33%
9	9	Load test on induction generator.	8.33%
10	10	Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.	8.33%
11	11	Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.	8.33%
12	12	Conduct an experiment to draw V and Λ curves of synchronous motor at no load and load.	8.33%

12.0 QUESTION BANK

1. How are alternators classified?
2. Name the types of alternator based on their rotor construction.
3. Why do cylindrical alternators operate wth steam turbines?
4. Which type of synchronous generators are used in hydro-electric plants and why?
5. What are the advantages of salient pole type construction used for synchronous machines?
6. Why is stator core of alternator laminated?
7. How does electrical degree differ from mechanical degree?
8. What is distributed winding?
9. Why short pitch s preferred over full pitch winding?
10. Define winding factor.
11. What will happen if a starting resistance is not provided while starting the dc shunt motor?
12. What you do to reverse the direction of dc shunt motor.
13. Does the direction of dc shunt motor get reversed if the armature current and field current both are reversed.
14. What are the limitations of armature control method for speed control of dc shunt motor.
15. Name the advantages of field control for controlling the speed of a dc shunt motor.
16. Why is speed of a dc shunt motor is practically constant?
17. Discuss ,what will happen if the dc shunt motor running on no load has its shunt field winding opened accidentally.
18. Will dc shunt motor start on a.c supply?
19. What are aims of performing a load test on dc shunt motor ?
20. Why does the speed of dc shunt motor falls slightly when it is loaded?
21. What can you say about the numerical value of efficiency obtained by swinburn's test?
22. What is the advantage of swinburn's test?
23. What are various losses that occur in dc gennerator?
24. Why hopkinson's test is also known as regenerative test?
25. How hopkinson's test is better than swinburn's test.
26. Compare the power drawn from supply in case of hopkinson's test and swinburn's test
27. What will happen if the shunt field winding of loaded dc shunt motor accidentally breaks?
28. What you mean by V and inverted V curve of synchronous motor.
29. Explain the working principle of three phase Induction Machine
30. Mention the effects of slip on to the rotor parameters.
31. Draw an equivalent circuit of 3-phase IM, how is this circuit different compare to equivalent circuit of transformer.
32. What is the condition for maximum torque in case of 3-phase IM.

Course Plan 2018-19 odd – Semester- 4th
Electrical & Electronics Engineering

13.0 University Result

Examination	Appeared	Passed	% Passing
July 2017	66	66	100
July 2018	54	51	94.44

Prepared by	Checked by		
Prof. S. B. Patil	Prof. A. U. Neshti	HOD	Principal

Subject Title	**OP- AMP AND LINEAR ICs LABORATORY**		
Subject Code	17EEL48	**CIE Marks**	40
No of Practical Hrs / Week	03	**SEE Marks**	60
Total No of Practical Hrs	42	**Exam Hours**	03
			CREDITS – 02

FACULTY DETAILS:		
Name: Mr. S D Hirekodi	**Designation:** Asst. Professor	**Experience:** 18 Years
No. of times course taught: 01 Times	**Specialization:** Power Electronics	
Name: Mr. Sagar S Birade	**Designation:** Asst. Professor	**Experience:** 07 Years
No. of times course taught: 03 Times	**Specialization:** VLSI Design & ES	

1.0 Prerequisite Subjects:

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

2.0 Course Objectives

- To conduct different experiments using OP-Amps
- To conduct experiments using Linear IC's

3.0 Course Outcomes

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

CO	Course Outcome	RBT Level	POs
CO1	To conduct experiment to determine the characteristic parameters of Op-Amp.	L1, L2, L3, L4	1,2,9,10
CO2	To design the Op-Amp as Amplifier, adder, subtractor, differentiator & integrator	L1, L2, L3, L4	1,2,9,10
CO3	To design test the OP-Amp as oscillators and filters	L1, L2, L3, L4	1,2,9,10
CO4	Design and study of Linear IC's as multivibrator power supplies.	L1, L2, L3, L4	1,2,9,10
Total Hours of instruction		**42**	

4.0 Course Content

Experiments

1. Design and verify a precision full wave rectifier. Determine the performance parameters.
2. Design and realize to analyze the frequency response of an op – amp amplifier under inverting and non - inverting configuration for a given gain.
3. Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.
4. Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).
5. Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.
6. Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.

7. Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.
8. Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.
9. Design and realization of R – 2R ladder DAC.
10. Realization of Two bit Flash ADC.
11. Design and verify an IC 555 timer based pulse generator for the specified pulse.
12. Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series

5.0 Relevance to future subjects

S. No	Semester	Subject	Topics / Relevance
01	VI	DSP Lab	Provides basics of filters.
02	VIII	Project work	Designing of components for project

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Design of various circuits using op-amp.
02	Conduct investigations of complex Problems.
03	Development of prototype models.

7.0 Books Used and Recommended to Students

Text Books
1. "Operational Amplifiers and Linear ICs", David A. Bell, Oxford University Press 3rd Edition 2011.
Reference Books
1. "Linear Integrated Circuits", Muhammad H Rashid, Cengage Learning 1st Edition, 2014. 2. "Operational Amplifiers and Linear ICs', David A. Bell, Oxford University Press 3rd Edition 2011.
Additional Study material & e-Books
1. Operational Amplifiers: Theory and Practice Second Edition Version 1.8.1 James K. Roberge Kent H. Lundberg Massachusetts Institute of Technology April 19, 2007

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

Website and Internet Contents References	
1.	www.allaboutcircuits.com/video-lectures/**op-amp-applications**/
2.	www.circuitdigest.com/**555-timer**-circuits

9.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	AEÜ - International Journal of Electronics and Communications	www.journals.elsevier.com/aeu
2	International Journal of Electronics	http://www.tandfonline.com/

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 (40 Marks)
(a) Internal Assessment test in the same pattern as that of the main examination: 10marks.
(b) Continuous Assessment: 30marks

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- 30 marks

11.0 Course Delivery Plan

Expt No	Lecture / Pract No	Name of the Experiment	% Of Portion
1	1	Design and verify a precision full wave rectifier. Determine the performance parameters.	8.33%
2	2	Design and realize to analyze the frequency response of an op – amp amplifier under inverting and non - inverting configuration for a given gain.	8.33%
3	3	Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.	8.33%
4	4	Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).	8.33%
5	5	Verify the operation of an op – amp as (a) voltage comparator circuit and (b) ZCD	8.33%
6	6	Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.	8.33%
7	7	Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.	8.33%
8	8	Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.	8.33%
9	9	Design and realization of R – 2R ladder DAC	8.33%
10	10	Realization of Two bit Flash ADC	8.33%
11	11	Design and verify an IC 555 timer based pulse generator for the specified pulse.	8.33%
12	12	Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series	8.33%

12.0 QUESTION BANK

1. What is the output if the diode is reversed?
2. What is precision rectifier?
3. What is a super diode?
4. What is an op-amp?
5. What is an inverting amplifier?
6. What is the difference between inverting and non inverting amplifier?
7. Define CMRR.
8. Write the equation for gain of an inverting amplifier.
9. State the two conditions for oscillator.
10. What is barkhausen criterion?
11. What is damped oscillation?
12. What is the formula for RC-phase shift oscillator?
13. What is the other name for Schmitt trigger circuit?
14. In Schmitt trigger which type of feedback is used?
15. What is meant by hysteresis?
16. What is the saturation voltage of 741 in terms of VCC?
17. What is the maximum voltage that can be given at the inputs?
18. What are the problems of ideal differentiator?
19. What are the problems of ideal integrator?
20. What are the applications of differentiator and integrator?
21. What is the need for Rf in the circuit of integrator?
22. What is the effect of C1 on the output of a differentiator?
23. What is meant by frequency scaling?
24. How do you convert an original frequency (cut off) f_H to a new cut off frequency f_H?
25. What is the effect of order of the filter on frequency response characteristics?
26. How do you change the frequency of square wave?
27. What are the applications of function generator?
28. How do you obtain a positive staircase waveform?
29. What is the effect of number of bits on output?
30. What is the effect of amplitude and frequency of trigger on the output?
31. How to achieve variation of output pulse width over fine and course ranges?
32. What is the effect of V_{CC} on output?
33. What are the ideal charging and discharging time constants (in terms of R and C) of capacitor voltage?
34. What is the other name of monostable Multivibrator? Why?
35. What are the applications of monostable Multivibrator?

13.0 University Result

Examination	No of Students Appeared	No of Students Passed	% Passing
May/June 2018	54	48	88.9
May/June 2017	66	66	100

Prepared by	Checked by		
31.01.19	31.01.19	31.1.19	
Mr. Sagar S Birade	Mr. S D Hirekodi	HOD	Principal