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, 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

I. To educate students with core knowledge of Electrical and Electronics Engineering to excel in their professional career.

II. To develop problem solving skills, professional skills and ethical values among the students for the betterment of mankind.

III. To prepare technically competent and socially responsible Electrical Engineer to serve the future needs of the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the program will be able to

PEO1: Achieve successful professional career in Electrical Engineering and allied disciplines.

PEO2: Pursue higher studies and continuously engage in upgrading the professional skills.

PEO3: Demonstrate professional & ethical values, effective communication skills and teamwork to solve issues related to profession, society and environment.

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

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 modeling 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 (PSOs) :

PSO1: Apply knowledge & competencies to analyze & design Electrical & Electronics Circuits, Controls and Power Systems, Machines & Industrial Drives.

PSO2: Use Software/Hardware tools for the design, simulation and analysis of Electrical and Electronics Systems.

Contents of VII-SEM

1.0 Student Help Desk

Sl. No	Coordination Work	Contact Person	
		Faculty	Instructor
01	Attestations	Dr. B. V. Madiggond	-
02	Exam forms signature, Overall department administration, Counseling/interaction with Parents/Students.		
03	Research Centre Coordinator, Academic Coordinator		
04	Project Coordinator, KSCST Coordinator, Hobby & Mini Project Coordinator	Prof. S. D. Hirekodi	-
05	Mentorship Coordinator, GATE Coaching Coordinator	Prof. H. R. Zinage	-
06	Dept. Association Coordinator	Prof. M. P. Yenagimath	-
07	Website Coordinator, Professional Body (ISTE & IEEE) Coordinator, Alumni Coordinator	Prof. O. B. Heddurshetti	-
08	AICTE/VTU/NIRF Coordinator, Dept. News & Publicity Coordinator, AICTE Activity Coordinator	Prof. A. U. Neshti	-
10	Library Coordinator	Prof. A. U. Neshti	Shri. S. B. Beelur
11	IA & EMS Coordinator	Prof. K. B. Negalur	-
12	Seminar Coordinator, News letter/Technical Magazine Coordinator	Prof. S. G. Huddar	-
13	Dispensary	Dr. Arun G. Bullannavar, Contact No. 9449141549	
Class Teacher			
15	3rd Semester	Prof. A. U. Neshti	Shri. S. B. Beelur
16	5th Semester	Prof. O. B. Heddurshetti	Shri. V. M. Mutalik
17	7th Semester	Prof. H. R. Zinage	Shri. R. S. Bardol

2.0 Departmental Resources

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

2.1 Faculty Position

S.N.	Category	No. in position	Average experience
1	Teaching faculty	8	18 Y
2	Technical supporting staff	3	25 Y
3	Helper	2	19 Y

2.2 Major Laboratories

SL. No.	Name of the laboratory	Area in Sq. Mtrs	Amount Invested (Rs)
01	Electronics Lab	71	4,49,488.00
02	Operational Amplifier & Linear Integrated Lab		1,29,776.00
03	Power Electronics Lab	92	7,85,162.00
04	Control Systems Lab		2,14,127.00
05	Power System Simulation Lab	71	17,95,111.00
06	Computer Aided Electrical Drawing Lab		6,50,988.40
07	Microcontroller Lab / Digital Signal Processing Lab	72	5,94,122.00
09	Electrical Machines Lab	200	14,85,725.0
10	Relay & High Voltage Lab	94	11,72,383.00
11	Basic Electrical Engg. Lab	96	42,321.00
	Total	**696**	73,19,203.40

3.0 Faculty Details

S.N.	Faculty Name	Designation	Qualification	Area of specialization	Professional membership	Industry Experience (in years)	Teaching Experience (in years)	Contact Nos.
01	Dr. B. V. Madiggond	HOD/Prof.	Ph. D	Power Electronics	LMISTE, YHAI	-	29	9343454993
02	Prof. V. B. Dhere	Asst. Prof.	M. Tech, (Ph. D)	Electronics & Telecommunication	LMISTE, IMPARC	4	25	9886597573
03	Prof. S. D. Hirekodi	Asst. Prof.	M. Tech.	Power Electronics	LMISTE	1	22	9480849338
04	Prof. H. R. Zinage	Asst. Prof.	M. Tech.	Power System	LMISTE	-	22	9480849335
05	Prof. M. P. Yanagimath	Asst. Prof.	M. Tech (Ph. D)	VLSI & ES	LMISTE	1	16.5	9341449466
06	Prof. O. B. Heddurshetti	Asst. Prof.	M. Tech.	Power Electrics	LMISTE	1	15	9448420509
07	Prof. A. U. Neshti	Asst. Prof.	M. Tech.	Digital Electronics	ISTE	-	14	9538223362
08	Prof. K. B. Neglur	Asst. Prof.	M. Tech.	Industrial Electronics	LMISTE	-	09	9886644507
09	Prof. S. G. Huddar	Asst. Prof.	M. Tech.	Power System Engg.	LMISTE	-	09	9742066852

4.0 Institute Academic Calendar

S J P N Trust's
Hirasugar Institute of Technology, Nidasoshi.
Inculcating Values, Promoting Prosperity
Approved by AICTE, New Delhi, Permanently Affiliated to VTU, Belagavi
Recognized under 2(f) & 12B of UGC Act, 1956
Accredited at 'A' Grade by NAAC & Programmes Accredited by NBA:CSE & ECE

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CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2022-23 (Odd)

Date	Events
19-09-2022	Commencement of Classes for VII Semester
24-09-2022	NSS Foundation Day
02-10-2022	Gandhi Jayanthi
10-10-2022	Commencement of Classes for V Semester
24-10-2022 to 30-10-2022	Traffic Week
27-10-2022 to 29-10-2022	First Internal Assessment for VII Semester
31-10-2022	Feedback -I on Teaching-Learning for VII Semester
31-10-2022	National Integration Day
31-10-2022	Commencement of Classes for III Semester
01-11-2022	Kannad Rajyothsava
03-11-2022	Display of 1st Internal Assessment Marks and submission of Feedback-I of VII Semester to office
09-11-2022 to 18-11-2022	Environment Awareness Month
22-11-2022	World's Aids Day
26-11-2022	First Assignment Submission of III Semester (PCC + IPCC)
28-11-2022 to 30-11-2022	Second Internal Assessment for VII Semester & First Internal Assessment for III (PCC + IPCC) /V Semester
01-12-2022	Feedback –II on Teaching-Learning for VII Semester & Feedback – I on Teaching-Learning for III/V Semester
06-12-2022	Display of 2nd Internal Assessment Marks and submission of Feedback-II of VII Semester & Display of 1st Internal Assessment Marks and submission of Feedback-I of III/V Semester to office
10-12-2022	Human Rights Day
10-12-2022	Sports Day
23-12-2022 & 24-12-2022	First Lab Internal Assessment for III Semester (PCC+AEC)
26-12-2022 & 27-12-2022	Lab Internal Assessment for VII Semester
29-12-2022 to 31-12-2022	Third Internal Assessment for VII Semester & Second Internal Assessment for III (PCC + IPCC) /V Semester
31-12-2022	Last working day for VII Semester
02-01-2023	Feedback –II on Teaching-Learning for III/V Semester
05-01-2023	Display of Final IA Marks of VII Semester
05-01-2023	Display of 2nd Internal Assessment Marks and submission of Feedback-II of III/V Semester to office
07-01-2023	Second Assignment Submission of III Semester (PCC + IPCC)
12-01-2023	National Youth Day
15-01-2023	NSS Day
20-01-2023 & 21-01-2023	Lab Internal Assessment for V Semester
23-01-2023 to 25-01-2023	Third Internal Assessment for V Semester
26-01-2023	Republic Day
27-01-2023	Last working day for V Semester
30-01-2023 to 01-02-2023	Second Lab Internal Assessment for III Semester (PCC+IPCC+AEC)
31-01-2023	Display of Final IA Marks of V Semester
06-02-2023 to 08-02-2023	Third Internal Assessment for III Semester (PCC)
11-02-2023	Last working day for III Semester
14-02-2023	Display of Final IA Marks of III Semester

September-2022

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October-2022

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30	31					

04- Mahanavami, Ayudhapooja 05- Vijayadashami
24- Naraka Chaturdashi, 26- Balipadyami Deepavalli

Novemner-2022

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20	21	22	23	24	25	26
27	28	29	30			

01- Kannada Rajyothsava, 11- Kanakadasa Jayanti

December-2022

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January-2023

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22	23	24	25	26	27	28
29	30	31				

14-Makara Sankranti, 26- Republic Day

February-2023

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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

18- Mahashivaratri

19/9/22
Dr. B. V. Madiggond
Dean (Academics)

19/9
Dr. S. C. Kamate
Principal

5.0 Department Academic Calendar

S J P N Trust's
Hirasugar Institute of Technology, Nidasoshi.
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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGG.

CALENDAR OF EVENTS FOR THE ACADEMIC YEAR 2022-23 (Odd)

Date	Events
19-09-2022	Commencement of Classes for VII Semester
24-09-2022	NSS Foundation Day
01-10-2022	*Awareness Program on "How to carryout Literature Survey"*
02-10-2022	Gandhi Jayanthi
10-10-2022	Commencement of Classes for V Semester
24-10-2022 to 30-10-2022	Traffic Week
27-10-2022 to 29-10-2022	First Internal Assessment for VII Semester
31-10-2022	Feedback -I on Teaching-Learning for VII Semester
31-10-2022	National Integration Day
31-10-2022	Commencement of Classes for III Semester
01-11-2022	Kannad Rajyothsava
03-11-2022	Display of 1st Internal Assessment Marks and submission of Feedback-I of VII Semester to office
04-11-2022	*Inauguration of EESSA Activities for the AY 2022-23 & Welcome function to 3rd Sem Students*
09-11-2022 to 18-11-2022	Environment Awareness Month
12-11-2022	*Awareness Program on "PPT Preparation, Presentation and E-mail Etiquette"*
18-11-2022	*MOCK Press Event*
22-11-2022	World's Aids Day
26-11-2022	First Assignment Submission of III Semester (PCC + IPCC)
28-11-2022 to 30-11-2022	Second Internal Assessment for VII Semester & First Internal Assessment for III (PCC + IPCC) /V Semester
01-12-2022	Feedback –II on Teaching-Learning for VII Semester & Feedback – I on Teaching-Learning for III/V Semester
02-12-2022	*Seminar/ Guest lecture by Alumni/Resource person from industry*
05-12-2022 to 09-12-2022	*Five days workshop on "Python Programming for Electrical Engineers"*
06-12-2022	Display of 2nd Internal Assessment Marks and submission of Feedback-II of VII Semester & Display of 1st Internal Assessment Marks and submission of Feedback-I of III/V Semester to office
10-12-2022	Human Rights Day
10-12-2022	Sports Day
16-12-2022	*'Pick & Speak' Competition*
23-12-2022 & 24-12-2022	First Lab Internal Assessment for III Semester (PCC+AEC)
26-12-2022 & 27-12-2022	Lab Internal Assessment for VII Semester
29-12-2022 to 31-12-2022	Third Internal Assessment for VII Semester & Second Internal Assessment for III (PCC + IPCC) /V Semester
31-12-2022	Last working day for VII Semester
02-01-2023	Feedback –II on Teaching-Learning for III/V Semester
05-01-2023	Display of Final IA Marks of VII Semester
05-01-2023	Display of 2nd Internal Assessment Marks and submission of Feedback-II of III/V Semester to office
06-01-2023	*Industrial Visit to III & V Sem students*
07-01-2023	Second Assignment Submission of III Semester (PCC + IPCC)
12-01-2023	National Youth Day
15-01-2023	NSS Day
20-01-2023 & 21-01-2023	Lab Internal Assessment for V Semester
23-01-2023 to 25-01-2023	Third Internal Assessment for V Semester
26-01-2023	Republic Day
27-01-2023	Last working day for V Semester
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31-01-2023	Display of Final IA Marks of V Semester
06-02-2023 to 08-02-2023	Third Internal Assessment for III Semester (PCC)
11-02-2023	Last working day for III Semester
14-02-2023	Display of Final IA Marks of III Semester

September-2022

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October-2022

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16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

04- Mahanavami, Ayudhapooja 05- Vijayadashami
24- Naraka Chaturdashi,
26- Balipadyami Deepavalli

Novemner-2022

S	M	T	W	T	F	S
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13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

01- Kannada Rajyothsava, 11- Kanakadasa Jayanti

December-2022

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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

January-2023

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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

14-Makara Sankranti, 26- Republic Day

February-2023

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				

18- Mahashivaratri

Shri. M. P. Yenagimath	Dr. B. V. Madiggond	Dr. S. C. Kamate
EESSA Coordinator	**HOD**	**Principal**

5.1 Scheme of Teaching & Examination

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

VII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18 EE71	Power System Analysis – 2	EEE	2	2	--	03	40	60	100	3
2	PCC	18 EE72	Power System Protection	EEE	3	--	--	03	40	60	100	3
3	PEC	18 EE73X	Professional Elective - 2	EEE	3	--	--	03	40	60	100	3
4	PEC	18 EE74X	Professional Elective - 3	EEE	3	--	--	03	40	60	100	3
5	OEC	18 EE75X	Open Elective -B	EEE	3	--	--	03	40	60	100	3
6	PCC	18 EEL76	PSS laboratory	EEE	--	2	2	03	40	60	100	2
7	PCC	18 EEL77	Relay & HV lab	EEE	--	2	2	03	40	60	100	2
8	Project	18 EEP78	Project Work Phase - 1	EEE	--	--	2	--	100	--	100	1
9	Internship	--	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	**14**	**06**	**06**	**21**	**380**	**420**	**800**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective - 2

Course code under 18XX73X	Course Title
18EE731	Solar and Wind Energy
18EE732	**Micro and Nano Scale Sensors and Transducers**
18 EE733	Integrated of Distribution Generation.
18 EE734	Advanced Control Systems
18 EE735	Reactive Power Control in Electric Power Systems

Professional Electives - 3

Course code under 18 EE74X	Course Title
18 EE741	Industrial Drives and Application
18 EE742	Utilization of Electrical Power
18 EE743	**AI Techniques for Electrical and hybrid Electric Vehicles**
18 EE744	Smart Grid
18 EE745	Artificial Neural Network With Applications to Power Systems

Open Elective -B

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX75X).
Selection of an open elective shall not be allowed if,
The candidate has studied the same course during the previous semesters of the programme.
The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
A similar course, under any category, is prescribed in the higher semesters of the programme.
Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

CIE procedure for Project Work Phase - 1:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report(covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

Subject Title	POWER SYSTEM ANALYSIS_-2		
Subject Code	18EE71	CIE Marks	40
Number of Lecture Hrs / Week	2:2:0	SEE Marks	60
Total Number of Lecture Hrs	40	Exam Hours	03
		CREDITS – 03	

FACULTY DETAILS:		
Name: Prof. H. R. Zinage	**Designation:** Asst. Professor	**Experience:**22 Years
No. of times course taught:-01(including present)		**Specialization:** Power Systems

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	I/II	Basic Electrical Engineering
02	Electrical and Electronics Engineering	III/IV	Electric Power Generation
03	Electrical and Electronics Engineering	VI	Power system analysis & stability

2.0 Course Objectives

1. To explain formulation of network models and bus admittance matrix for solving load flow problems.
2. To discuss optimal operation of generators on a bus bar and optimum generation scheduling.
3. To explain symmetrical fault analysis and algorithm for short circuit studies.
4. To explain formulation of bus impedance matrix for the use in short circuit studies on power systems.
5. To explain numerical solution of swing equation for multi-machine stability

3.0 Course Outcomes

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

	Course Outcome	RBT Level	POs
CO 401.1	Formulate network matrices and models for solving load flow problems.	L4	1,2,3,4,5,6,8, 9,10,12
CO 401.2	Perform steady state power flow analysis of power systems using numerical iterative techniques.	L4	1,2,3,4,5,6,8, 9,10,12
CO 401.3	Solve issues of economic load dispatch and unit commitment problems.	L4	1,2,3,4,5,6,8, 9,10,1212
CO 401.4	Analyze short circuit faults in power system networks using bus impedance matrix.	L4	1,2,3,4,5,6,8, 9,10,12
CO 401.5	Apply Point by Point method and Runge Kutta Method to solve Swing Equation.	L4	1,2,3,4,5,6,8, 9,10,12

4.0 Course Content

Module-1

Network Topology: Introduction and basic definitions of Elementary graph theory Tree, cut-set, loop analysis. Formation of Incidence Matrices. Primitive network- Impedance form and admittance form, Formation of Y Bus by Singular Transformation. Ybus by Inspection Method. Illustrative examples. T1,T2

Module-2

Load Flow Studies: Introduction, Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidal iterative method. Illustrative examples. T1, R1

Module-3

Load Flow Studies(continued) Newton-Raphson method derivation in Polar form, Fast decoupled load flow method, Flow charts of LFS methods. Comparison of Load Flow Methods. Illustrative examples. T1,R1

Module-4

Economic Operation of Power System: Introduction and Performance curves, Economic generation scheduling neglecting losses and generator limits, Economic generation scheduling including generator limits and neglecting losses, Economic dispatch including transmission losses, Derivation of transmission loss formula. Illustrative examples.

Unit Commitment: Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flow chart and Algorithm only). T3

Module-5

Symmetrical Fault Analysis: Z Bus Formulation by Step by step building algorithm without mutual coupling between the elements by addition of link and addition of branch. Illustrative examples. Z bus Algorithm for Short Circuit Studies excluding numerical.T1 **Power System Stability**: Numerical Solution of Swing Equation by Point by Point method and Runge Kutta Method. Illustrative examples. T1

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
1	VIII	PSOC	ALL

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Power system operation
02	Carryout load flow analysis
03	Power system stability studies

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Visit to power plant	Power system operation study

8.0 Books Used and Recommended to Students

Text Books

1. Modern Power System Analysis D P Kothari, I J Nagrath McGraw Hill 4th Edition, 2011
2. Computer Methods in Power Systems Analysis Glenn W. Stagg Ahmed H Ei – Abiad Scientific International Pvt. Ltd. 1st Edition, 2019
3. Power Generation Operation and Control Allen J Wood etal Wiley 2nd Edition,2016

Reference Books

1. Computer Techniques in Power System Analysis M.A. Pai McGraw Hill 2nd Edition, 2012
2. Power System Analysis Hadi Saadat McGraw Hill 2nd Edition, 2002

Additional Study material & e-Books

1. http://pdfstuff4u.com/ebook.php?id=1071881
2. http://sjbit.edu.in

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

Website and Internet Contents References

1. ieeexplore.ieee.org/document/152452/--
2. https://engineering.purdue.edu/jump/8cb309
3. nptel.iitg.ernet.in

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Society of energy engineers and managers	www.energyprofesionals.in
2	IEEE Explore	ieeexplore.ieee.org/xpl/RecentIssue
3	Journal of Modern Power Systems and Clean Energy	www.springer.com

11.0 Examination Note

SCHEME OF EVALUATION FOR CIE (40 MARKS)

- Internal Assessment test will be done in the same pattern as that of the main examination.

Internal Assessment: 50 Marks scaled down to 30 marks

Assignment marks: 10 marks.

SCHEME OF EXAMINATION: 100 Marks, scaled down to 60 in VTU result sheet.

- The question paper will have ten questions.
- Each full question is for 20 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

UNIT No.	Lecture No.	Content of Lecture	% of Portion
I	1	**Network Topology**: Introduction and basic definitions of Elementary graph theory	20
	2	Tree, cut-set, loop analysis.	
	3	Formation of Incidence Matrices.	
	4	Primitive network- Impedance form and admittance form.	
	5	Formation of Y Bus by Singular Transformation.	
	6	Ybus by Inspection Method.	
	7	Illustrative examples.	
	8	Illustrative examples.	
II	9	**Load Flow Studies**: Introduction	20
	10	Classification of buses.	
	11	Power flow equation,	
	12	Operating Constraints,	
	13	Data for Load flow,	
	14	Gauss Seidal iterative method.	
	15	Gauss Seidal iterative method.	
	16	Illustrative examples.	
III	17	**Load Flow Studies(continued)** Newton-Raphson method derivation in Polar form	20
	18	Newton-Raphson method derivation in Polar form	
	19	Fast decoupled load flow method	
	20	Fast decoupled load flow method	

	21	Flow charts of LFS methods.	
	22	Comparison of Load Flow Methods.	
	23	Illustrative examples.	
	24	Illustrative examples.	
IV	25	**Economic Operation of Power System:** Introduction and Performance curves.	
	26	Economic generation scheduling neglecting losses and generator limits	
	27	Economic generation scheduling including generator limits and neglecting losses.	
	28	Economic dispatch including transmission losses	
	29	Derivation of transmission loss formula.	
	30	Illustrative examples.	
	31	**Unit Commitment:** Introduction, Constraints and unit commitment solution by prior list method	
	32	Dynamic forward DP approach (Flow chart and Algorithm only).	
V	33	**Symmetrical Fault Analysis**: Z Bus Formulation	**20**
	34	Z bus formulation by Step by step building algorithm without mutual coupling between the elements by addition of link and addition of branch.	
	35	Z bus formulation by Step by step building algorithm without mutual coupling between the elements by addition of link and addition of branch.	
	36	Illustrative examples.	
	37	Z bus Algorithm for Short Circuit Studies excluding numerical.	
	38	**Power System Stability:** Numerical Solution of Swing Equation by Point by Point method	
	39	Numerical Solution of Swing Equation by Runge Kutta Method.	
	40	Illustrative examples.	

13.0 Assignments

Sl.No.	Title	Outcome expected	Allied study	Week No.	Individual / Group activity	Reference: book/website /Paper
1	Assignment1: University Questions on network topology	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	3	Individual Activity.	Book 1 of the Text book list. Website of the Reference list
2	Assignment 2: University Questions on Load flow Analysis using GS method	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	5	Individual Activity.	Book 1 of the Text book list. Website of the Reference list
3	Assignment3: University Questions on Load flow Analysis using NR & FDLF method	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	7	Individual Activity.	Book 1 of the reference list. Website of the Reference list
4	Assignment4: University Questions On economic operation of power system	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity.	Book 1 of the reference list. Website of the Reference list
5	Assignment5: University Questions	Students study the Topics and write the	Module 5 of the	9	Individual Activity.	Book 1 of the reference list.

	on symmetrical fault analysis & power system stability	Answers. Get practice to solve university questions.	syllabus			Website of the Reference list

14.0 QUESTION BANK

Module -1

1. Define the following
   i. Graph
   ii. Sub-graph
   iii. Path
   iv. Tree
   v. Co-tree
   vi. Link
   vii. Cutset
2. Explain the following
   i. Explain element node incidence matrix
   ii. Explain bus incidence matrix
   iii. Explain branch path incidence matrix
   iv. Explain basic cutest incidence matrix
   v. Explain augmented cutest incidence matrix
   vi. Explain basic loop incidence matrix
   vii. Explain augmented loop incidence matrix
3. Explain about the primitive network in impedance and admittance form.
4. Explain the formation of Y_{Bus} by method of inspection.
5. Explain the formation of Y_{Bus} by method of singular transformation.

Module -2

1. What are different types of buses considered during power system load flow analysis.
2. Explain G-S load flow solution procedure for a system having both PV & PQ buses. Derive the associated algorithmic expressions used for determining the unknown variables.
3. With the help of flow chart explain G-S method of load flow analysis
4. What are the advantages of Y_{Bus} based power flow analysis
5. The following is the system data for a load flow solution:

Bus code	Admittance
1-2	2.0 -j8.0
1-3	1.0 – j3.0
2-3	0.6 – j2.0
2-4	1.0 –j4.0
3-4	2.0 –j8.0

The schedule of active and reactive power is

	Bus code	P	Q	V	Remarks
a.	1	-	-	1.05+j0.0	Slack
b.	2	0.5	0.2	1.0+j0.0	PQ
c.	3	0.4	0.3	1.0+j0.0	PQ
d.	4	0.3	0.1	1.0+j0.0	PQ

Determine the voltage at the end of first iteration Using 1) Gauss – Seidal method, Take acceleration factor = 1.4

6. What is the need for acceleration factor?
7. What is Q-limit of generator?

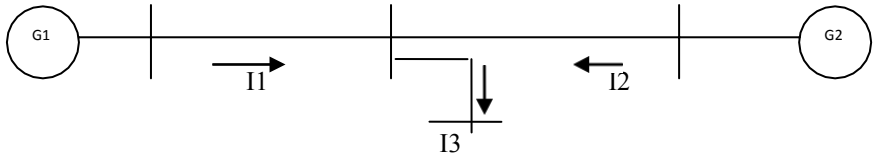
Module -3

1. Explain the significance of Jacobian matrix of N-R LF analysis.
2. With the help of flow chart, explain the procedure of fast decoupled load flow analysis.
3. What are all the approximations made in fast decoupled load flow solution?
4. With the help of flow chart explain N-R method of load flow analysis
5. Refer question 5 of module 2 and solve by Newton Raphson Method.
6. Compare different method of load flow solution procedure in respect of the following.
   I) Time per iteration

ii) Total solution time
iii) Acceleration of convergence of iterative solution
iv) Adaptability for power system calculations

Module -4

1. Explain with reference to economic operation of electric power system, the equal incremental cost criterion. Comment on the same, if the filtration way to include the effect of transmission line losses also.
2. What are transmission line loss coefficients? Obtain the general expression B_{mn} with usual notations.
3. Explain in brief penalty factors & loss co-efficient. Derive the relevant expression.
4. For the system shown in figure, obtain the loss co-efficient. Assume I_1 & I_2 are in phase.



5. Explain problem formulation, solution procedure & algorithm for hydrothermal coordination.
6. Explain unit commitment solution by prior list method.
7. Explain the flowchart of forward Dynamic Programming (DP) approach for solution of unit commitment problem?
8. What are the constrains in unit commitment?

Module-5

1. Derive the swing equation in the form $d^2 / dt^2 = \Pi f / H$ (Pm-Pe)
2. Explain the simplified representation of synchronous machine for transient stability studies. Why its detailed representation of synchronous machine is also necessary for stability studies?
3. Explain clearly the representation of load for transient stability studies.
4. Explain how the network performs equation used for load flow analysis can be applied to describe the performance of the network during a transient period.
5. Starting from the pair of equations representing a swing equation, explain the modified Eulers method of obtaining swing curie.
6. With the help of flow diagram, explain the method of finding the transient stability of a given power system based on Runga-Kutta method.
7. Explain step by step method for the numerical analysis of swing equation.
8. Explain Milne's predictor-corrector method for transient stability studies.
9. Explain the Z BUS building algorithm.

Prepared by	Checked by		
21/9/22	21/9/22	21/9/22	
Prof. H. R. Zinage	**Prof. H. R. Zinage**	**HOD**	**Principal**

Subject Title	**POWER SYSTEM PROTECTION**		
Subject Code	18EE72	**CIE Marks**	40
Number of Lecture Hrs / Week	3:0:0	**SEE Marks**	60
Credits	03	**Exam Hours**	03

FACULTY DETAILS:		
Name: Prof. Onkar B Heddurshetti	**Designation:** Asst .Professor	**Experience:**16 Years
No. of times course taught: 01		**Specialization:** Power Electronics

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical & Electronics Engineering	I/II	BEE
02	Electrical & Electronics Engineering	III	T&G
03	Electrical & Electronics Engineering	IV	T&D

2.0 Course Objectives

The subject aims to provide the student with:

1. To discuss performance of protective relays, components of protection scheme and relay terminology.
2. To explain relay construction and operating principles.
3. To explain Overcurrent protection using electromagnetic and static relays and Overcurrent protective schemes.
4. To discuss types of electromagnetic and static distance relays, effect of arc resistance, power swings, line length and source impedance on performance of distance relays.
5. To discuss pilot protection; wire pilot relaying and carrier pilot relaying.
6. To discuss construction, operating principles and performance of various differential relays for differential protection.
7. To discuss protection of generators, motors, Transformer and Bus Zone Protection.
8. To explain the principle of circuit interruption and different types of circuit breakers.
9. To describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.
10. To discuss protection against Over voltages and Gas Insulated Substation (GIS)

3.0 Course Outcomes

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

	Course Outcome	RBT Level	POs
C402.1	Discuss causes and effects of faults, performance, classification, construction and operating principles of protective relays.	L3	PO1,2,3,6,8,12
C402.2	Explain over current protective schemes, the working of distance relays and the effects of arc resistance, power swings, line length and source impedance on performance of distance relays.	L3	PO1,2,3,6,8,12
C402.3	Discuss various Pilot protection schemes, protection of generators, motors, Transformers and construction, operating principles, performance of differential relays for differential protection.	L3	PO1,2,3,6,8,12
C402.4	Explain the principle of circuit interruption in different types of circuit	L3	PO1,2,3,6,8,12
C402.5	Describe the construction and operating principle of different types of fuses and modern trends in power system protection.	L3	PO1,2,3,6,8,12

4.0 Course Content

MODULE-1

Introduction to Power System Protection: Need for protective schemes, Nature and Cause of Faults, Types of Fault, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Classification of Protective Relays, Automatic Reclosing, Current Transformers for protection, Voltage Transformers for Protection.

Relay Construction and Operating Principles: Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.

Overcurrent Protection: Introduction, Time – current Characteristics, Current Setting, Time Setting. **8 Hours**

MODULE-2

Overcurrent Protection (continued): Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays.

Distance Protection: Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays. **8Hours**

MODULE-3

Pilot Relaying Schemes: Introduction, Wire Pilot Protection, Carrier Current Protection **Differential Protection**: Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection.

Rotating Machines Protection: Introduction, Protection of Generators.

Transformer and Buszone Protection: Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection.**8Hours**

MODULE-4

Circuit Breakers: Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers.

8Hours

MODULE-5

Fuses: Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination.

Protection against Overvoltages: Causes of Overvoltages, Lightning phenomena, Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning, Klydonograph and Magnetic Link, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub – Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL).

Modern Trends in Power System Protection: Introduction, gas insulated substation/switchgear (GIS). **8Hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Use of protectionschemes against faults in final year projects.
02	VII	Power System Operation and Control	Use of relays and circuit breakers in power system.

6.0 Relevance to Real World

SL.No	Real World Mapping
01	Student understands the usage of fuses& circuit breakers in home& industrial applications.
02	Use of different types of relays & circuit breakers in substations& receiving stations & power generating stations.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Practical approach	Visiting the substations & generating stations to realize use of protective devices.
02	NPTEL	Working of restricted earth fault relay & pole discrepancy relay.
03	Mi power tool	Simulation of relay coordination

8.0 Books Used and Recommended to Students

Text Books
1. Power System Protection and Switchgear Badri Ram, D.N. Vishwakarma McGrawHill 2nd Edition.
2. Power System Protection and Switchgear BhuvaneshOza et al McGraw Hill 1st Edition, 2010.
Reference Books
1. Protection and Switchgear Bhavesh et al Oxford 1st Edition, 2011.
2. Power System Switchgear and Protection N. Veerappan S.R. Krishnamurthy S.Chand 1st Edition, 2009.
3. Fundamentals of Power System Protection Y.G.Paithankar S.R. BhidePHI 1st Edition, 2009.
Additional Study material & e-Books
1. "Switchgear &Protection", by U.A. Bakshi&M.V.bakshi. 2. www.NPTEL.com

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

Website and Internet Contents References
1) Electrical4u.com
2) http://books.google.co.in/books
3) http://www.vlab.co.in/
4) https://www.accessengineeringlibrary.com
5) WWW.NPTEL.com

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	Electrical construction & maintenance magazine	ecmweb.com
2	IEEE industry applications Magazine	ieeexplore.ieee.org

11.0 Examination Note

Scheme of Evaluation for CIE (40 Marks)

- **Internal Assessment: 30 Marks**

Total of Three Internal Assessment tests will be conducted for 50 Marks each. Average of three tests is scaled downed to 30 Marks.

- **Assignment: 10 Marks**

SCHEME OF EXAMINATION: 100 Marks, scaled down to 60 in VTU result sheet.

The question paper will have ten questions.

- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from eachmodule.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

12.0 Course Delivery Plan

Module No	Lecture No.	Content of Lecture	% of Portion
1	1	**Introduction to Power System Protection:** Need for protective schemes, Nature and Cause of Faults,	20%
	2	Types of Fault, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection,	
	3	Essential Qualities of Protection, Performance of Protective Relaying,Classification of Protective Relays, Automatic Reclosing.	
	4	Current Transformers for protection, Voltage Transformers for Protection.	
	5	**Relay Construction and Operating Principles:** Introduction,	
	6	Static Relays – Merits and Demerits of Static Relays	
	7	Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.	
	8	**Over current Protection:** Introduction, Time – current Characteristics,	
2	9	Over current Protective Schemes, Reverse Power or Directional Relay.	20%
	10	Protection of Parallel Feeders, Protection of Ring Mains.Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme.	
	11	Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays.	
	12	**Distance Protection:** Introduction, Impedance Relay.	
	13	Reactance Relay, Mho Relay.	
	14	Angle Impedance Relay, Effect of Arc Resistance on the Performance of	
	15	Reach of Distance Relays. Effect of Power Surgeson Performance of Distance	
	16	Effect of Line Length and Source Impedance on Performance of Distance Relays.	
3	17	**Pilot Relaying Schemes:** Introduction, Wire Pilot Protection, Carrier Current Protection.	20%
	18	**Differential Protection**: Introduction, Differential Relays.	
	19	Simple Differential Protection, Percentage or Biased Differential Relay,	
	20	Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection.	
	21	**Rotating Machines Protection:** Introduction, Protection of Generators	
	22	**Transformer and Buszone Protection:** Introduction, Transformer Protection	
	23	Buszone Protection	
	24	Frame Leakage Protection	

4	25	**Circuit Breakers:** Introduction, Fault Clearing Time of a Circuit Breaker	20%
	26	Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage,	
	27	Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers.	
	28	Air – Break Circuit Breakers, Oil Circuit Breakers	
	29	Air – Blast Circuit Breakers, SF6 Circuit Breakers,	
	30	Vacuum Circuit Breakers,	
	31	High Voltage Direct Current Circuit Breakers	
	32	Rating of Circuit Breakers, Testing of Circuit Breakers	
5	33	**Fuses:** Introductions, Definitions, Fuse Characteristics, Types of Fuses,	20%
	34	Applications of HRC Fuses, Selection of Fuses, Discrimination.	
	35	**Protection against Over voltages:** Causes of Over voltages, Lightning phenomena.	
	36	Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning.	
	37	Klydonograph and Magnetic Link, Protection of Transmission Lines against	
	38	Protection of Stations and Sub – Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination.	
	39	Basic Impulse Insulation Level (BIL).	
	40	**Modern Trends in Power System Protection:** Introduction, Gas insulated substation/switchgear (GIS)	

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: Introduction to power system protection	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity. Written solution is expected.	Book 1 of the reference list. Website of the Reference list
2	Assignment 2: Over current & Distance protection	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity. Written solution is expected.	Book 1 of the reference list. Website of the Reference list
3	Assignment 3: Pilot relaying schemes & rotatingmachine, Transformer &Bus zoneprotection.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity. Written solution is expected.	Book 1 of the reference list. Website of the Reference list
4	Assignment 4: Circuit breakers	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity. Written solution is expected.	Book 1 of the reference list. Website of the Reference list
5	Assignment 5: Fuses, Protection against over voltages and Modern trends in power system protection.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity. Written solution is expected.	Book 1 of the reference list. Website of the Reference list

14.0 QUESTION BANK

Module No. 1:

1. Explain need of protection schemes?
2. Mention different types of faults?
3. With neat sketch explain primary and backup protection?
4. Explain the classification of protective relays?
5. Mention merits and demerits of static relays?
6. Compare electromechanical and Numerical relays?
7. With a neat diagram, explain zones of protection in a power system.
8. Explain the various methods of back up protection.
9. Briefly explain essential qualities of protective relay.
10. Draw the schematic diagram of Numerical relay and briefly describe its various components.

Module No. 2:

1. Explain over current protective schemes?
2. With neat sketch explain the operation of Directional relay?
3. Explain the protection of parallel feeders & Ring mains?
4. Explain earth fault and phase fault protection?
5. Explain the operation of static over current relay?
6. With neat sketch explain the operation of impedance relay?
7. With neat sketch explain the operation of reactance relay & Mho relay?
8. Explain the effect of arc resistance on the performance of Distance relays?
9. Explain the effect of power surges on performance of Distance relays?
10. Mention effect of source impedance & line length on performance of distance relays?
11. With neat sketch, explain Directional overcurrent relay.
12. With a neat circuit diagram, explain Directional over current relay.

Module No. 3

1. Explain carrier current protection?
2. With neat sketch explain the operation of differential relay?
3. With neat diagram explain the operation of percentage or biased differential relay?
4. Explain differential protection of 3 phase circuits?
5. Explain the operation of balanced voltage differential protection?
6. Explain the protection of Generators?
7. Explain transformer protection?
8. Explain buszone protection?
9. Explain the term Pilot with reference to power line protection.
10. Describe the balanced (opposed) voltage differential protection scheme.
11. With a neat diagram. Explain the working of Buchholz relay.

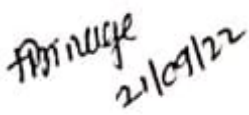
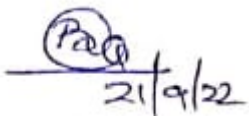
Module No. 4

1. Explain the basic principle of operation of Circuit breaker?
2. Explain arc interruption in circuit breaker?
3. Define restriking & recovery voltage?
4. With neat sketch explain interruption of capacitive current?
5. With neat sketch the operation of fallowing circuit breakers?
   - Air-break circuit breaker
   - Oil circuit breaker
   - Air-blast circuit breaker
   - SF6 circuit breaker
   - Vacuum circuit breaker
   - High voltage direct current circuit breaker
6. Explain the ratings of circuit breaker?
7. Explain various methods of testing of circuit breakers?

8. Explain how interruption of capacitive current takes place in AC circuit breaker.
9. With a neat sketch, explain the construction and working of Non-Puffer type of SF6 Circuit breaker.
10. With the help of Schematic diagram, explain the working of short circuit test plant.

Module No. 5

1. Mention different types of fuses?
2. With neat sketch explain the operation of HRC fuse?
3. With neat sketch explain the construction & working of Liquid fuse?
4. Explain the procedure for selection of fuses and define discrimination?
5. Mention the causes of over voltages?
6. Explain the lightning phenomena?
7. Explain the protection of transmission lines against direct lightning strokes?
8. Explain the protection of substations from direct strokes?
9. Explain the basic Impulse insulation level?
10. Explain about Gas insulated substation?
11. Define the fusing factor and Fuse.
12. With a neat sketch, explain the working of Klydonograph.
13. What are the various components of a GIS? Briefly describe their functions.

Prepared by	Checked by		
			
Prof. Onkar B Heddurshetti	**Prof. H. R. Zinage**	**HOD**	**Principal**

Subject Title	**INTEGRATION OF DISTRIBUTED GENERATION**		
Subject Code	18EE733	**IA Marks**	40
Number of Lecture Hrs / Week	03	**Exam Marks**	60
Total Number of Lecture Hrs	40	**Exam Hours**	03
			CREDITS – 03

FACULTY DETAILS:		
Name: Prof. Sujata. G. Huddar	**Designation:** Asst.Professor	**Experience:** 8Years
No. of times course taught:01	**Specialization :**Power System Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics	IV	Transmission and Distribution
02	Electrical and Electronics	V	Renewable Energy Systems
03	Electrical and Electronics	VI	Solar and Wind Energy

2.0 Course Objectives

1. To explain power generation by alternate energy source like wind power and solar power.
2. To explain selection of size of units and location for wind and solar systems.
3. Discuss the effects of integration of distributed generation on the performance the system.
4. To provide practical and useful information about grid integration of distributed generation.

3.0 Course Outcomes

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

	Course Outcome	RBT Level	Pos
C405.1	Explain energy generation by wind and solar power & discuss the flexibilities in choosing locations with respect to wind and solar systems.	L2	1,2,3,5,8,9
C405.2	Explain the performance of the system when distributed generation is integrated to the system.	L2	1,2,3,5,8,9
C405.3	Discuss effects of the integration of DG: the increased risk of overload, increased losses, increased risk of over voltages.	L3	1,2,3,5,8,9
C405.4	Discuss effects of the integration of DG: incorrect operation of the protection and increased levels of power quality disturbances.	L3	1,2,3,5,8,9
C405.5	Discuss effects of the integration of DG for different types of power quality disturbances.	L3	1,2,3,5,8,9
Total Hours of instruction		**40**	

4.0 Course Content

Module-1

Distributed Generation: Introduction, status, Properties of wind power, Power Distribution as a function of wind speed, Solar Power: Status, Properties, Space requirements, Photovoltaic's, Seasonal variation in production capacity, Combined Heat-and-Power: Status, Options for space Heating, Hydropower: Properties of Large Hydro, Properties of small Hydro, Variation with time, Tidal Power, Wave Power, Geothermal Power, Thermal Power Plant. **8 Hours**

Module-2

Distributed Generation (continued): Interface with the Grid. Power System Performance: Impact of Distributed Generation on the Power System, Aims of the Power System, Hosting Capacity Approach, Power Quality, Voltage Quality and Design of Distributed Generation, Hosting Capacity Approach for Events, Increasing the Hosting Capacity. Overloading and Losses: Impact of Distributed Generation, Overloading: Radial Distribution Networks, Active Power Flow Only, Active and Reactive Power Flow Overloading: Redundancy and Meshed Operation Redundancy in Distribution Networks Meshed Operation, Losses. **8 Hours**

Module-3

Over loading and Losses (continued): Increasing the Hosting Capacity: Increasing the Loadability Building New Connections, Inter trip Schemes, Advanced protection Schemes, Energy Management Systems. Power Electronics approach, Demand Control, Prioritizing Renewable Energy, DynamicLoadability.

Voltage Magnitude Variations: Impact of Distributed Generation, Voltage Marginand Hosting Capacity: Voltage Control in Distribution Systems, Voltage Rise Owing to Distributed Generation, Hosting Capacity, Estimating hosting capacity without Measurements, Sharing hosting capacity. Design of Distribution Feeders: Basic Design Rules, Terminology, An Individual Generator Along a MediumVoltage Feeder, Low voltage feeders, Series and Shunt Compensation, A Numerical Approach to Voltage Variations: Example for Two-stage Boosting, General Expressions for Two-Stage Boosting Tap Changers with Line- Drop Compensation: Transformer with One Single Feeder, Adding a Generator.ProbabilisticMethodsforDesignofDistributionFeeders:Need for Probabilistic Methods, The System Studied, Generation with Constant Production, Adding Wind Power. **8 Hours**

Module-4

VoltageMagnitudeVariations(continued): StatisticalApproachtoHostingCapacity,Increasingthe HostingCapacity: New or Stronger Feeders, Alternative Methods for Voltage Control Accurate Measurement of the Voltage Magnitude Variations, Allowing Higher Overvoltage's Overvoltage Protection, Over Voltage Curtailment Compensating the generators voltage variations, Distributed generation with voltage control, Coordinated voltage control.

Power Quality Disturbances: Impact of Distributed Generation, Fast Voltage Fluctuations: Fast Fluctuations in Wind Power, Fast Fluctuations in Solar Power, Rapid Voltage Changes, Very Short Variations. Voltage Unbalance: Weaker Transmission System, Stronger Distribution System, Large Single-Phase Generators, Stronger Distribution Grid Voltage Unbalance. **8 Hours**

Module-5

Power Quality Disturbances(continued): Low-Frequency Harmonics: Wind Power: Induction Generators, Generators with Power Electronics Interfaces, Synchronous Generators, Measurement Example, Harmonic Resonances, Weaker Transmission Grid, Stronger Distribution Grid. HighFrequency Distortion: Emission by Individual Generators, Grouping Below and Above 2 kHz, Limits Below and Above 2 kHz,Voltage Dips: Synchronous Machines Balanced Dips and Unbalanced Dips, Induction generators and unbalanced dips. Increasing the Hosting Capacity: Strengthening the Grid, Emission Limits for Generator Units, Emission Limits for Other Customers, Higher Disturbance Levels, Passive Harmonic Filters, Power Electronics Converters, Reducing the Number of Dips, Broadband and High-Frequency Distortion. **8 Hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project work	Renewable energy related projects

6.0 Relevance to Real World

SlNo	Real World Mapping
01	Students are capable of explaining the operation of different types ofintegrated distribution generating plants.
02	Development of a project.

7.0 Gap Analysis and Mitigation

Sl No	Delivery Type	Details
01	Activity	Industrial Visit

8.0 Books Used and Recommended to Students

Text Books				
1.	Integration of Distributed Generation in the Power System	Math Bollen	Wiley	2011
Reference Books				
1. Advanced Power Electronic Interfaces for Distributed Energy Systems W. Kramer, S. Chakraborty, B. Kroposki, and H.Thomas March 2008				
Additional Study material & e-Books				
1. IEEE papers related to distributed generation.				

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

Website and Internet Contents References
1)https://en.wikipedia.org/wiki/Power_electronics#DC/AC_converters_(inverters)
2)https://en.wikipedia.org/wiki/AC-to-AC_converter
3)https://www.dg.history.vt.edu/ch1/introduction.html
4)https://www.epa.gov/energy/distributed-generation-electricity-and-its-environmental-impacts

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Distributed Generation & Alternative Energy Journal	https://ieeexplore.ieee.org/document/985677
2	PV Magzine	https://www.pv-magazine.com/2020/02/04/predicting-solar-power-generation-with-deep-photovoltaic-nowcasting/
3	POWER Magazine	https://www.powermag.com/

11.0 Examination Note

Scheme of Evaluation for CIE (40 Marks)

Internal Assessment test will be done in the same pattern as that of the main examination.

Internal Assessment: 50 Marks, scaled down to 30marks

Assignment: 10 Marks

Scheme Of Examination: 100 Marks, scaled down to 60 in VTU result sheet.

The question paper will have ten questions.

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

12.0 Course Delivery Plan

Module	Lecture No.	Content of Lecturer	% of Portion
1	1.	Distributed Generation: Introduction , status	20
	2.	Properties of Wind Power	
	3.	Power Distribution as a function of wind speed	
	4.	Solar Power: Status, Properties.	
	5.	Combined Heat-and-Power	
	6.	Hydropower properties of large & small hydro.	
	7.	Tidal Power, Wave Power&Geothermal Power.	
	8.	Thermal Power Plants and Interface with the Grid	
2	9.	Impact of Distributed Generation on the Power System	20
	10.	Aims of the Power System	
	11.	Hosting Capacity Approach	
	12.	Power Quality & Voltage Quality	
	13.	Design of Distributed Generation	
	14.	Hosting Capacity Approach for Events &Increasing the Hosting Capacity.	
	15.	Overloading and Losses: Impact of Distributed Generation	
	16.	Overloading: Radial Distribution Networks, Meshed Operation, Losses.	
3	17.	Increasing the Load ability Building New Connections	20
	18.	Inter trip Schemes, Advanced protection Schemes,	
	19.	Energy Management Systems. Power Electronics approach, Demand Control	
	20.	Voltage Magnitude Variations: Impact of Distributed Generation	
	21.	Design of Distribution Feeders, basic design rules	
	22.	A Numerical Approach to Voltage Variations	
	23.	Tap Changers with Line-Drop Compensation	
	24.	Probabilistic Methods for Design of Distribution Feeders	
4	25.	Statistical Approach to Hosting Capacity	
	26.	Increasing the Hosting Capacity.	
	27.	Alternative Methods for Voltage Control.	20
	28.	Overvoltage Protection,	
	29.	Distributed generation with voltage control &Coordinated voltage control.	
	30.	Power Quality Disturbances: Impact of Distributed Generation	20
	31.	Fast Voltage Fluctuations	
	32.	Voltage Unbalance	
5	33.	Power Quality Disturbances : Low-Frequency Harmonics	

	34.	HighFrequency Distortion, voltage dips.	
	35.	Synchronous Machines Balanced and Unbalanced Dips	
	36.	Increasing the Hosting Capacity, Higher Disturbance Levels,	
	37.	Strengthening the Grid.	
	38.	Emission Limits for Generator Units& for Other Customers,	
	39.	Passive Harmonic Filters & Power Electronics Converters.	
	40.	Broadband and High-Frequency Distortion	

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 Distributed Generation.	Students study the Topic and write the Answers. Get practice to solve university questions.	module 1 of the syllabus	2	Individual Activity. Written answers are expected.	Book 1, of text book
2	Assignment 2: University Questions on Impactof Distributed Generation on the Power System	Students study the Topic and write the Answers. Get practice to solve university questions.	module 2 of the syllabus	4	Individual Activity. Written answers are expected.	Book 1 of text book
3	Assignment 3: University Questions on overloading and losses of distributed generation.	Students study the Topics and write the Answers. Get practice to solve university questions.	module 3 of the syllabus	6	Individual Activity. Written answers are expected.	Book 1of text book
4	Assignment 4: University Questions on Voltage Magnitude Variations in distributed generation	Students study the Topics and write the Answers. Get practice to solve university questions.	module 4 of the syllabus	8	Individual Activity. Written answers are expected.	Book 1 of text book
5	Assignment 5: University Questions on Power Quality Disturbances on distributed generation.	Students study the Topics and write the Answers. Get practice to solve university questions.	module 5 of the syllabus	10	Individual Activity. Written answers are expected.	Book 1 of text book

14.0 QUESTION BANK

MODULE 1

1. List the different reasons for new type of power production in the power system.
2. Explain persuasively how power is produced from wind list out the properties of wind power.
3. Enumerate the main barriers to the wide scale use of renewable energy.
4. Briefly explain the different MPPT algorithms incorporated within the interface technology.
5. Write short note on wind power.
6. Write short note on tidal power.
7. Explain persuasively how power is produced from wave.

MODULE 2

1. With a neat figure explain two possible schemes of interfacing distributed generation to grid.
2. Discuss four different approaches to prevent DG interfering with the ability of power system to fulfill its primary aims.
3. Explain direct machine coupling with the grid.
4. Write a note on power quality concerned to distributed generation.
5. Explain Full Power Electronics Coupling with the Grid.
6. Explain impact of the type of Interface on the Power System.

MODULE 3

1. Outline Intertrip schemes used during connecting large generator unit into the network.
2. Briefly explain, how voltage magnitude variations impacts the design of distributed generation.
3. Explain Knowledge Server for Controllers (KSC) used in energy management system.
4. Explain basic design rules of distribution feeders.
5. Explain hosting capacity approach for power quality events.
6. Explain multiple generator tripping.

MODULE 4

1. Discuss how strong feeders increase the hosting capacity.
2. List the various power quality disturbances developed due to distributed generation.
3. Explain the dynamic voltage control used for increasing the hosting capacity
4. Explain two main sources of unbalanced voltage at transmission level.
5. Explain various power quality disturbances developed due to distributed generation.

MODULE 5

1. What is the maximum permissible voltage distortion according to IEEE standard and briefly explain low frequency harmonics in distributed generation.
2. Summarize high frequency distortion as power quality disturbance.
3. List the causes of voltage dips in distributed generation.
4. Outline the measures required to increase the hosting capacity when power quality disturbance sets the limit to distributed generation interconnection.
5. Write short note on voltage dip.
6. Write short note on weaker transmission grid.
7. Write short note on stronger distribution grid.

Prepared by	Checked by		
	21/9/22	21/9/22	
Prof. S.G.Huddar	Prof. H. R. Zinage	HOD	Principal

Subject Title	**Smart Grid**		
Subject Code	18EE744	**CIE Marks**	40
Number of Lecture Hrs / Week	04	**SEE Marks**	60
Total Number of Lecture Hrs	40	**Exam Hours**	03
			CREDITS – 03

FACULTY DETAILS:		
Name: Prof. K. B. Negalur	**Designation:** Asst. Professor	**Experience: 0**9
No. of times course taught: 01	**Specialization:** Industrial Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical &Electronics Engineering	VI	Power system analysis –I
02	Electrical &Electronics Engineering	IV	Transmission and Distribution
03	Electrical &Electronics Engineering	IV	Power Generation and Economics

2.0 Course Objectives

- To understand the basic concept of smart grid, attributes of Smart Grid
- To describe the over view of the perfect power system configuration
- To know about DC power delivery systems ,data centers and information technology loads
- To understand the importance of Technology Alternatives in smart Grid
- To understand the Dynamic energy systems in Smart Grid
- To describe the overview of Demand side planning and evaluation

3.0 Course Outcomes

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

CO	Course Outcome	Cognitive Level	Pos
1	Explain the concept of Smart grid and need of smart grid.	L2	1,2,3,4,6,8,9, 10,12
2	Outline the benefits and drivers of DC Power delivery system.	L3	1,2,3,4,6,8,9, 10,12
3	Summarize the Intelligrid Architecture for the smart grid.	L3	1,2,3,4,6,8,9, 10,12
4	Explain the Efficient Electric End-use Technology Alternatives.	L2	1,2,3,4,6,8,9, 10,12
5	Discuss Demand side planning and Evaluation.	L2	1,2,3,4,6,8,9, 10,12
Total Hours of instruction		**40**	

4.0 Course Content

Module-1

Introduction: Introduction to smart grid, electricity network, local energy networks, electric transportation, low carbon central generation, attributes of the smart grid.

Smart Grid to Evolve a Perfect Power System: Introduction, overview of the perfect power system configurations, device level power system, building integrated power systems, distributed power systems, fully integrated power system. **08 Hours**

Module-2

DC Distribution and Smart Grid: AC Vs. DC sources, benefits of and drives of DC power delivery systems, powering equipment and appliances with DC, data centers and information technology loads, potential future work and research

Intelligrid Architecture for the Smart Grid: Introduction, launching intelligrid, intelligrid today, smart grid vision based on the intelligrid architecture. **08 Hours**

Module-3

Dynamic Energy Systems Concept: Smart energy efficient end use devices, smart distributed energy resources, advanced whole building control systems, integrated communications architecture, energy management, role of technology in demand response, current limitations to dynamic energy management, distributed energy resources, overview of a dynamic energy management, key characteristics of smart devices, key characteristics of advanced whole building control systems, key characteristics of dynamic energy management system. **08 Hours**

Module-4

Efficient Electric End Use Technology Alternatives: Existing technologies ,lighting, space conditioning, indoor air quality, domestic water heating, hyper efficient appliances, ductless residential heat pumps and air conditioners, variable refrigerant flow air conditioning, heat pump water heating, hyper efficient residential appliances, data center energy efficiency, LED street and area lighting, industrial motors and drives, equipment retrofit and replacement, process heating, cogeneration, thermal energy storage, industrial energy management programs, manufacturing process, electro - technologies, residential, commercial and industrial sectors. **08 Hours**

Module-5

Demand side planning: Introduction, Selecting Alternatives, Issues Critical to the Demand-side Issues Critical to the Demand-side, The Utility Planning Process, Demand-side Activities, Alternatives that Are Most Beneficial.

Demand-Side Evaluation: Levels of Analysis. General Information Requirements .System, Context, Transferability, Data Requirement, Cost/Benefit Analysis, Program Interaction. **08 Hours**

5.0 Relevance to future subjects

Sl No	Semester	Subject	Topics
01	VIII	Project	Power System performance study and analysis.

6.0 Relevance to Real World

SL.No	Real World Mapping
01	More efficient transmission of electricity.
02	Reduced operations and management costs for utilities.

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	Expert Lecture/Field Visit	"Smart Grid"

8.0 Books Used and Recommended to Students

Text Books
The Smart Grid, Enabling Energy Efficiency and Demand Side Response by Clark W Gellings CRC Press, 2009 3rd Edition, 2013.
Additional Study material & e-Books
Smart Grid :Technology and Applications by Janaka Ekanayake, Kithsiri Liyanage,Jianzhong Wiley 2012
Fundamentals of Design and Analysis James Momoh Wiley IEEE press 2012

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

Website and Internet Contents References
1) nptel.ac.in
2) freevideolectures.com › Electrical Engineering › IIT Kanpur
3) nptel.iitg.ernet.in

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	Website
1	International Journal of Smart Grid and Clean Energy	http://www.ijsgce.com/

11.0 Examination Note

Scheme of Evaluation for CIE (40 Marks)
Internal Assessment test will be done in the same pattern as that of the main examination.
Internal Assessment: 50 Marks, Scaled down to 30 marks
Assignment: 10 Marks

SCHEME OF EXAMINATION: 100 marks, scaled down to 60 marks in VTU result sheet.

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three 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.

Unit No.	Lecture No.	Content of Lecture	% of Portion
I	1.	Introduction to smart grid	20
	2.	Electricity network	
	3.	Local energy networks	
	4.	Electric transportation	
	5.	Low carbon central generation	
	6.	Attributes of the smart grid	
	7.	Building integrated power systems & device level power system	
	8.	Distributed power systems & fully integrated power system.	
II	9.	AC Vs. DC sources, benefits of and drives of DC power delivery systems	20
	10.	Powering equipment and appliances with DC	
	11.	Data centers and information technology loads	
	12.	Potential future work and research	
	13.	Intelligrid Architecture for the Smart Grid.	
	14.	Launching intelligrid	

	15.	Intelligrid today	
	16.	Smart grid vision based on the intelligrid architecture	
III	17.	Smart energy efficient end use devices	**20**
	18.	Smart distributed energy resources	
	19.	Advanced whole building control systems	
	20.	Integrated communications architecture, energy management	
	21.	Role of technology in demand response	
	22.	Current limitations to dynamic energy management	
	23.	Distributed energy resources	
	24.	Key characteristics of smart devices, key characteristics of advanced whole building control systems	
IV	25.	Existing technologies ,lighting, space conditioning	**20**
	26.	Indoor air quality & domestic water heating	
	27.	Hyper efficient appliances & ductless residential heat pumps and air conditioners	
	28.	Variable refrigerant flow air conditioning & heat pump water heating, hyper efficient residential appliances,	
	29.	Data center energy efficiency & LED street and area lighting	
	30.	Industrial motors and drives & equipment retrofit and replacement	
	31.	Process heating, cogeneration, thermal energy storage	
	32.	industrial energy management programs & electro -technologies, residential, commercial and industrial sectors.	
V	33.	Demand side planning	**20**
	34.	Selecting Alternatives, Issues Critical to the Demand-side Issues Critical to the demand-side.	
	35.	The Utility Planning Process, Demand-side Activities	
	36.	Alternatives that are Most Beneficial	
	37.	Demand-Side Evaluation and analysis levels	
	38.	General Information Requirements System, Context,	
	39.	Transferability, Data Requirement	
	40.	Cost/Benefit Analysis, Program Interaction	

12.0 Assignments

Sl. No.	Title	Outcome expected	Allied study	Week No	Individual / Group activity	Reference: book/website /Paper
1	Assignment 1: University Questions on Electricity network, local energy network, electric transportation and perfect power system configurations	Students study the topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity	Text Book 1of the list.
2	Assignment 2: University Questions on DC Distribution and Smart Grid and Intelligrid Architecture for the Smart Grid.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module2 of the syllabus	4	Individual Activity	Text Book 1 of the list.
3	Assignment3: University Questions on Dynamic Energy Systems.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity	Text Book 1 of the list.

4	Assignment 4: University Questions on Efficient Electric End Use Technology Alternatives.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity	Text Book 1 of the list.
5	Assignment 5: University Questions on Demand side planning and evaluation.	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity	Text Book 1 of the list.

13.0 QUESTION BANK

MODULE -1

1. Explain what you understand by "Smart Grid". Compare Today's Grid with Smart Grid.
2. Show the general view of the Smart Grid Market Drivers.
3. Discuss about Smart Meters, and Measurements Technologies.
4. Write a short note on perfect power system configuration.
5. Describe the Contingency Studies for the Smart Grid.

MODULE -2

1. Explain the benefits of DC power delivery systems.
2. Write a short note on potential future work and research.
3. Explain briefly about Intelligrid Architecture for the Smart Grid.
4. Explain smart grid vision based on the intelligrid architecture.

MODULE -3

1. Write a short note on Smart energy efficient end use devices.
2. Explain the operation of advanced whole building control systems
3. Explain the current limitations to dynamic energy management.
4. Explain briefly about smart distributed energy resources.
5. List the characteristics of dynamic energy management system.

MODULE -4

1. Write a short note on existing technologies.
2. Explain about equipment retrofit and replacement.
3. Explain briefly the thermal energy storage system.
4. Explain the most energy-efficient residential appliances.
5. Explain variable refrigerant flow air conditioning in brief.

MODULE -5

1. Explain the objectives of demand side planning.
2. How Demand Side Management could help to strengthen the grid?
3. Explain the principle of demand side planning.
4. What are the utility benefits of Demand Side Management?

Prepared by	Checked by		
	28/09/22	29/9/22	
Prof. Keshav Negalur	**Prof. S. D. Hirekodi**	**HOD**	**Principal**

Subject Title	**PYTHON APPLICATION PROGRAMMING (OPEN ELECTIVE)**		
Subject Code	18CS752	**IA Marks**	40
Number of Lecture Hrs/ Week	03 L	**Exam Marks**	60
Total Number of Lecture Hrs	40	**Exam Hours**	03
CREDITS – 03			

FACULTY DETAILS:		
Name: Prof. Prasanna Patil	**Designation:** Asst.Professor	**Experience:09** Years
No. of times course taught: 01	**Specialization:**Computer Science and Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Computer Science and Engineering	I/II	Programming in C and Data Structures

2.0 Course Objectives

Students should learn to:

1. Learn Syntax and Semantics and create Functions in Python.
2. Handle Strings and Files in Python.
3. Understand Lists, Dictionaries and Regular expressions in Python.
4. Implement Object Oriented Programming concepts in Python
5. Build Web Services and introduction to Network and Database Programming in Python.

3.0 Course Outcomes

After studying this course, students will be able to

	Course Outcome	Cognitive Level	POs
C414.1	Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.	L3	1, 2, 3, 8, 12
C414.2	Demonstrate proficiency in handling Strings and File Systems.	L2	1, 2, 3, 8, 12
C414.3	Create, run and manipulate Python Programs using core data structures like Lists, Dictionaries and use Regular Expressions.	L3	1, 2, 3, 8, 12
C414.4	Interpret the concepts of Object-Oriented Programming as used in Python.	L2	1, 2, 3, 8, 12
C414.5	Develop exemplary applications related to Network Programming, Web Services and Databases in Python.	L3	1, 2, 3, 8, 12
Total Hours of instruction		**40**	

4.0 Course Content

Module – 1 **8 Hours**

Why should you learn to write programs, Variables, expressions and statements,Conditional execution, Functions

Module – 2 **8 Hours**

Iteration, Strings, Files.

Module – 3 **8 Hours**

Lists, Dictionaries, Tuples, Regular Expressions

Module – 4 **8 Hours**

Classes and objects, Classes and functions, Classes and methods

Module – 5 **8 Hours**
Networked programs, Using Web Services, Using databases and SQL

5.0 Relevance to future subjects

Sl. No	Semester	Subject	Topics
01	VIII	Academic Projects	Project Work

6.0 Relevance to Real World

Sl.No	Real World Mapping
01	Implementation of machine learning algorithms
02	Final year projects on analytics

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	YouTube Videos	Python Tutorials
02	Coursera Courses	Crash Courses

8.0 Books Used and Recommended to Students

Text Books

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf) (Chapters 1 – 13, 15)
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 15, 16, 17)

Reference Books

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Tylor & Francis 2018, ISBN-13:978-08115394372
3. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978-9350232873
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176
5. ReemaThareja, "Python Programming using problem solving approach", Oxford university press, 2017, ISBN-13:978-0199480173
6. Wesley J Chun, "Core Python Applications Programming", 3rd Edition,Pearson Education India, 2015.

Additional Study material & e-Books

1. Python Notes for Professionals, GoalKicker.com Free Programming books

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

Website and Internet Contents References

1. https://www.tutorialspoint.com/python/
2. https://www.guru99.com/python-tutorials.html

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Python for Scientific Computing	http://ieeexplore.ieee.org/document/4160250/

11.0 Examination Note

Internal Assessment: 30+10=40 Marks

30 Marks - from Three Internal Assessment Test
10 Marks - from the Assignments

Scheme of Evaluation for Internal Assessment (30 Marks)

a) Internal Assessment test in the same pattern as that of the main examination (Average of the three Tests): 30marks.
b) Assignment marks for each module is 25. Average of 5 assignment marks will be taken and finally scale down to 10 marks.

Internal Assessment Question Paper Pattern (IA):

1. Two main questions to be set from syllabus covered up to IA tests.
2. Student has to answer two full main questions and each question carries 25 marks, Total test marks are 50
   a. Q.No I or Q.No II = 25 Marks
   b. Q.No III or Q.No IV = 25 Marks
   c. Total = 50 Marks

Question Paper Pattern and instructions for Main Exam

1. The question paper will have ten questions
2. Each full Question consisting of 20 marks
3. There will be 2 full questions (with a maximum of four sub questions) from each module
4. Each full question will have sub questions covering all the topics under a module
5. The 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	Why should you learn to write programs	20
	2	Variables	
	3	Expressions and statements	
	4	Continued…	
	5	Conditional execution	
	6	Continued…	
	7	Functions	
	8	Continued…	
2	9	Iteration	20
	10	Continued…	
	11	Strings	
	12	Continued…	
	13	Continued…	
	14	Files	
	15	Continued…	
	16	Continued…	
3	17	Lists	20
	18	Continued…	
	19	Dictionaries	
	20	Continued…	
	21	Tuples	
	22	Continued…	
	23	Regular Expressions.	
	24	Continued…	
4	25	Classes and objects	20
	26	Continued…	
	27	Continued…	
	28	Classes and functions	

	29	Continued…	
	30	Continued…	
	31	Classes and methods	
	32	Continued…	
5	33	Networked programs	20
	34	Continued…	
	35	Continued…	
	36	Using Web Services	
	37	Continued…	
	38	Continued…	
	39	Using databases and SQL	
	40	Continued…	

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 Module 1	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 of the syllabus	2	Individual Activity. Printed solution expected.	Book 1
2	Assignment 2: University Questions on Module 2	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 of the syllabus	4	Individual Activity. Printed solution expected.	Book 1
3	Assignment 3: University Questions on Module 3	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 of the syllabus	6	Individual Activity. Printed solution expected.	Book 1
4	Assignment 4: University Questions on Module 4	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 of the syllabus	8	Individual Activity. Printed solution expected.	Book 2
5	Assignment 5: University Questions on Module 5	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 of the syllabus	10	Individual Activity. Printed solution expected.	Book 1

14.0 QUESTION BANK

MODULE– 1

1. What is wrong with the following code:
   >>>primt 'Hello world!'
   File "<stdin>", line 1
   primt 'Hello world!'
   ^
   SyntaxError: invalid syntax
   >>>
2. Write a program that uses input to prompt a user for their name and then welcomes them.
3. Write a program to prompt the user for hours and rate per hour to compute gross pay.
4. Write a program which prompts the user for a Celsius temperature, convert the temperature to Fahrenheit, and print out the converted temperature.
5. Rewrite your pay computation to give the employee 1.5 times the hourly rate for hours worked above 40 hours.
6. Rewrite your pay program using try and except so that your program handles non-numeric input gracefully by printing a message and exiting the program. The following shows two executions of the program:
   Enter Hours: 20

Enter Rate: nine
Error, please enter numeric input

Enter Hours: forty
Error, please enter numeric input

7. What is the purpose of the "def" keyword in Python?
8. Rewrite your pay computation with time-and-a-half for overtime and create a function called computepay which takes two parameters (hours and rate).
9. Rewrite the grade program from the previous chapter using a function called computegrade that takes a score as its parameter and returns a grade as a string.

Score	Grade
> 0.9	A
> 0.8	B
> 0.7	C
> 0.6	D
<= 0.6	F

MODULE– 2

1. Write a program which repeatedly reads numbers until the user enters "done". Once "done" is entered, print out the total, count, and average of the numbers. If the user enters anything other than a number, detect their mistake using try and except and print an error message and skip to the next number.
2. Write another program that prompts for a list of numbers as above and at the end prints out both the maximum and minimum of the numbers instead of the average.
3. Write a while loop that starts at the last character in the string and works its way backwards to the first character in the string, printing each letter on a separate line, except backwards.
4. Given that fruit is a string, what does fruit[:] mean?
5. Take the following Python code that stores a string: str = 'X-DSPAM-Confidence:0.8475'
   Use find and string slicing to extract the portion of the string after the colon character and then use the float function to convert the extracted string into a floating point number.
6. Write a program to read through a file and print the contents of the file (line by line) all in upper case.
7. Write a program to prompt for a file name, and then read through the file and look for lines of the form: X-DSPAM-Confidence:0.8475.
   When you encounter a line that starts with "X-DSPAM-Confidence:" pull apart the line to extract the floating-point number on the line. Count these lines and then compute the total of the spam confidence values from these lines. When you reach the end of the file, print out the average spam confidence.
8. Sometimes when programmers get bored or want to have a bit of fun, they add a harmless Easter Egg to their program Modify the program that prompts the user for the file name so that it prints a funny message when the user types in the exact file name "nana boo boo". The program should behave normally for all other files which exist and don't exist.

MODULE– 3

1. Write a function called chop that takes a list and modifies it, removing the first and last elements, and returns None. Then write a function called middle that takes a list and returns a new list that contains all but the first and last elements.
2. Figure out which line of the above program is still not properly guarded. See if you can construct a text file which causes the program to fail and then modify the program so that the line is properly guarded and test it to make sure it handles your new text file.
3. Rewrite the guardian code in the above example without two if statements. Instead, use a compound logical expression using the and logical operator with a single if statement.
4. Download a copy of the file from www.py4e.com/code3/romeo.txt Write a program to open the file romeo.txt and read it line by line. For each line, split the line into a list of words using the split function. For each word, check to see if the word is already in a list. If the word is not in the list, add it to the list. When the program completes, sort and print the resulting words in alphabetical order.
5. Rewrite the program that prompts the user for a list of numbers and prints out the maximum and minimum of the numbers at the end when the user enters "done". Write the program to store the numbers the user enters in a list and use the max() and min() functions to compute the maximum and minimum numbers after the loop completes
6. Write a program that categorizes each mail message by which day of the week the commit was done. To do this look for lines that start with "From", then look for the third word and keep a running count of each of the days of the week. At the end of the program print out the contents of your dictionary (order does not matter). Sample Line: From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008.

7. Write a program that reads a file and prints the letters in decreasing order of frequency. Your program should convert all the input to lower case and only count the letters a-z. Your program should not count spaces, digits, punctuation, or anything other than the letters a-z. Find text samples from several different languages and see how letter frequency varies between languages. Compare your results with the tables at wikipedia.org/wiki/Letter_frequencies.
8. Change the socket program socket1.py to prompt the user for the URL so it can read any web page. You can use split('/') to break the URL into its component parts so you can extract the host name for the socket connect call. Add error checking using try and except to handle the condition where the user enters an improperly formatted or non-existent URL.
9. Change your socket program so that it counts the number of characters it has received and stops displaying any text after it has shown 3000 characters. The program should retrieve the entire document and count the total number of characters and display the count of the number of characters at the end of the document.

MODULE– 4

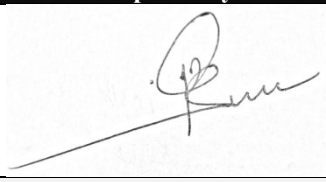
1. Write a definition for a class named Circle with attributes center and radius, where center is a Point object and radius is a number. Instantiate a Circle object that represents a circle with its center at (150, 100) and radius 75. Write a function named point_in_circle that takes a Circle and a Point and returns True if the Point lies in or on the boundary of the circle.
2. Write a function named rect_in_circle that takes a Circle and a Rectangle and returns True if the Rectangle lies entirely in or on the boundary of the circle. Write a function named rect_circle_overlap that takes a Circle and a Rectangle and returns True if any of the corners of the Rectangle fall inside the circle. Or as a more challenging version, return True if any part of the Rectangle falls inside the circle.
3. Write a function called draw_rect that takes a Turtle object and a Rectangle and uses the Turtle to draw the Rectangle.Write a function called draw_circle that takes a Turtle and a Circle and draws the Circle.
4. Write a function called mul_time that takes a Time object and a number and returns a new Time object that contains the product of the original Time and the number. Then use mul_time to write a function that takes a Time object that represents the finishing time in a race, and a number that represents the distance, and returns a Time object that represents the average pace (time per mile).The datetime module provides time objects that are similar to the Time objects in this chapter, but they provide a rich set of methods and operators.
5. Use the datetime module to write a program that gets the current date and prints the day of the week. Write a program that takes a birthday as input and prints the user's age and the number of days, hours, minutes and seconds until their next birthday. For two people born on different days, there is a day when one is twice as old as the other. That's their Double Day.
6. Write a program that takes two birthdays and computes their Double Day. For a little more challenge, write the more general version that computes the day when one person is n times older than the other.
7. This exercise is a cautionary tale about one of the most common, and difficult to find, errors in Python. Write a definition for a class named Kangaroo with the following methods: An __init__ method that initializes an attribute named pouch_contents to an empty list. A method named put_in_pouch that takes an object of any type and adds it to pouch_contents. A __str__ method that returns a string representation of the Kangaroo object and the contents of the pouch. Test your code by creating two Kangaroo objects, assigning them to variables named kanga and roo, and then adding roo to the contents of kanga's pouch.

MODULE – 5

1. Change the socket program socket1.py to prompt the user for the URL so it can read any web page. You can use split('/') to break the URL into its component parts so you can extract the host name for the socket connect call. Add error checking using try and except to handle the condition where the user enters an improperly formatted or non-existent URL.
2. Change your socket program so that it counts the number of characters it has received and stops displaying any text after it has shown 3000 characters. The program should retrieve the entire document and count the total number of characters and display the count of the number of characters at the end of the document.
3. Use urllib to replicate the previous exercise of (1) retrieving the document from a URL, (2) displaying up to 3000 characters, and (3) counting the overall number of characters in the document. Don't worry about the headers for this exercise, simply show the first 3000 characters of the document contents.
4. Change the urllinks.py program to extract and count paragraph (p) tags from the retrieved HTML document and display the count of the paragraphs as the output of your program. Do not display the paragraph text, only count them. Test your program on several small web pages as well as some larger web pages.
5. Change either the www.py4e.com/code3/geojson.py or www.py4e.com/code3/geoxml.py to print out the two-character country code from the retrieved data. Add error checking so your program does not traceback if the country code is not there. Once you have it working, search for "Atlantic Ocean" and make sure it can handle locations that are not in any country.

15.0 University Result

Examination	APPEARED	PASS	FAIL	%Passing
FEB/ MARCH 2022	95	84	11	88.4

Prepared by	Checked by		
			
Prof. Prasanna Patil	**Prof. M. G. Huddar**	**HOD**	**Principal**

Subject Title	**ENERGY AND ENVIRONMENT**		
Subject Code	18ME751	**IA Marks**	40
No of Lecture Hrs + Tutorial Hrs / Week	03	**Exam Marks**	60
Total No of Lecture + Tutorial Hrs	40	**Exam Hours**	03
			CREDITS – 03

FACULTY DETAILS:		
Name: Dr. M. M. Shivashimpi	**Designation:** Associate Professor	**Experience:** 15 Years
No. of times course taught: 01	**Specialization:** Thermal Power Engineering	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
1	Common to all	I/II	Chemistry
2	Common to all	I/II	Physics
3	Common to all	V	Environmental Studies

2.0 Course Objectives

1. To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies.
2. To learn about methods of energy storage, energy management and economic analysis
3. To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.
4. To understand environment and its ecosystems.
5. To introduce various aspects of environmental pollution and its control. To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.

3.0 Course Outcomes

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

CO	Course Outcome	RBT level	POs
CO1	Summarize the basic concepts of energy, its distribution and general Scenario.	L1	PO1, PO6, PO7, PO8, PO9, PO10, PO11, PO12
CO2	Explain different energy storage systems, energy management, audit and economic analysis.	L2	PO1, PO2, PO3, PO6, PO7, PO8, PO9, PO10, PO11, PO12
CO3	Summarize the environment eco system and its need for awareness.	L1	PO1, PO6, PO7, PO8, PO10, PO12
C04	Identify the various types of environment pollution and their effects.	L1	PO1, PO6, PO7, PO8, PO10, PO12
C05	Discuss the social issues of the environment with associated acts.	L2	PO1, PO6, PO7, PO8, PO10, PO12
Total Hours of instruction		**40**	

4.0 Course Content

Module-1: Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment. (8 Hours)

Module-2: Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. (8 Hours)

Module-3: Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

Module-4: Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies. (8 Hours)

Module-5: Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation. Group assignments: Assignments related to e-waste management; Municipal solid waste management; Air pollution control systems; Water treatment systems; Wastewater treatment plants; Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Bio-fuels; Environmental status assessments; Energy status assessments etc. (8 Hours)

5.0 Relevance to future subjects/Career

SL. No	Semester	Subject	Topics / Relevance
01	VII & VIII	Project Phase-1 & Pahse-2	All modules
02	After graduation	Energy and Pollution Analysis and resolving related problems	All modules

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Electrical Engineering and Automobile Engineering
02	Power plant engineering, thermal power plant
03	Environmental Science

7.0 Gap Analysis and Mitigation

Sl. No	Delivery Type	Details
01	nptel.ac.in	E- Learning
02	VTU, E- learning	E- Learning
03	Open courseware	E- Learning

8.0 Books Used and Recommended to Students

Text Books

1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education by University grant commission and Bharathi Vidyapeeth Institute of environment education and Research ,Pune
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.

Reference Books

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. Murphy, W. R., Energy Management, Elsevier, 2007.
3. Smith, C. B., Energy Management Principles, Pergamum, 2007
4. Environment pollution control Engineering by C S rao, New Age International, 2006, reprint 2015, 2nd edition
5. Environmental studies, by Benny Joseph, Tata McGraw Hill, 2008, 2nd edition.

Additional Study material & e-Books

- Nptel.ac.in
- VTU, E- learning
- India Energy Outlook 2015(www.iea.org/.../IndiaEnergyOutlook_WEO2015.pdf)
- Open courseware

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

Website and Internet Contents References

1. http://www.nptel.ac.in
2. www.iea.org

10.0 Magazines/Journals Used and Recommended to Students

Sl.No	Magazines/Journals	website
1	Elsevier	https://www.journals.elsevier.com/renewable-energy
2	Environmental Sciences Journals	https://www.omicsonline.org/environmental-sciences-journals

11.0 Examination Note

Internal Assessment: 40 Marks
Theoretical aspects as well as relevant sketches should be drawn neatly for questions asked in Internal Assessments

Scheme of Evaluation for Internal Assessment
Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests):40marks.

SCHEME OF EXAMINATION:

- There are five modules two questions from each module
- Student has to answer any five question choosing at least one questions from each module.
- Max. Marks: 60Marks

12.0 Course Delivery Plan

Module No.	Lecture No.	Content of Lecture	% of Portion
1		**Basic Introduction to Energy:**	20
	1	Energy and power, forms of energy, primary energy sources	
	2	Energy flows, world energy production and consumption	
	4	Key energy trends in India: Demand	
	5	Electricity, Access to modern energy,	
	6	Energy production and trade, Factors affecting India's energy development	
	7	Economy and demographics Policy and institutional framework	
	8	Energy prices and affordability, Social and environmental aspects, Investment	
2		**Energy storage systems, Energy Management, Energy Audit, Economic Analysis**	20
	1	Thermal energy storage methods,	
	2	Energy saving, Thermal energy, storage systems	
	3	Principles of Energy Management,	
	4	Energy demand.	
	5	Energy estimation, Energy pricing	
	6	Energy Audit: Purpose	
	7	Methodology with respect to process Industries,	
	8	Characteristic method employed in Certain Energy Intensive Industries.	
	9	Economic Analysis: Scope	
	10	Characterization of an Investment Project	
3		**Environment, Ecosystem:**	20
	1	Environment**:** Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance.	
	2	Need for public awareness.	
	3	Ecosystem**:** Concept, Energy flow Structure and function of an ecosystem.	
	4	Food chains, food webs and ecological pyramids	
	5	Forest ecosystem, Grassland ecosystem,	

	6	Desert ecosystem and Aquatic ecosystems,	
	7	Desert ecosystem and Aquatic ecosystems	
	8	Ecological succession	
4		**Environmental Pollution:**	**20**
	1	Environmental Pollution definition, Cause and effects	
	2	Control measures of - Air pollution,	
	3	Water pollution, Soil pollution,	
	4	Marine pollution, Noise pollution.	
	5	Thermal pollution and Nuclear hazards ,	
	6	Solid waste Management, Disaster management	
	7	Role of an individual in prevention of pollution	
	8	Pollution case studies	
5		**Social Issues and the Environment:**	**20**
	1	Climate change, global warming, acid rain, ozone layer depletion	
	2	Nuclear accidents and holocaust. Case Studies.	
	3	Wasteland reclamation, Consumerism and waste products	
	4	Environment Protection Act	
	5	Air (Prevention and Control of Pollution) Act	
	6	Water (Prevention and control of Pollution) Act, Wildlife Protection Act,	
	7	Forest Conservation Act,	
	8	Issues involved in enforcement of environmental legislation	

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	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 1 syllabus	3	Individual Activity and submission of hard copy.	Book 1 and all the reference book
2	Assignment 2: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 2 syllabus	6	Individual Activity and submission of hard copy.	Book 1 and all the reference book
3	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 3 syllabus	9	Individual Activity and submission of hard copy.	Book 1 and all the reference book
4	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 4 syllabus	12	Individual Activity and submission of hard copy.	Book 1 and all the reference book

5	Assignment 3: University Questions	Students study the Topics and write the Answers. Get practice to solve university questions.	Module 5 syllabus	15	Individual Activity and submission of hard copy.	Book 1 and all the reference book

15.0 QUESTION BANK

Sl. No	Questions
Unit-I	1. Interpret World Energy Scenario with respect to production and consumption using relevant statistics 2. Define Energy and Power. Differentiate the same. 3. Outline the factors that affect India's energy development. 4. Explain the various key energy trends in India. 5. With relevant statistics, enumerate the primary energy production trend for India.
Unit-II	1. Explain in the detail the various phases of energy audit methodology. 2. List the various thermal energy storage methods. Explain sensible heat and latent heat storage methods. 3. Define Energy audit. Explain the need for energy audit. 4. Write a short note on energy demand estimation. 5. Calculate the cost of generation per kWh for a power station having the following data: Installed capacity of the plant = 200 MW , Capital cost = Rs 400 crores ,Rate of interest and depreciation = 12% , Annual cost of fuel, salaries and taxation = Rs 5 crores Load factor = 50% Also estimate the saving in cost per kWh if the annual load factor is raisedto 60%. 6. Explain in the detail the various phases of energy audit methodology 7. Elaborate the benefits of thermal energy storage.
Unit-III	1. What is an ecosystem? Discuss forest ecosystem. Explain how conservation of forest can be done. 2. Discuss how oxygen cycle is utilized in the ecosystem. 3. Write a short note on (i) ecological succession (ii) food chain, food web and ecological pyramid. 4. Elaborate how the nitrogen cycle ecosystem operates. 5. Enumerate the utilization of carbon in ecosystem. 6. Describe grassland ecosystem. What are its types? How conservation of grassland can be made 7. Discuss how oxygen cycle is utilized in the ecosystem 8. Define Environment. Mention its scope. Discuss the need for public awareness
Unit-IV	1. Discuss briefly the causes, effects and control measures of air pollution. 2. Discuss Solid Waste Management techniques. 3. Elaborate the causes, effects and control measures of (i) Soil Pollution (ii) Noise Pollution (iii) Thermal Pollution 4. Enumerate the role of an individual in prevention of pollution. 5. Enumerate the water pollution causes and its effects. Mention the control measures that can be initiated for mitigating the same. 6. Discuss any two case studies related to pollution of environment in detail. 7. Elaborate the causes, effects and control measures of (i) Soil Pollution (ii) Noise Pollution (iii) Thermal Pollution 8. Discuss Solid Waste Management techniques.
Unit-V	1. What is acid rain? What are its effects? 2. Explain the salient features of Air Pollution act. 3. Explain about Environment Impact Assessment (EIA). 4. Discuss (i) Wildlife Protection act (ii) Forest Conservation act 5. Write a note on ozone layer depletion. 6. Express the need for reclaiming the wasteland and its development

	7. What are the regulations governing water pollution prevention act? 8. Enumerate the impact of global warming on our mother nature.

16.0 University Result

Year	S,A (FCD)	B (FC)	C,D,E (SC)	%age of passing
February/ March 2022	57	06	00	100

Prepared by	Checked by		
Dr. M. M. Shivashimpi	**Dr. K. M. Akkoli**	**HOD**	**Principal**

Subject Title	**POWER SYSTEM SIMULATION LABORATORY**		
Subject Code	18EEL76	**CIE Marks**	40
No of Practical Hrs / Week	0:2:2	**SEE Marks**	60
Exam Hours	03		
Credits-02			

FACULTY DETAILS:		
Name: Prof. H. R. Zinage	**Designation:** Asst. Professor	**Experience:** 22 Years
No. of times course taught: 05 Times		**Specialization:** Power Systems

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	IV	Transmission and Distribution
01	Electrical and Electronics Engineering	VI	Power System Analysis-I
01	Electrical and Electronics Engineering	VII	Power System Analysis-II

2.0 Course Objectives

1. To explain the use of MATLAB package to assess the performance of medium and long transmission lines.
2. To explain the use of MATLAB package to obtain the power angle characteristics of salient and non- salient pole alternator.
3. To explain the use of MATLAB package to study transient stability of radial power systems under three phase fault conditions.
4. To explain the use of MATLAB package to develop admittance and impedance matrices of interconnected power systems.
5. To explain the use of Mi-Power package to solve power flow problem for simple power systems.
6. To explain the use of Mi-Power package to perform fault studies for simple radial power systems.
7. To explain the use of Mi-Power package to study optimal generation scheduling problems for thermal power plants.

3.0 Course Outcomes

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

CO	Course Outcome	RBT Level	POs
C406.1	Develop a program in MATLAB to assess the performance of medium and long transmission lines.	L_4	1,2,3,5,9,10, 12
C406.2	Develop a program in MATLAB to obtain the power angle characteristics of salientand non-salient pole alternator.	L_4	1,2,3,5,9,10, 12
C406.3	Develop a program in MATLAB to assess the transient stability under three phasefault at different locations in a of radial power systems.	L_4	1,2,3,5,9,10, 12
C406.4	Develop programs in MATLAB to formulate bus admittance and bus impedance matrices of interconnected power systems.	L_4	1,2,3,5,9,10, 12
C406.5	Use Mi-Power package to solve power flow problem for simple power systems.	L_4	1,2,3,5,9,10, 12
C406.6	Use Mi-Power package to study unsymmetrical faults at different locations in radialpower systems.	L_4	1,2,3,5,9,10, 12
C406.7	Use of Mi-Power package to study optimal generation scheduling problems for thermal power plants.	L_4	1,2,3,5,9,10, 12

4.0 Course Content

Sl. No		Experiments
1	Use of MATLAB package	Formation for symmetric π /T configuration for Verification of $AD-BC=1$, Determination of Efficiency and Regulation.
2		Determination of Power Angle Diagrams, Reluctance Power, Excitation, Emf and Regulation for Salient and Non-Salient Pole Synchronous Machines.
3		To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.
4		Y Bus Formation for Power Systems with and without Mutual Coupling, by Singular Transformation and Inspection Method.
5		Formation of Z Bus (without mutual coupling) using Z-Bus Building Algorithm.
6		Determination of Bus Currents, Bus Power and Line Flow for a Specified System Voltage (Bus) Profile.
7	Use of Mi-Power package	Formation of Jacobian for a System not Exceeding 4 Buses (No PV Buses) in Polar Coordinates.
8		Load Flow Analysis using Gauss Siedel Method, NR Method and Fast Decoupled Method for Both PQ and PV Buses.
9		To Determine Fault Currents and Voltages in a Single Transmission Line System with Star-Delta Transformers at a Specified Location for LG and LLG faults by simulation.
10		Optimal Generation Scheduling for Thermal power plants by simulation.
Revised Bloom's Taxonomy Level		L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating,

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work	Analysis of power system using MATLAB &Mi-power

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Calculating A, B, C, D parameters of transmission line.
02	Stability study of power system.
03	Load flow analysis of power system.
04	Fault analysis of power system.
05	Economic dispatch of power system.

7.0 Books Used and Recommended to Students

Text Books

Text Books:1 Modern Power System Analysis D. P. Kothari McGraw Hill 4th Edition, 2011

Reference Books

1. Stag, G. W., and EI-Abiad, A. H., "Computer Methods in Power System Analysis", McGraw Hill International Student Edition. 1968

2. .Pai, M. A., "Computer techniques in Power System Analysis", TMH, 2nd edition, 2006.

4.Hadi Saadat,"power system analysis"
McGraw Hill 2nd Edition, 2002

Additional Study material & e-Books

1. http://pdfstuff4u.com/ebook.php?id=1071881
2. http://sjbit.edu.in

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

Website and Internet Contents References
1. ieeexplore.ieee.org/document/152452/--
2. https://engineering.purdue.edu/jump/8cb309
3. nptel.iitg.ernet.in

9.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	Society of energy engineers and managers	www.energyprofesionals.in
2	IEEE Explore	ieeexplore.ieee.org/xpl/RecentIssue
3	Journal of Modern Power Systems and Clean Energy	www.springer.com

10.0 Examination Note

CIE: 40 Marks

Conduction of experiments, Viva Voce, Submission of records 24 Marks
Lab IA (One question can be set on any of the experiment) 16 Marks
Total 40 Marks

SEE: 100 Marks(Scaled down to 60Marks)

One question can be set on any of the experiment

Write up	15 Marks
Conduction	70 Marks
Viva – Voce	15 Marks
	Total 100 Marks

11.0 Course Delivery Plan

Sl. No		Experiments	% of Portion
1	Use of MATLAB package	Formation for symmetric π /T configuration for Verification of $AD-BC=1$, Determination of Efficiency and Regulation.	10
2		Determination of Power Angle Diagrams, Reluctance Power, Excitation, Emf and Regulation for Salient and Non-Salient Pole Synchronous Machines.	10
3		To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.	10
4		Y Bus Formation for Power Systems with and without Mutual Coupling, by Singular Transformation and Inspection Method.	10
5		Formation of Z Bus (without mutual coupling) using Z-Bus Building Algorithm.	10
6		Determination of Bus Currents, Bus Power and Line Flow for a Specified System Voltage (Bus) Profile.	10
7	Use of Mi-Power package	Formation of Jacobian for a System not Exceeding 4 Buses (No PV Buses) in Polar Coordinates.	10
8		Load Flow Analysis using Gauss Siedel Method, NR Method and Fast Decoupled Method for Both PQ and PV Buses.	10
9		To Determine Fault Currents and Voltages in a Single Transmission Line System with Star-Delta Transformers at a Specified Location for LG and LLG faults by simulation.	10
10		Optimal Generation Scheduling for Thermal power plants by simulation.	10
Revised Bloom's Taxonomy Level		L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating,	

12.0 QUESTION BANK

1. What is importance of Ybus?
2. What is reactance diagram?
3. Define Per Unit.
4. What are symmetrical components?
5. How symmetrical components are useful in solution of Power System?
6. What are unsymmetrical faults?
7. Define Stability.
8. What is singular transformation?
9. What is load flow study?
10. What are the different methods of LFA?
11. Compare different methods of LFA?
12. What is the importance of Jaccobian matrix?
13. What is bus building algorithm?
14. Give formulas for different modifications in building algorithm?
15. What are A, B, C, D parameters?
16. How transmission lines are classified &represented?
17. What is voltage regulation?
18. What is maximum& minimum voltage regulation?
19. What is power angle diagram?
20. What are salient & non salient pole machines?
21. What is reluctance power?
22. What is the effect of saliency &saturation?
23. What is swing equation?
24. What is the importance of swing curve?
25. What is critical clearing angle &time?
26. How to determine critical clearing time graphically?
27. Classify faults in the power system?
28. What are sequence impedances &sequence networks?
29. Explain different types of buses in the power system
30. What is single line diagram?
31. What are the conditions to draw single line diagram?
32. How sequence networks are connected in case of different faults?
33. What is economic operation of power system?
34. What are the conditions for economic dispatch with &without loss?
35. What are the guidelines to select initial value of lambda?
36. What is spinning reserve?
37. Give guidelines to select spinning reserve?
38. What are the constraints in unit commitment &economic dispatch?
39. What is the difference between steady state & transient stability?
40. Stability limits have single or multiple values?
41. What are the methods to improve steady state & transient stability?
42. Explain equal area criterion?
43. How stability is improved using equal area criterion?
44. What is the advantage of MATLAB& simulation?

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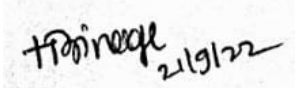	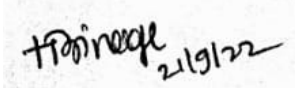		
Prof. H. R. Zinage	**Prof. H. R. Zinage**	**HOD**	**Principal**

Subject Title	RELAY AND HIGH VOLTAGE LAB		
Subject Code	18EEL77	**CIE Marks**	40
No of Practical Hrs/ Week	0:2:2	**SEE Marks**	60
Credits	02	**Exam Hours**	03

FACULTY DETAILS:		
Name: Prof. O. B. Heddurshetti	**Designation:** Asst. Professor	**Experience:**16Years
No. of times course taught:02	**Specialization:** Power Electronics	

1.0 Prerequisite Subjects:

Sl. No	Branch	Semester	Subject
01	Electrical and Electronics Engineering	V	High Voltage Engineering
01	Electrical and Electronics Engineering	VII	Power System Protection

2.0 Course Objectives

1. To conduct experiments to verify the characteristics of over current, over voltage, under Voltage relays both electromagnetic and static type.
2. To verify the operation of negative sequence relay.
3. To conduct experiments to verify the characteristics of microprocessor based over current, Over Voltage, under voltage relays and distance relay.
4. To conduct experiments on generator, motor and feeder protection.
5. To conduct experiments to study the spark over characteristics for both uniform and non-Uniform Configurations using High AC and DC voltages.
6. To measure high AC and DC voltages
7. To experimentally measure the breakdown strength of transformer oil.
8. To experimentally measure the capacitance of different electrode configuration models using lectrolytic Tank.
9. To generate standard lightning impulse voltage and determine efficiency, Energy of Impulse generator and 50% probability flashover voltage for air insulation.

3.0 Course Outcomes

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

CO	Course Outcome	RBT level	POs
C418.1	Experimentally verify the characteristics of over current, over voltage, under voltage and negative sequence relays of both electromagnetic and static type.	L4	1,2,8,9,10
C418.2	Experimentally verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.	L4	1,2,8,9,10
C418.3	Justify knowledge of protection schemes of generator, motor and feeders.	L4	1,2,8,9,10
C418.4	Analyze the spark over characteristics for both uniform and non-uniform field configurations using High voltage AC and DC.	L4	1,2,8,9,10
C418.5	Measure high AC and DC voltages and breakdown strength of transformer oil.	L4	1,2,8,9,10
C418.6	Draw electric field lines andmeasure the capacitance of different electrode configuration models.	L4	1,2,8,9,10
C418.7	Justify knowledge of generating standard lightning impulse voltage to determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation.	L4	1,2,8,9,10

4.0 Course Content

PART A

1. over current relay
   (a) IDMT non-directional characteristics
   (b) Directional features
   (c) IDMT directional
2. IDMT characteristics of over voltage or under voltage relay (Solid state or electromechanical type)
3.Operation of negative sequence relay.

PART B

4. Operating characteristics of microprocessor based (numeric) overcurrent relay.
5. Operating characteristics of microprocessor based (numeric) distance relay.
6. Operating characteristics of microprocessor based (numeric) over/under voltage relay.

PART C

7. Generator protection –Merz-Price- protection scheme.
8. Feeder protection against faults.
9. Motor protection against faults.

PART D

10. Spark Over Characteristics of Air subjected to High Voltage AC with Spark Voltage Corrected to StandardTemperature and Pressure for Uniform [as per IS1876: 2005] and Non-uniform [As per IS2071 (Part 1): 1993] Configurations: Sphere – Sphere, Point –Plane, Point – Point and Plane – Plane.
11. Spark over characteristics of air subjected to high voltage DC.
12. Measurement of HVAC and HVDC using standard spheres as per IS 1876:2005
13. Measurement of Breakdown Strength of Transformer Oil as per IS 1876:2005
14.Field Mapping using Electrolytic Tank for any one of the following Models: Cable/ Capacitor/ Transmission Line/ Sphere Gap.
15.(a) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse Generator. (b) To determine 50 % probability flashover voltage for air insulation subjected to mpulse voltage.

5.0 Relevance to future subjects

SL. No	Semester	Subject	Topics / Relevance
01	VIII	Project work	Design and Testing of hardware models related to HVE

6.0 Relevance to Real World

SL. No	Real World Mapping
01	Electric breakdown phenomenain gases and liquid dielectrics
02	High voltage AC, DC generation in power research laboratory for insulation testing of electrical equipments and switchgear.
03	High voltage measurements in research laboratory during testing of electrical equipments and switchgear.
04	Working of electromechanical type over current, over voltage and microprocessor based over current and over /under voltage relay.
05	Equi-potential lines of different electrode models
06	Fault analysis of 3-phase Induction motor

7.0 Books Used and Recommended to Students

Text Books

1. **High Voltage Engineering** by M.S.Naidu and Kamaraju- 4th Edition, THM, 2008.
2. **High Voltage Engineering Fundamentals** by E.Kuffel and W.S. Zaengl, 2nd Edition, Elsevier Press, 2005.
3. **High Voltage Engineering** by C.L.Wadhwa, New Age International Private limited, 1995.

Reference Books

1.**High Voltage Engineering Theory and Practice** by Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, Roshdy Radwan, 2nd Edn(Revised & Expanded) Marcel-Dekker Publishers(Special Indian Edn.).
2.**High voltage Engineering** by Subir Ray, Newage International

Additional Study material & e-Books

1. High Volatge test and measuring techniques: Springer
2. High voltage and electrical insulation engineering by Ravindra Arora

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

Website and Internet Contents References
1)http://www.cpri.in/about-us/departmentsunits/high-voltage-division-hvd.html 2) http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6432571

9.0 Magazines/Journals Used and Recommended to Students

Sl. No	Magazines/Journals	website
1	IEEE Technology Navigator	http://technav.ieee.org/tag/8470/relays#concepts

10.0 Examination Note

Scheme of Evaluation for CIE**: (40Marks)**

(a) Internal Assessment test in the same pattern as that of the main examination: 16marks.

(b) Continuous assessment for laboratory experiments: 24 marks.

SCHEME OF EXAMINATION:

One question is to be setfor 100 marks.

a) Write-up: 15% of Maximum marks
b) Conduction: 70% of Maximum marks
c) Viva-voce: 15% of Maximum marks

11.0 Course Delivery Plan

Part	Expt. No.	Name of the experiment	% of Portion
D	1	Spark over characteristics of air subjected to high voltage DC.	46%
	2	Measurement of HVAC and HVDC using standard spheres as per IS 1876:2005	
	3	Spark Over Characteristics of Air subjected to High Voltage AC with Spark Voltage Corrected toStandardTemperature and Pressure for Uniform [As per IS1876: 2005] and Non-uniform [As per IS2071 (Part 1): 1993] Configurations: Sphere – Sphere, Point – Plane, Point – Point and Plane – Plane.	
	4	Measurement of Breakdown Strength of Transformer Oil as per IS 1876:2005	
	5	Field Mapping using Electrolytic Tank for any one of the following Models: Cable/ Capacitor/Transmission Line/ Sphere Gap.	
C	6	Motor protection against faults	18%
	7	Generator protection –Merz-Price- protection scheme.	
B	8	Operating characteristics of microprocessor based (numeric) overcurrent relay	18%
	9	Operating characteristics of microprocessor based (numeric) over/under voltage relay.	
A	10	Over current relay (a) IDMT non-directional characteristics (b) Directional features (c) IDMT directional	18%
	11	IDMT characteristics of over voltage or under voltage relay (Electromechanicaltype)	

12.0 QUESTION BANK

1. What is protective relay? Explain its function in an electrical system.
2. What are the fundamental requirements of protective relaying?
3. Define the following terms as applied to protective relaying.
    a. Pick up current
    b. Current setting
    c. Plug setting multiplier (PSM)
    d. Time setting multiplier (TSM)
4. What is the difference between a fuse and a relay?
5. What is the difference between an over current relay and current differential relay?

6. Why are differential relays more sensitive than over current relays?
7. Sketch a typical time Vs PSM curve.
8. What do you understand by differential relay?
9. What are the different types of differential relay?
10. How do you classify relays based on their time of operation?
11. How do you classify relays based on their operating principle?
12. How do you classify relays based on their application?
13. List out some important types of electromagnetic attraction relays.
14. What are the various steps to be followed for calculating the actual relay operating time?
15. How do you classify relays based on their application?
16. What is a fuse? What are its advantages and disadvantages?
17. Why do we prefer silver as a fuse element?
18. Define the following terms as applied to fuse.
    Fusing current, Cut-off current, Operating Time, Breakingcapacity, Fusing factor, Current rating of fuse element, Prospectivecurrent, Pre-arcing time, Arcing time
19. What is the difference between a fuse and a circuit breaker?
20. Why are circuit breakers preferred to fuses?
21. Why fuses cannot provide adequate discrimination on heavy short circuit?
22. Why fuses can interrupt heavy short circuit currents successfully?
23. On what factors fusing current of fuse element depends?
24. What are commonly used materials for manufacturing fuse elements?
25. What are desirable characteristics of fuse elements?
26. What is fuse law?
27. What do you understand by fuse constant? What are typical values of fuse constant for different fuse elements?
28. How do you classify fuses?
29. What are the protection schemes available for induction motor?
30. What are causes of over currents in an Induction motor?
31. How to protect Induction motor against over currents?
32. What do you understand by "single phasing'' of an Induction motor?
33. How to protect Induction motor against "single phasing'' problems?
34. What are the causes of over voltages in an Induction motor?
35. How to protect Induction motor against over voltages?
36. What are the advantageous of micro-processor based relays over electro-mechanical relays?
37. What is the definition of high voltage?
38. What are the different types of voltages occurring in high voltage practice?
39. What is the usual classification of voltages used in A.C. transmission?
40. What are the materials used for high voltage equipment and transmission lines?
41. For what purposes are materials used in H.V. work?
42. What are the usual materials for conductors used in high voltage equipment and transmission lines/
43. What are the salient characteristics of metals to consider for use in high voltage work?
44. How are insulating materials used in H.V. work classified?
45. What are the most important types of solid insulation?
46. What are the physical and electrical properties of important solid insulations suitable for high voltage work?
47. Define the following terms as applied to solid insulation
    1) Dielectric strength2)Loss angle 3)Dielectric constant.
48. What are most usual insulating materials used in high voltage equipment?
49. What are the salient properties of liquid insulating materials?
50. What are the most usual gaseous insulating media used in high voltage equipment?
51. What are the physical and electrical properties of important gaseous insulating media?
52. What are the important properties of vacuum as insulation?
53. What is meant by Electrical Breakdown?
54. What are the units for measurement of the breakdown strength of insulating materials?
55. What is meant by the withstand strength of an insulations?
56. What are the breakdown voltage values of some important insulating materials?
57. What are the shapes of electrodes in common use in high voltage equipment?
58. What are the major factors causing electrical breakdown of solid insulation?
59. What is the mechanism of electrical breakdown of a solid insulating material such as paper?
60. What are the mechanisms for breakdown of liquid dielectrics?
61. What is the principal mechanism for breakdown of a gaseous insulation?
62. What is the formula for spark over voltage for an air gap in uniform field?
63. What is meant by Corona in non-uniform field gaps?

64. What are the different types of cables used for high voltage work?
65. What is meant by Corona? How and where does it occur in high voltage equipment?
66. What are the effects of corona in high voltage equipments?
67. What is the minimum clearance prescribed by the national electrical Code or Codes for high voltage transmission lines from safety considerations?
68. What is a cascade –connected transformer and where is this used?
69. What are the standard high voltages used for A.C. transmission lines and high voltage equipment?
70. What are the types of protection required in high voltage systems?
71. What are the types of sources required to perform tests on equipment in a high voltage laboratory?
72. What is the wave shapes of voltage and current used in high voltage testing?
73. What are the major types of measurement to be carried out in a high voltage laboratory for testing equipment?
74. How does a sphere gap measure a voltage? What is the technique to be followed in using this?
75. How is a resistive voltage divider used for measuring high voltage?

Prepared by	Checked by		
			
Prof. O. B. Heddurshetti	**Prof. A. U. Neshti**	**HOD**	**Principal**