ACADEMIC REGULATIONS

MASTER OF TECHNOLOGY

(MTECH-15) w. e. f: 2015-2016

(Common to all branches)

&

DETAILED SYLLABUS

of

Two Years

M Tech Degree Program

(Semester System)

POWER SYSTEMS ENGINEERING

DEPARTMENT OF
ELECTRICAL &ELECTRONICS ENGINEERING
VELAGAPUDI RAMAKRISHNA
SIDDHARTHA ENGINEERING COLLEGE
(AUTONOMOUS)
(Sponsored by Siddhartha Academy of General & Technical Education)
VIJAYAWADA – 520 007

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

2 YEAR M. TECH DEGREE PROGRAM
IN
POWER SYSTEMS ENGINEERING

Institute Vision

To nurture excellence in various fields of engineering by imparting timeless core values to the learners and to mould the institution into a centre of academic excellence and advanced research

Institute Mission

To impart high quality technical education in order to mould the learners into globally competitive technocrats who are professionally deft, intellectually adept and socially responsible. The institution strives to make the learners inculcate and imbibe perception and pro-active nature so as to enable them to acquire a vision for exploration and an insight for advanced enquiry

Department Vision

To impart quality education and strive for centre of excellence in research

Department Mission

Prepare future technocrats for a global workplace through excellence in teaching and research. The department endeavors to prepare the students professionally skilful, intellectually proficient and socially responsible.

W.E.F. 2015-16

MTECH-15

ACADEMIC REGULATIONS

MASTER OF TECHNOLOGY

(MTECH-15) w. e. f: 2015-2016

(Common to all branches)

VELAGAPUDI RAMAKRISHNA
SIDDHARTHA ENGINEERING COLLEGE

(An Autonomous, ISO 9001:2008 Certified Institution)
(Approved by AICTE, Accredited by NAAC with 'A' Grade, Affiliated to JNTUK, Kakinada)
(Sponsored by Siddhartha Academy of General & Technical Education)
Kanuru, Vijayawada
Andhra Pradesh - 520007, INDIA.
www.vrsiddhartha.ac.in

VELAGAPUDI RAMAKRISHNA

SIDDHARTHA ENGINEERING COLLEGE

(Autonomous)
Kanuru, Vijayawada – 520 007
(Approved by AICTE, Accredited by NAAC with 'A' Grade, and ISO 9001: 2008 Certified)
(Affiliated to Jawaharlal Nehru Technological University, Kakinada)

Academic Regulations for M. Tech (MTECH-15) w. e. f: 2015-2016

(Common to all branches)

1. INTRODUCTION

Academic Programmes of the College are governed by rules and regulations as approved by the Academic Council, which is the highest Academic Body of the Institute. These academic rules and regulations are effective from the academic year 2015-16, for students admitted into two year PG programme offered by the college leading to Master of Technology (M. Tech).

The regulations listed under this head are common for postgraduate programmes, leading to award of M. Tech degree, offered by the college with effect from the academic year 2015-16 and they are called as "M. TECH-15" regulations.

The regulations hereunder are subjected to amendments as may be made by the Academic Council of the college from time to time, keeping the recommendations of the Board of Studies in view. Any or all such amendments will be effective from such date and to such batches of candidates including those already undergoing the programme, as may be decided by the Academic Council.

2. DEFINITIONS

a) "Commission" means University Grants Commission (UGC)
b) "Council" means All India Council for Technical Education (AICTE)
c) "University" means Jawaharlal Nehru Technological University Kakinada, Kakinada (JNTUK)
d) "College" means Velagapudi Ramakrishna Siddhartha Engineering College (VRSEC)
e) "Programme" means any combination of courses and/or requirements leading to the award of a degree
f) "Course" means a subject either theory or practical identified by its course title and code number and which is normally studied in a semester.
g) "Degree" means an academic degree conferred by the university upon those who complete the postgraduate curriculum.

3. PROGRAMMES OFFERED

The nomenclature and its abbreviation given below shall continue to be used for the degree programmes under the University, as required by the Council and Commission.

Master of Technology (M. Tech) Besides, the name of the programme shall be indicated in brackets after the abbreviation. For example PG engineering degree in Computer Science and Engineering is abbreviated as M. Tech (Computer Science and Engineering).

Presently, the college is offering Post Graduate programme in Engineering with the following programmes:

Table 1: List of Programmes offered by college leading to M. Tech Degree

S. No	Programme	Department
1	Structural Engineering	Civil Engineering
2	Computer Science and Engineering	Computer Science and Engineering
3	Power Systems Engineering.	Electrical and Electronics Engineering
4	Communication Engineering & Signal Processing	Electronics and Communication Engineering
5	Telematics	
6	VLSI Design and Embedded Systems	
7	Computer Science & Technology	Information Technology
8	CADCAM	Mechanical Engineering
9	Thermal Engineering	

These Regulations shall be applicable to any new postgraduate programme (M. Tech) that may be introduced from time to time.

4. DURATION OF THE PROGRAMME

- The duration of the programme is two academic years consisting of four semesters.
- A student is permitted to complete the programme within a maximum duration of 4 years.

5. MINIMUM INSTRUCTION DAYS

- Each semester shall consist of a minimum of 90 instruction days with about 25 to 35 contact periods per week.

6. ELIGIBILITY CRITERIA FOR ADMISSION

- The eligibility criteria for admission into M.Tech programme are as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE).

6.1 CATEGORY –A Seats:

- These seats will be filled by the Convener, PGECET Admissions.

6.2 CATEGORY –B Seats :

- These seats will be filled by the College as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE).

7. PROGRAMME STRUCTURE

The programme structure is designed in such a way that it facilitates the courses required to attain the expected knowledge, skills and attitude by the time of their post-graduation as per the needs of the stakeholders. The curriculum structure consists of various course categories to cover the depth and breadth required for the programme and for the attainment of programme outcomes of the corresponding programme.

7.1 Programme Core:

The core consists of set of courses considered necessary for the students of the specific. The courses under this category should satisfy the programme specific criteria prescribed by the appropriate professional societies. The credits for programme core courses are 40.

7.2 Programme Electives:

The electives are set of courses offered in that which covers depth and breadth to further strengthen their knowledge. The students may register for appropriate electives offered in the based on their area of interest. The credits for the programme electives are 12.

7.3 Independent Learning:

The students are expected to learn the courses offered under this category on their own. The courses offered under this category include:

7.3.1 Self-Learning Course:

The self-learning courses shall be taken from the list of approved MOOCs in the respective Board of Studies. The courses under this category shall carry two credits.

7.3.2 Seminar:

One seminar shall be delivered by the students as individual presentation. The seminar topics shall be related to the contemporary aspects of the programme. The seminar shall carry 2 credits.

- The self learning course and seminar shall be offered either in 1^{st} year or in 2^{nd} year of the programme depending upon this scheme approved by BOS & Academic Council.

7.3.3 Project:

The Project shall be offered in 2^{nd} year of the programme. The project shall be carried out by the students, as individual project, for a minimum period of one academic year. The project shall be carried out in the major areas pertaining to the programme approved by Project Review Committee and may address the societal problems/issues related to the programme. The project shall consist of Part-A and Part-B with a weightage of 10 and 14 credits, respectively spreading over for one semester each. The project part B shall be the extension of project Part A.

- If a candidate wishes to change his/her topic of the project, he/she can do so with approval of the project review committee within one week from the completion of 1st review.

7.3.3.1 PROJECT IN COLLABORATION WITH INDUSTRY:

- A student may, with the approval of the Head of the Department/Centre, visit an industry or a Research Laboratory for data collection, discussion of the project, experimental work, survey, field studies, etc. during the project period. Projects sponsored by the industry or Research Laboratories will be encouraged and a close liaison with such organizations will be maintained.
- A student may, with the approval of Project Review Committee, do the project work in collaboration with an industry, a Research and Development Organization. A Joint Supervisor may be appointed from the Industry and Research Laboratory with the approval of the HOD. The student shall acknowledge the involvement and / or contribution of an industry, R&D organization in completing the project in his/her thesis and a certificate to this effect, issued by the supervisor from the industrial organization, will be included in the thesis. The Internal Supervisor may visit the industry or the research laboratory in connection with the project work of his / her student if felt necessary.
- It is mandatory for all the students (especially those who do their project in an Industry, R&D organization in India or abroad) to make full disclosure of all data on which they wish to base their project. They cannot claim confidentiality simply because it would come into conflict with the Industry's or R&D laboratory's own interests. Any tangible intellectual property other than copyright of the thesis may have to be assigned to the Institute. The copyright of the thesis itself would however lie with the student as per the IPR policy in force.

7.4 Course Code and Course Numbering Scheme

Course Code consists of Nine characters in which the one is the numeral and second to fourth are alphabets and the rest are numerals.

- The First character '15' indicates year of regulation.
- The second to fourth characters are described in Table 2 and 3.

Table 2: Second to Third Character description

Second & Third Characters	Name of the Department
CE	Civil Engineering Department
CS	Computer Science and Engineering Department
EC	Electronics & Communication Engineering Department
EE	Electrical & Electronics Engineering Department
IT	Information Technology Department
ME	Mechanical Engineering Department

The fourth and fifth character represents specialization offering as mentioned in Table No. 3.

Table 3: Fourth and Fifth Character description

Fourth & Fifth Characters	Name of the Specialization
SE	Structural Engineering
CS	Computer Science and Engineering
SP	Communication Engineering and Signal Processing
VE	VLSI Design and Embedded Systems
TM	Telematics
PS	Power Systems Engineering
CT	Computer Science & Technology
CC	CADCAM
TE	Thermal Engineering

For all the Sixth and Seventh characters represent semester number and syllabus version number of the course offered.

Eighth character represents course type, as per Table No. 4

Table 4: Course type description

EIGHTH CHARACTER	DESCRIPTION
0	Theory course
5	Lab course

Ninth character represents course number as described in Figure 1 below.

For example, in **15 MECC 1051** course, the numeral **15** indicates year of regulation and the course is offered by Mechanical Engineering Department (**ME**) in CAD/CAM specialization offered in the first semester (**1**), the course syllabus version number (**0**), the course is of lab type (**5**) and the course number is (**1**), as given in figure.1 below.

15	M	E	C	C	1	0	5	1
Year of Regulation	Department Code		Specialization Code		Semester Number	Version Number	Course type	Course Number

Figure 1: Course Code Description

7.5 Scheme of Instruction for 1st and 2nd Years

- The scheme of instruction and exact syllabi of all post graduate programmes are given separately.

7.6 Contact Hours and Credits

Credit means quantifying and recognizing learning. Credit is measured in terms of contact hours per week in a semester.

The Course Credits are broadly fixed based on the following norms:

- Lectures – One Lecture period per week is assigned one credit.
- Tutorials - Two tutorial periods per week are assigned one credit.
- Practical – 2 periods per week is assigned one credit
- Seminar/Mini Project shall have 2 credits.
- Major Project shall have 24 credits.
- However, some courses are prescribed with fixed number of credits depending on the subject complexity and importance.

7.7 Theory / Tutorial Classes

Each course is prescribed with fixed number of lecture periods per week. During lecture periods, the course instructor shall deal with the concepts of the course. For certain courses, tutorial periods are prescribed, to give exercises to the students and to closely monitor their learning ability.

7.8 Laboratory Courses

A minimum prescribed number of experiments have to be performed by the students, who shall complete these in all respects and get each experiment evaluated by teacher concerned and certified by the Head of the Department concerned at the end of the semester.

7.9 Programme Credits

Each specialization of M. Tech programme is designed to have a total of 80 credits, and the student shall have to earn all the credits for the award of degree.

8. MEDIUM OF INSTRUCTION

The medium of instruction and examination is English.

9. SYLLABUS

As approved by the concerned BOS and the Academic Council.

10. ELIGIBILITY REQUIREMENT FOR APPEARING SEMESTER END EXAMINATION AND CONDONATION

- A regular course of study means a minimum average attendance of 75% in all the courses computed by totaling the number of periods of lectures, tutorials, practical courses and project as the case may be, held in every course as the denominator and the total number of periods attended by the student in all the courses put together as the numerator.
- Condonation of shortage in attendance may be recommended by the respective Heads of Departments on genuine medical grounds, provided the student puts in at least 65% attendance as calculated above and provided the Principal is satisfied with the genuineness of the reasons and the conduct of the student.
- Students, having shortage of attendance, shall have to pay the requisite fee towards Condonation**.**
- Minimum of 50% aggregate marks must be secured by the candidates in the continuous evaluations conducted in that semester for courses such as theory, laboratory courses, seminar and project to be eligible to write semester end examinations. However, if the student is eligible for promotion based on the attendance, in case necessary, a shortage of internal marks up to a maximum of 10% may be condoned by the Principal based on the recommendations of the Heads of the Departments.
- Students having shortage of internal marks up to a maximum of 10% shall have to pay requisite fee towards Condonation**.**

- A student, who does not satisfy the attendance and/or internal marks requirement, shall have to repeat that semester.
- Eligible candidates who failed to register for all courses for the semester-end examinations shall not be permitted to continue the subsequent semester and has to repeat the semester for which he/she has not registered for semester end examinations.

11. EXAMINATIONS AND SCHEME OF EVALUATION

11.1 Continuous Evaluation:

11.1.1 Theory Courses

Each course is evaluated for **40** marks (a+b)

a) The continuous evaluation shall be made based on the two midterm examinations each of 2**0** marks will be conducted in every theory course in a semester. The midterm marks shall be awarded giving a weightage of $2/3^{rd}$ in the examination in which the student scores more marks and $1/3^{rd}$ for the examination in which the student scores less marks. Each midterm examination shall be conducted for duration of 90 minutes without any choice**.**

b) The remaining 20 marks are awarded through continuous evaluation of assignments / mini project in each subject as notified by the teacher at the beginning of the semester.

Students shall be informed regarding the comprehensive assignment/ during the first week of the semester and they have to submit completed assignment on or before 12^{th} week of semester.

11.1.2 Laboratory Courses: 40 marks

- For Laboratory courses there shall be continuous evaluation during the semester for 40 continuous evaluation marks. The distribution of continues evaluation marks is given below:

Table 5: Distribution of Marks

Sl. No.	Criteria	Marks
1	Day to Day work	10
2	Record	10
3	Continuous Evaluation	20

11.1.3 Seminar: 40 marks

The distribution of continues evaluation marks for the seminar is given below.

Table 6: Distribution of Marks

Sl. No.	Criteria	Marks
1	Report	15
2	Presentation	15
3	Viva-voce	10

The Seminar Review Committee (SRC) to be constituted by HOD with minimum two members related to programs specialization.

11.1.4 Project: (40 marks)

The continuous evaluation (Project Part A and Project Part B) for 40 marks shall be on the basis of two seminars by each student evaluated by a review committee and the day to day assessment by the supervisor in respective semester. The review committee consists of HOD, Programme coordinator, respective internal guide and two senior members of faculty of the department with expertise in the respective specialization nominated by HOD. The distribution of marks is as follows in Table 7.

Table 7: Continuous evaluation in each semester

Sl. No.	Criteria	Marks
1	Two reviews	15+15
2	Day to day assessment	10

Rubrics shall be prepared by review committee using appropriate performance indicators for each review separately and informed to the students well in advance.

11.1.5 Self-Learning Courses

For the courses under this category, there shall be continuous evaluation for 40 marks and semester end examination of 60 marks. The distribution of marks for continuous evaluation will be same as theory courses (Section 11.1.1).

11.2 SEMESTER END EXAMINATIONS

11.2.1 Theory Courses: 60 marks

The Semester end examinations shall be conducted for 3 hours duration at the end of the semester. The question paper shall be given in the following pattern: There shall be two questions from each unit with internal choice. Each question carries 15 marks. Each course shall consist of four units of the syllabus.

11.2.2 Lab Courses: 60 marks

40 marks are allotted for experiments/job works & 15 marks are allotted for viva-voce examination and 5 marks for the record.

11.2.3 Seminar: 60 marks

There shall be a seminar presentation. For Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee. The Departmental Committee consists of Head of the Department, supervisor and two other senior faculty members of the department. For Seminar, the evaluation is done for 60 marks internally.

11.2.4 Self-Learning Courses: 60 marks

The semester end examinations for courses under this category are evaluated for 60 marks.

11.2.5 Project: 60 marks

The project (Project Part A and Part B) shall be evaluated for 60 marks in respective semesters. The semester end examination for project part – A shall be evaluated by HOD, Programme coordinator and one of the senior Professors of the Department.

Project part – B shall be evaluated by a project evaluation committee consisting of the Head of the Department, project internal guide and an external examiner approved by the Principal from a panel submitted by the HOD.

The rubrics for evaluation of semester end examination shall be defined by the Project review committee separately for Part – A and Part B.

12. CONDITIONS FOR PASS AND AWARD OF CREDITS FOR A COURSE

12.1 Conditions for Pass and award of Grades & Credits:

a) A candidate shall be declared to have passed in individual Theory course if he/she secures a minimum of 50% aggregate marks (continues evaluation & semester end examination marks put together), subject to a minimum of 40% marks in the semester end examination.

b) A candidate shall be declared to have passed in individual labs/ seminar/ course if he/she secures a minimum of 50% aggregate marks (continues evaluation & semester end examination marks put together), subject to a minimum of 50% marks in the semester end examination.

c) If a candidate secures minimum of 40% marks in Theory Courses in the semester end examination and 40% - 49% of the total marks in the semester end examination and continues evaluation taken together in some theory courses and secures an overall aggregate of 50% in all theory courses in that semester he/she declared to be passed in the theory courses of that semester in semester end Examinations. This provision is applicable for Regular candidates only during Regular Semester – end Examinations.

d) The student has to pass the failed course by appearing the examination when conducted subsequently, as per the requirement for the award of degree.

e) A candidate shall be declared to have passed the Project part A/ **P**roject part B, if he/she secures minimum of 50 % aggregate marks (continuous evaluation and semester end examination marks put together), subject to a minimum of 50 % of marks in semester end examinations.

f) If any candidate does not fulfill the pass requirement as per 12.1.(e) in semester end examination of Project Part – A, he / she will be given two months additional time to re appear at the semester end examination after paying the requisite examination fee and also the candidate has to bear the expenditure for conducting examination. If the candidate does not fulfill the pass requirement again in Project Part – A as per 12.1(e), he/she has to repeat the semester in next academic year.

g) In a special case, if any student does not submit his / her thesis of Project Part – B, due to ill health or any other genuine reason, he / she will be given another chance to appear at Project Part - B examination conducted separately at a later date i.e. within two months from the completion of Project Part – B semester end examination of that particular academic year after paying the requisite examination fee, if the expenditure for conducting Project Part – B is completely borne by the candidate.

h) On passing a course of a programme, the student shall earn assigned credits in that Course.

12.2 Method of Awarding Letter Grades and Grade Points for a Course.

A letter grade and grade points will be awarded to a student in each course based on his/her performance as per the grading system given below.

Table 8: Grading System for individual subjects/labs

Theory	Lab	Grade Points	Letter Grade
>= 90%	>= 90%	10	Ex
80-89%	80-89%	9	A+
70-79%	70-79%	8	A
60-69%	60-69%	7	B
50-59%	55-59%	6	C
45-49%	50-54%	5	D
40-44%	-	4	E
< 40%	< 50%	0	F (Fail)
ABSENT	ABSENT	0	AB

12.3 Calculation of Semester Grade Points Average (SGPA)* and award of division for the program.

The performance of each student at the end of the each semester is indicated in terms of SGPA. The SGPA is calculated as below:

$$SGPA = \frac{\sum (CR \times GP)}{\sum CR}$$ (For all courses passed in semester)

Where CR= Credits of a course

GP = Grade points awarded for a course

*SGPA is calculated for the candidates who passed all the courses in that semester.

12.4 Calculation of Cumulative Grade Point Average (CGPA) for Entire Programme.

The CGPA is calculated as below:

$$CGPA = \frac{\sum (CR \times GP)}{\sum CR} \qquad \text{(For entire programme)}$$

Where CR= Credits of a course

GP = Grade points awarded for a course

Table 9: Award of Divisions

CGPA	DIVISION
≥7.75	First Class with distinction
≥6.5 - <7.75	First Class
≥5.5 - <6.5	Second Class
≥4 - <5.5	Pass Class
<4	Fail

For the purpose of awarding first class with distinction, the candidate should complete the programme with in 2 years and should get required CGPA.

Detained, Break in study candidates, and the candidates who availed themselves of the opportunity of extension of project part – B for a further period of two months are not eligible for the award of first class with distinction.

For the purpose of awarding first/ second/ pass class, CGPA obtained in the examinations appeared within the maximum period allowed for the completion of course including extensions in project, if any shall be considered.

12.5 Transitory Regulations

A candidate, who is detained or discontinued in the semester, on readmission shall be required to pass all the courses in the curriculum prescribed for such batch of students in which the student joins subsequently and the academic regulations be applicable to him/her which have in force at the time of his/her admission. However, exemption will be given to those candidates who have already passed in such courses in the earlier semester(s) and additional subjects are to be studied as approved by Board of Studies and ratified by Academic Council.

12.6 Consolidated Grade Card

A consolidated grade card containing credits & grades obtained by the candidates will be issued after completion of the two years M. Tech Programme.

13. READMISSION CRITERIA

A candidate, who is detained in a semester due to lack of attendance/marks, has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling all the required norms stipulated by the college in addition to paying an administrative fee of Rs. 1,000/-.

Rules for calculation of attendance for re-admitted students:

a) No. of classes conducted will be counted from the day 1 of the semester concerned, irrespective of the date of payment of tuition fee.

b) They should submit a written request to the principal of the college, along with a challan paid towards tuition and other fee, for re–admission before the commencement of class work.

c) Student should come to know about the date of commencement of class – work of the semester in to which he / she wishes to get re – admission. The information regarding date of commencement of class – work for each semester is available in the college notice boards / website.

14. BREAK IN STUDY

Student, who discontinues the studies for whatsoever may be the reason, can get readmission into an appropriate semester of M. Tech program after a break-in study only with the prior permission of the Principal of the College provided such candidate shall follow the transitory regulations applicable to such batch in which he/she joins. An administrative fee of Rs. 2000/- per each year of break in study in addition to the prescribed tuition and special fee has to be paid by the candidate to condone his/her break in study.

15. ELIGIBILITY FOR AWARD OF M.TECH DEGREE

The M. Tech., Degree shall be conferred on a candidate who satisfies the following requirement. A student should register himself for 80 Credits, and should obtain all the 80 credits in order to become eligible for the award of M.Tech Degree.

16. CONDUCT AND DISCIPLINE

- Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the students of our Institute.

- As per the order of the Honorable Supreme Court of India, ragging in any form is considered a criminal offense and is banned. Any form of ragging will be severely dealt with.
- The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures with regard to ragging.
    i. Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.
    ii. Willful damage or distribution of alcoholic drinks or any kind of narcotics to fellow students /citizens.

The following activities are not allowed within the campus

- Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.
- Mutilation or unauthorized possession of library books.
- Noisy and unseemly behavior, disturbing studies of fellow students.
- Hacking computer systems (such as entering into other person's areas without prior permission, manipulation and/or damage of computer hardware and software or any other cyber crime etc.
- Use of cell phones in the campus.
- Plagiarism of any nature.
- Any other act of gross indiscipline as decided by the college from time to time.
- Commensurate with the gravity of an offense, the punishment may be reprimanded, fine, expulsion from the institute / hostel, debarment from a examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.
- For an offense committed in (i) a hostel (ii) a department or in a classroom and (iii) elsewhere, the Chief Warden, the Head of the Department and the Principal, respectively, shall have the authority to reprimand or impose fine.
- Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Principal for taking appropriate action.
- Unauthorized collection of money in any form is strictly prohibited.

- Detained and Break-in-Study candidates are allowed into the campus for academic purposes only with permission from the authorities.
- Misconduct committed by a student outside the college campus, but having the effect of damaging, undermining & tarnishing the image & reputation of the institution will make the student concerned liable for disciplinary action commensurate with the nature & gravity of such misconduct.
- The Disciplinary Action Committee constituted by the Principal, shall be the authority to investigate the details of the offense, and recommend disciplinary action based on the nature and extent of the offense committed.
- "Grievance appeal Committee" (General) constituted by the Principal shall deal with all grievances pertaining to the academic / administrative /disciplinary matters.
- All the students must abide by the code and conduct rules of the college.

17. MALPRACTICES

- The Principal shall refer the cases of malpractices in internal assessment tests and Semester-End Examinations, to a Malpractice Enquiry Committee, constituted by him/her for the purpose. Such committee shall follow the approved scales of punishment. The Principal shall take necessary action, against the erring students based on the recommendations of the committee.
- Any action on the part of the candidate at an examination trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder. The involvement of the Staff, who are in charge of conducting examinations, valuing examination papers and preparing/keeping records of documents relating to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and recommended for award of appropriate punishment after thorough enquiry.

18. OTHER MATTERS

18.1 The physically challenged candidates who have availed additional examination time and a scribe during their B. Tech/PGECET/GATE examinations will be given similar concessions on production of relevant proof/documents.

18.2 Students who are suffering from contagious diseases are not allowed to appear either internal or semester end examinations.

18.3 The students who participated in coaching/tournaments held at the state / National /International levels through University / Indian Olympic Association during the end semester external examination period will be promoted to subsequent semesters till the entire course is completed as per the guidelines of University Grants Commission Letter No .F.1-5/88 (SPE/PES), dated 18-08-1994.

18.4 The Principal shall deal with any academic problem, which is not covered under these rules and regulations, in consultation with the Heads of the Departments in an appropriate manner, and subsequently such actions shall be placed before the academic council for ratification. Any emergency modification of regulation, approved in the Heads of the Departments Meetings, shall be reported to the academic council for ratification.

19. AMENDMENTS TO REGULATIONS

The Academic Council may, from time to time, revise, amend, or change the regulations, Schemes of examination and/or syllabi.

W.E.F. 2015-16

MTECH-15

DETAILED SYLLABUS

of

Two Years

M Tech Degree Program

(Semester System)

in

POWER SYSTEMS ENGINEERING

V. R. SIDDHARTHA ENGINEERING COLLEGE:: VIJAYAWADA (AUTONOMOUS)
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
FOUR SEMESTERS M.TECH. DEGREE PROGRAM

POWER SYSTEMS ENGINEERING

COURSE STRUCTURE VR15 (w.e.f 2015-2016)

SCHEME OF INSTRUCTIONS FOR THE CURRICULUM & DETAILED SYLLABUS

S.No.	Course Code	Course Title	Periods/week		Internal marks	End Semester Examination		Credits
			L+T	P		Duration	Marks	
First Semester								
1.	15EEPS1001	Modern Optimization Techniques	4	--	40	3	60	4
2.	15EEPS1002	Modern Control Theory	4	--	40	3	60	4
3.	15EEPS1003	Advanced Power System Analysis	4	--	40	3	60	4
4.	15EEPS1004	Advanced Power Electronics	4	--	40	3	60	4
5.	15EEPS1005	*Elective-I*	4	--	40	3	60	4
6.	15EEPS1006	*Elective-II*	4	--	40	3	60	4
7.	15EEPS1051	Power Systems Lab-I	--	3	40	3	60	2
8.	15EEPS1052	Simulation Lab – I	--	3	40	3	60	2
		TOTAL	**24**	**6**	**320**	**--**	**480**	**28**
Second Semester								
1.	15EEPS2001	Flexible AC Transmission Systems	4	--	40	3	60	4
2.	15EEPS2002	Advanced Power System Stability	4	--	40	3	60	4
3.	15EEPS2003	Power System Operation & Control	4	--	40	3	60	4
4.	15EEPS2004	Advanced Power System Protection	4	--	40	3	60	4
5	15EEPS2005	*Elective-III*	4	--	40	3	60	4
6.	15EEPS2006	*Self Learning course*	--	--	40	3	60	2
7.	15EEPS2051	Power Systems Lab-II	--	3	40	3	60	2
8.	15EEPS2052	Simulation Lab – II	--	3	40	3	60	2
9.	15EEPS2053	Seminar	--	3	40	--	60	2
		TOTAL	**22**	**9**	**360**	**--**	**540**	**28**
Third Semester								
1.	15EEPS3051	**Project Work Part-A**	--	--	**40**	--	**60**	**10**
Fourth Semester								
1.	15EEPS4051	**Project Work Part-B**	--	--	**40**	--	**60**	**14**
		Grand TOTAL	46	15	**760**	**--**	**1140**	**80**

ELECTIVE-I		*ELECTIVE-III*	
15EEPS1005/1	High Voltage Testing Techniques	15EEPS2005/1	HVDC Transmission
15EEPS1005/2	Advanced Digital Signal Processing	15EEPS2005/2	Digital Control Systems
15EEPS1005/3	Transients in Power Systems	15EEPS2005/3	Deregulated Power System
15EEPS1005/4	Soft computing methods to Power Systems	15EEPS2005/4	Power System State Estimation
ELECTIVE-II		*Self Learning course*	
15EEPS1006/1	Power Quality	15EEPS2006/1	Smart Grid Design and Analysis
15EEPS1006/2	Microcontrollers & their applications	15EEPS2006/2	Renewable Power Generation Technologies
15EEPS1006/3	Power Distribution Systems	15EEPS2006/3	Energy Management and Auditing
15EEPS1006/4	Industrial Power System Analysis & Design	15EEPS2006/4	Distributed Generation and Micro grid

15EEPS1001: MODERN OPTIMIZATION TECHNIQUES

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: Formulate and solve LP Problem

CO2: Solve non linear Programming Problems

CO3: Apply search methods to solve constrained and unconstrained optimization Problems.

CO4: Solve optimization problems using evolutionary techniques and MATLAB toolboxes like LPP, NLP, QP, Genetic Algorithms.

UNIT - I

Linear Programming: Introduction and formulation of models, Standard and canonical forms of LPP, assumptions in LPP, Graphical Method, simplex method, simplex method using Artificial Variables, duality in L.P., dual simplex method, sensitivity analysis: change in coefficients of objective function.

UNIT–II

Non-linear Programming: Unconstrained problems of Maxima and Minima, Constrained problems of Maxima and Minima. Lagrangian Method, Kuhn Tucker conditions. Quadratic programming: Wolfe's Modified simplex method, separable Programming.

UNIT–III

Dynamic Programming: Solution of linear programming problem, simple examples One dimensional optimization, sequential search, Fibonacci search, multi dimensional search method, Univariate search, gradient methods, steepest descent / ascent methods, conjugate gradient method, Fletcher – Reeves method, penalty function approach.

UNIT – IV

Evolutionary Optimization Techniques: Evolution in nature-Fundamentals of Evolutionary algorithms-Working Principles of Genetic Algorithm, Genetic Operators: Selection, Crossover and Mutation, Issues in GA implementation.

MATLAB: Solving LPP, Quadratic Programming, NLP problems using Toolboxes, Genetic Algorithm toolbox and its usage.

References:

1. Engineering Optimizaion: Theory and Practice by S.S.Rao, 3rd Ed., New Age International, 1998
2. Operations Research by S.D.Sharma
3. Optimization for Engineering Design: Algorithms and Examples, Kalyanmoy Deb, Phi Learning Pvt. Ltd.
4. Neural networks, Fuzzylogic and Genetic Algorihms: Synthesis and Applications, Rajasekaran S, Pai, G.A. Vijaya Lakshmi., PHI.
5. Applied Optimization with MATLAB Programming, P. Venkataraman, John Wiley & Sons.

15EEPS1002: MODERN CONTROL THEORY*

Lecture : 4 Hrs/ Week **Practical:** - **Internal Assessment:** 40
Credits : 4 **Final Examination:** 60

Course Outcomes: After completion of this course the student should be able to

CO1: **Design** a control system via pole assignment and observer using state feedback

CO2: **Perform** the stability analysis of nonlinear systems using describing functions and phase plane methods

CO3: **Analyze** linear and non-linear systems using Lyapunov theorems and **Design**Lyapunov function for stable systems

CO4: **Formulate** an optimal control problem and **design** optimal controller using Hamiltonian and/or LQR methods

UNIT – I
STATE FEEDBACK CONTROLLERS AND OBSERVERS

Review of state space concepts, Controllability and Observability, State space representations of transfer-function systems –controllable, observable, diagonal (Jordan) canonical forms; State feedback controller design through Pole Assignment- Direct, Transformation Matrix, Ackermann's methods; State observers - Full order and Reduced order - Direct, Transformation Matrix, Ackermann's methods

UNIT- II
Nonlinear Systems

Introduction –Properties of nonlinear systems - Types of Nonlinearities – Singular Points – Introduction to linearization of nonlinear systems,– Describing function–describing function analysis of nonlinear systems – Stability analysis of Nonlinear systems - describing function and phase plane methods

UNIT-III
LyapunovStability Analysis

Equilibrium state, Stability in the sense of Lyapunov, Scalar functions-Sign definiteness, Lyapunov's stability and instability theorems - Stability analysis of the linear continuous- time invariant systems by Lyapunov second method– Direct method of Lyapunov – Generation of Lyapunov functions – Variable gradient and Krasoviskii's methods

UNIT- IV
Optimal Control

Introduction to optimal control - Formulation of optimal control problems – calculus of variations –Minimization of functions - Minimization of functional – functional involving independent functions – constrained minimization – formulation using Hamiltonian method – Linear Quadratic regulator.

References:

1. Modern Control System Theory – M.Gopal – New Age International -3/E
2. Modern Control Engineering – Ogata.K – PHI – 5/E
3. Control Systems – Principles and Design – M Gopal TMH, 3/E
4. Control System Engineering – IJ Nagrath and M Gopal New Age International -5/E
5. Control Systems – ManjithaSrivastavaet. al. – TMH

* continuous-time systems only

15EEPS1003: ADVANCED POWER SYSTEM ANALYSIS

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: **Formulate** the incidence and network matrices using singular transformation and model the transmission lines and transformer.

CO2: **Perform** load flow analysis using Gauss-Seidel, Newton-Raphson, Fast decoupled and DC power flow methods.

CO3: **Formulate** bus impedance matrix using building algorithm and apply for short circuit studies.

CO4: **Analyze** the power system for contingency and state estimation.

UNIT-I

INCIDENCE AND NETWORK MATRICES: Introduction – graphs – incidence matrices formation - Y_{Bus}, Y_{BR} and Z_{loop} by singular transformation, single phase modeling of transmission lines, off-nominal transformer tap representation, phase shift representation.

UNIT –II

POWER FLOW ANALYSIS: Formulation of power flow problem – solution through Gauss-Seidel method, Newton Raphson method - decoupled and fast decoupled power flow solutions - DC power flow solution – comparison of GS – NR – FDC method. Formulation of Three phase load flow problem. Fast decoupled three phase algorithm

UNIT-III

FAULT STUDIES: Algorithms for formation of Zbus matrix – Short –Circuit (SC) studies – introduction – SC calculations using Z_{bus} – Z^f_{abc} – Y^f_{abc} – Z^f_{012} – Y^f_{012} matrices for various faults, SC calculations using Z_{bus} for L–L–L, L-G, L-L and L-L–G faults.Analysis of open circuit faults- one line conductor open and two line conductor open.

UNIT-IV

CONTINGENCY ANALYSIS: Adding and removing multiple lines, piece wise solution of interconnected systems, analysis of single and multiple contingencies, Contingency analysis by DC Model.

STATE ESTIMATION: Method of least squares – statistics – errors – estimates – test for bad data – structure and formation of Hessian matrix – power system state estimation.

References:

1. Stagg G.Ward, El–Abiad: Computer methods in power system analysis, McGraw Hill ISE, 1986.
2. J.Arrilaga and C.P. Arnold: Computer Modeling of Electric Power Systems, John Wiley & Sons, N.Y., 1st edition, 2001
3. Nagarath& Kothari Modern power system analysis 3rd Edition, TMH.
4. Nagsarkar&Sukhija, Power system analysis, Oxford press, New Delhi, 2007
5. Grainger, J.J. and Stevenson, W.D. ‘Power System Analysis’ Tata McGraw hill, New Delhi, 2007.

15EEPS1004: ADVANCED POWER ELECTRONICS

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: **Describe** the operation and control of PWM inverters
CO2: **Know** the significance of Multilevel inverters
CO3: **Analyze** the functional operation of DC-DC converters
CO4: **Describe** the principles, operation of Power Conditioners

UNIT-I
PWM INVERTERS (SINGLE-PHASE & THREE-PHASE)
Single phase inverter: Introduction – Voltage control of single phase inverters – single pulse PWM – Multiple pulsePWM – sinusoidal PWM –phase displacement Control – Advanced modulation techniques for improved performance – Trapezoidal, staircase, stepped, harmonic injection and delta modulations – Advantage – applications.
Three phase inverters: Introduction- voltage control of three phase inverters – sinusoidal PWM – Third Harmonic injection – 60 degree PWM – space vector modulation– Comparison of PWM techniques – harmonic reductions — advantages- applications.

UNIT-II
MULTILEVEL INVERTERS
Multilevel concept – Classification of multilevel inverters – Diode clamped multilevel inverter - Flying capacitors multilevel inverter -Cascaded multilevel inverter -Multilevel inverter applications - comparisons of multilevel converters

UNIT-III
DC-DC converters–Switching mode Regulators-Buck Regulator, boost regulator, buck - boost regulator, Cuk regulator, averaged circuit modeling, input-output equations, ripple calculations, filter design, comparison of Regulators,Active Filters for DC/DC Converters Active EMI Filters Active Ripple Filters- Configurations

UNIT-IV
Power Conditioners– Active Power Filters - Harmonic Definition, Harmonic Sources in Electrical Systems, Effects of Harmonics Harmonic Mitigation Methods-Classification of Active Filters- Current Source Active Filters -Voltage Source Active Filters Shunt active power filters – Series active power filters - Hybrid active power filters -UPQC

References:

1. Power Electronics – Mohammed H. Rashid – Pearson Education – Third Edition.
2. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley and Sons – Second Edition.
3. AliEmadi,A.Nasiri, andS.B.Bekiarov “UninterruptiblePowerSuppliesandActive Filters”, CRCPress, 2005.

15EEPS1005/1:HIGH VOLTAGE TESTING TECHNIQUES

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: Understand the concept of differenthigh voltage generators
CO2: Understand the concept of high voltage measurementtechniques
CO3: Analyze high voltage testing techniques of Power apparatus and causes over voltages
CO4: Analyze non destructive testing of insulators

UNIT-I
HIGH VOLTAGE GENERATORS FOR TESTING: Introduction –testing voltages; Generation of High direct voltages - A.C to D.C conversion, voltage doubler circuit, Cockcroft-walton voltage multiplier circuit, Electrostatic generators; generation of high alternating voltages – testing transformers, cascaded transformers, series resonant circuits, generation of high frequency alternating voltages using Tesla coil; Generation of high impulse voltages – Characteristics of Impulse Voltage, Single-stage Impulse Generator Circuits, Multi-stage Impulse Generator, tripping and control of impulse generators.

UNIT-II
HIGH VOLTAGE MEASUREMENTS FOR TESTING: Measurement of high alternating voltages – capacitor voltage divider, Capacitance voltage transformer; Measurement of high impulse voltages – Capacitance voltage divider, Delay cables; Measurement of peak voltages by using sphere gaps

UNIT-III
TESTING TECHNIQUES FOR ELECTRICAL EQUIPMENT: Testing of insulators-artificial pollution tests, bushings, air break switches, isolators, circuit breakers, power transformers, surge diverters,cable -testing methodology-recording of oscillograms-interpretation of test results.

UNIT-IV
NON-DSTRUCTIVE INSULATION TEST TECHNIQUES: Dynamic properties of dielectrics-dielectric loss and capacitance measurement-partial discharge measurements-basic partial discharge (PD) circuit – PD currents- PD quantities - Digital PD instruments and measurements, Corona and RIV measurements on line hardware.

References:
1. Diter Kind, Kurt Feser, "High voltage test techniques", SBA Electrical Engineering Series, New Delhi,1999.
2. Naidu M.S. and Kamaraju V., "High voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
3. Kuffel, E., Zaengl, W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India P Ltd, 2005
4. Gallagher, T.J., and Pearmain A., "High Voltage Measurements, Testing and Design", John Willey & Sons, New York, 1983.
5. IS, IEC and IEEE standards for "Dielectric Testing of High Voltage Apparatus" W.Nelson, Applied Life Data Analysis, John Wiley and Sons, New York, 1982.
6. IEC – 60270, "HV Test technique - Partial Discharge Mechanism",3/e December 2000.

15EEPS1005/2:ADVANCED DIGITAL SIGNAL PROCESSING

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: **Realize** different structures of FIR & IIR Filters.
CO2: **Design** IIR & FIR Filters using different techniques.
CO3: **Use** Filter implementation techniques and **explain** numerical round-off effects.
CO4: **Estimate** Power Spectrum using different techniques.

UNIT -I
Digital Filter Structure
Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

UNIT -II
Digital filter design
Preliminary considerations-Bilinear transformation method of IIR filter design-design of Low pass, highpass, Bandpass, and Band stop- IIR digital filters-Spectral transformations of IIR filters- FIR filter design-based on Windowed Fourier series- design of FIR digital filters with least –mean- Square-error-constrained Least-square design of FIR digital filters

UNIT -III
DSP algorithm implementation
Computation of the discrete Fourier transform- Number representation-Arithmetic operations-handling of overflow-Tunable digital filters-function approximation.

Analysis of finite Word length effects
The Quantization process and errors- Quantization of fixed -point and floating -point Numbers-Analysis of coefficient Quantization effects - Analysis of Arithmetic Round-off errors-Dynamic range scaling-signal- to- noise ratio in Low -order IIR filters-Low-Sensitivity Digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters- Round-off errors in FFT Algorithms.

UNIT-IV
Power Spectrum Estimation
Estimation of spectra from Finite Duration Observations signals – Non-parametric methods for power spectrum Estimation – Welch method-Blackman &tukey method- parametric method for power spectrum Estimation- the Yule- Walker method for the A R Model Parameters.

Applications of digital signal processing:
Dual Tone Multi-frequency Signal Detection, Spectral Analysis of Sinusoidal Signals, Spectral Analysis of Non stationary Signals, Over Sampling A/D Converter, Over Sampling D/A Converter.

References:

1. Digital signal processing-sanjit K. Mitra-TMH second edition
2. Digital Signal Processing principles, algorithms and Applications – John G.Proakis - PHI –Fourth edition
3. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint
4. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
5. Theory and Applications of Digital Signal Proceesing-LourensR. Rebinar&Bernold Digital Filter Analysis and Design-Auntonian-TMH
6. DSP- A Practical Approach- Emmanuel C Ifeacher Barrie. W. Jervis, Pearson Education.
7. Modern spectral Estimation techniques by S. M .Kay, PHI, 1997

15EEPS1005/3:ELECTRICAL TRANSIENTS IN POWER SYSTEMS

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: Analyze the electrical transients in power system and concepts of traveling waves and propagation

CO2: Distinguish the phenomena of Lightning, switching and temporary over voltages

CO3: Elucidate the concepts for Protection of Systems against Surges

CO4: Describe the issues related to insulation coordination

UNIT-I

INTRODUCTION

Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of theRLC circuit transients.Different types of power system transients - effect of transients on power systems – role of the studyof transients in system planning.

TRAVELLING WAVES ON TRANSMISSION LINE

Successive reflections - Bewley Lattice Diagrams - Attenuation and Distortion - Multi-conductor system - Self and mutual surge impedance - Voltage and currents for two conductor systems.

UNIT-II

LIGHTNING, SWITCHING AND TEMPORARY OVER VOLTAGES

Lightning: Physical phenomena of lightning - Interaction between lightning and power system - Factors contributing to line design - Switching: Short line or kilometric fault - Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault - Very Fast Transient Overvoltage (VFTO).

UNIT-III

PROTECTION OF SYSTEMS AGAINST SURGES

Transmission line insulation and performance - Ground wires - Protective angle - Tower footing resistance - Driven rods - Counterpoise - Protector tube - Substation protection - surge diverters - Selection of arrester rating - Location of arresters - Influence of additional lines - Effect of short length of cable - Surge capacitor, surge reactor and surge absorber - Shielding substation with ground wires - Protection of rotating machines.

UNIT-IV

INSULATION CO-ORDINATION

Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS),Basic Impulse level(BIL) and Switching Impulse Level(SIL) insulation level, statistical approach, co-ordination between insulation and protection level - overvoltage protective devices - lightning arresters, substation earthing . Principle of digital computation of transients: features and capabilities of EMTP; steady state and time step solution modules: basic solution methods.

References:

1. Allan Greenwood, “*Electrical Transients in Power System*”, Wiley & Sons Inc. New

York, 1991.

2. Rakosh Das Begamudre, *"Extra High Voltage AC Transmission Engineering*", (Second edition) Newage International (P) Ltd., New Delhi, 1990.
3. Naidu M S and Kamaraju V, *"High Voltage Engineering*", Tata McGraw.Hill Publishing Company Ltd., New Delhi, 2004.
4. Hermann W. Dommel, *EMTP Theory Book,* second Edition, Microtran Power System Analysis Corporation, Vancouver, British Columbia, Canada, May 1992, Last Update: April 1999
5. Thapar.B, Gupta.B.R and Khera.L.K, "Power System Transients and High Voltage Principles", Mohindra Capital Publishers
6. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980
7. Bewley, L. V. "Traveling waves on electric power systems." *Universidade de Lehigh, EUA* (1942).

15EEPS1005/4: SOFT COMPUTING METHODS TO POWER SYSTEMS

Lecture : 4 Hrs/ Week **Practical:** - **Internal Assessment:** 40
Credits : 4 **Final Examination:** 60

Course Outcomes: After completion of this course the student should be able to
CO1: **Explain** organization of the brain, biological and artificial neural networks, training algorithms, perceptron network and multi layer neural networks.
CO2: **Describe** genetetic operationsencoding, fitness function, reproduction, genetic operators, cross over and mutation and convergence of genetic algorithm.
CO3: **Explain** classical sets, fuzzy sets, membership function, rule base and Defuzzification methods.
CO4: **Apply** neural network and fuzzy logic to fault diagnosis and power system problems.

UNIT-I
Introduction to Neural Networks: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models. Introduction-neural network models-architectures-knowledge representation-learning process-learning tasks.
Feed Forward Neural Networks: Introduction, Perceptron Models; Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perception Convergence theorem, Limitations of the Perceptron Model, Applications.
ANN paradigm-back propagation-RBF algorithms-Hope field networks

UNIT-II
Genetic algorithms-introduction-encoding-fitness function-reproduction operators
Genetic modeling-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

UNIT-III
Classical and Fuzzy Sets: Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.
Fuzzy Logic System Components: Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

UNIT-IV
Neural network applications: Process identification, Function Approximation, control and Process Monitoring, fault diagnosis and load forecasting.
Genetic Algorithm applications: Economic Load dispatch, Optimization problems.
Fuzzy logic applications: Fuzzy logic control and Fuzzy classification specific applications to power systems load frequency control, fault diagnosis.

References:
1. Chennakesava R Alavala —Fuzzy logic and neural networks, New Age Int. Publishers.
2. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication.
3. Jacek M. ZuardaIntroduction to Artificial Neural Systems ,Jaico Publishing House, 1997.
4. N. Yadaiah and S. BapiRajuNeural and Fuzzy Systems: Foundation, Architectures and Applications, Pearson Education
5. C.Eliasmith and CH.AndersonNeural Engineering, PHI

15EEPS1006/1: POWER QUALITY

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: Assess the severity of power quality problems in power system
CO2: Analyze voltage sag problems and suggest preventive techniques
CO3: Analyze current and voltage related power quality issues
CO4: Assess the effect of DG in distribution system related to power quality problemsand understand the power quality monitoring

UNIT-I
POWER QUALITY - AN OVERVIEW: Power Quality definition, PQ characterization: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation
Power acceptability curves: CBEMA, ITIC – Sources for Electric Power Quality problem in power system: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage, the power quality evaluation procedure.

UNIT-II
Voltage sags and Interruptions: Sources of sags and Interruptions. Estimating Voltage sag performance—Area of vulnerability, equipment sensitivity to voltage sags, transmission system sag performance evaluation, Utility Distribution system sag performance evaluation.
Fundamental Principles of Protection.Solutions at the end-user level.Evaluating the economics of different Ride-through Alternatives.Motor-Starting Sags.

UNIT- III
Fundamentals of Harmonics: Harmonic distortion. Voltage versus Current distortion.Harmonics versus Transients.Harmonic indexes.Harmonic sources from commercial loads.Harmonic sources from industrial loads.Locating Harmonic sources.System response characteristics.Effects of Harmonic Distortion.
Power Quality Analysis: Measurements of Voltage, Current, Power, Energy, power factor-Harmonic analysis using Fourier transform and Wavelet Transform methods.

UNIT-IV
Distributed Generation and Power Quality: Resurgence of DG. DG Technologies. Interface to the Utility System. Power Quality issues. Operating conflicts. DG on distribution Networks . Sitting DG distributed Generation, Interconnection standards.
Power Quality Monitoring: Monitoring Consideration. Historical perspective of power quality measuring instruments. Power quality measurement equipment

References:

1. Electrical Power Systems Quality: Roger C. Dugan, MF McGranaghan, Surya Santoso and HW Beaty, TMH, 2/E
2. Jos Arrillaga, Neville R. Watson, “Power System Harmonics” - John Wiley & Sons, 2003.

3. Math H.J.Bollen, "Understanding Power Quality Problems-Voltage sag & Interruptions", IEEE Press, 2000.
4. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition).
5. Angelo Baggini 'Handbook of Power Quality' – Wiley.

1006/2: MICROCONTROLLERS AND THEIR APPLICATIONS

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of the course the student will be able to

CO1: Elucidate architecture and various addressing modes, subroutinesusing instruction set of 8051 microcontroller.

CO2: Develop embedded program for interfacing various devices to 8051 microcontroller

CO3: Explore the features of PIC microcontroller, TIMER programming and its interfacing with various types of data converters.

CO4: Utilize microcontrollers for power systems applications

UNIT-I

Introduction to Microcontrollers: Comparison of Microcontroller with Microprocessor, Criteria for choosing a microcontroller for particular application, Overview of 8051 family.

Introduction to 8051 microcontroller: Review of Architecture, Pin description, Special Function Registers, Addressing Modes, Instruction Set, Assembler directives, illustrative examples, Subroutines, parameter passing to subroutines.

UNIT-II

Programming 8051microcontroller using Assembly Language and 'C' Language: I/O port programming, on-chip timer/counter programming, Serial port programming, Interrupt programming,

Interfacing: Interfacing of external memory chips, address allocation technique and decoding; LED, LCD and Keyboard interfacing, Interfacing data converters and sensors

UNIT-III

Introduction to PIC microcontrollers: Types, Features, Architecture and Programming of 8 bit PIC microcontroller.

PIC18 Timer programming, Interfacing of ADC, DAC and sensor interfacing.

UNIT-IV

Microcontroller Applications: Measurement of Various Electrical and Non-Electrical Parameters, Speed Monitoring and Control of Various Motors, Control of Firing Circuits of Power Electronics Systems, Numerical Protective Relays.

References:

1. M.A.Mazidi, J.G.Mazidi, R.D.McKinlay, 'The 8051 Microcontroller and Embedded Systems using Assembly and C', Pearson Education2
2. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, 'PIC Microcontroller And Embedded Systems: Using Assembly And C For PIC18', Pearson Education
3. Ayala, Kenneth J., 'The 8051 Microprocessor Architecture, Programming and Applications', Penram International.
4. SubrataGhoshal, '8051 Microcontroller: Internals, Instructions, Programming and Interfacing', Pearson Education. A.V.Deshmukh, "Microcontrollers Theory and Applications", Tata McGraw Hill.

1006/3: POWER DISTRIBUTION SYSTEMS

Lecture : 4 Hrs/ Week **Practical:** - **Internal Assessment:** 40
Credits : 4 **Final Examination:** 60

Course Outcomes: After completion of the course the student will be able to
CO1: Analyse the distribution system planning and load characteristics
CO2: Design concepts of sub-transmission lines; Identify and select appropriate substation location
CO3: Design concepts of primary, secondary systemsandprotection schemes
CO4: Design distribution system control and automation; Identify best and optimum capacitor location

UNIT – I
Distribution systems planning: Distribution systems planning-Factors affecting system planning-present distribution system planning techniques-distribution system planning models-distribution system planning in future- Present and future role of computers in distribution system planning
Load Characteristics:
Definitions – Load forecasting – methods of forecast – regression analysis – correlation analysis and time series analysis – Load management – tariffs and metering of energy.

UNIT – II
Distribution transformers and Deign of sub-transmission lines: – Types of distribution transformers – Regulation and efficiency – Use of monograms for obtaining efficiency-Introduction to sub transmission systems –Types of sub transmission lines
Distribution substations: substation location and rating – Substation bus schemes-Application of network flow techniques in rural distribution networks to determine optimum location of sub-station.

UNIT – III
Design considerations on primary and secondary systems: Introduction - types of feeders - voltage levels - Radial type feeders - feeders with uniformly and non-uniformly distributed loads. Secondary voltage levels - Secondary banking - existing systems improvement.
Distribution system Protection: Basic definitions - over current protection devices - fuses, automatic circuit reclosures, automatic line sectionalizers - objectives of distribution system protection - coordination of protective devices - Fuse to Fuse co-ordination, Fuse to circuit breaker coordination, Reclosure to circuit breaker co-ordination.

UNIT-IV
Applications of Capacitors to distribution systems: Effect of series and shunt capacitors - Power factor correction - economic justification for capacitors - a computerized method to determine the economic power factor - Procedure to determine the best and optimum capacitor location
Distribution Automation: Introduction – description – benefits – distribution automation components – distribution SCADA – distribution management system – functions of DMS.

References:

1. TuranGonen “Electric Power Distribution system Engineering”, MGH.
2. Dr. V. Kamaraju “Electrical distribution systems”, Right Publishers.
3. A.S. Pabla “Electric Power Distribution” TMH, 4th Ed., 1997.

15EEPS1006/4: INDUSTRIAL POWER SYSTEM ANALYSIS & DESIGN

Lecture : 4 Hrs/ Week **Practical:** - **Internal Assessment:** 40
Credits : 4 **Final Examination:** 60

Course Outcomes: After completion of this course the student should be able to
CO1: Analyze various motor starting methods and computer aided evaluation criteria.
CO2: Explain various power factor correction studies.
CO3: Perform computer-aided harmonic analysis.
CO4: Analyze flicker analysisand grid grounding methodologies

UNIT-I
MOTOR STARTING STUDIES:
Introduction-Evaluation Criteria-Starting Methods-System Data-Voltage Drop Calculations-Calculation of Acceleration time-Motor Starting with Limited-Capacity Generators-Computer-Aided Analysis-Conclusions.

UNIT-II
POWER FACTOR CORRECTION STUDIES:
Introduction - System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis - Voltage Magnification Analysis-Sustained Over voltages - Switching Surge Analysis-Back-to-Back Switching-Summary and Conclusions.

UNIT-III
HARMONIC ANALYSIS:
Harmonic Sources - System Response to Harmonics - System Model for Computer - Aided Analysis - Acceptance Criteria-Harmonic Filters - Harmonic Evaluation - Case Study Summary and Conclusions.

UNIT-IV
FLICKER ANALYSIS:
Sources of Flicker - Flicker Analysis - Flicker Criteria - Data for Flicker analysis - Case Study Arc Furnace Load - Minimizing the Flicker Effects - Summary
GROUND GRID ANALYSIS: Introduction - Acceptance Criteria - Ground Grid Calculations – Computer - Aided Analysis - Improving the Performance of the Grounding Grids-Conclusions.

References:
1. Ramasamy Natarajan, ”Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2002.

15EEPS1051: POWER SYSTEMS LAB – I

Lecture :	--	**Practical:**	3Hrs/ Week	**Internal Assessment:**	40
Credits :	2			**Final Examination:**	60

Total a list of 12 experiments are given. Minimum of 8 experiments are to be conducted by the students.

1. Characteristics of electromagnetic relays
2. Reactive power control by tap changing transformers
3. Sequence reactances and fault studies on synchronous machine
4. Load compensation of power system network
5. Determination of sub-transient, transient, steady-state reactance of an alternator
6. Load flow study using AC network analyzer
7. Characteristics of static relays
8. Characteristics of multilevel Inverters
9. Speed control of separately excited DC motor by using single phase /three phase converter
10. High Voltage testing of insulators and cables
11. Measurement of Harmonics using power analyzer
12. Vector group measurement of three phase transformer

15EEPS1052: SIMULATION LAB – I

Lecture :	--	**Practical:**	3Hrs/ Week	**Internal Assessment:**	40
Credits :	2			**Final Examination:**	60

Total a list of 15 experiments are given. Minimum of 8 experiments are to be conducted by the students.

1. Develop program for Y_{bus} Matrix using Singular Transformation Method.
2. Develop program for Z_{bus} using building algorithm procedure.
3. Develop Program for Gauss Seidel Load Flow Analysis.
4. Develop Program for Newton Raphson Load Flow Analysis.
5. Develop Program for Fast Decoupled Load Flow Analysis.
6. Develop Program for Short Circuit Analysis.
7. Develop Program for performance of Transmission line.
8. Develop Program for solution of simultaneous differential equations
9. Simulation of RLC circuit.
10. Simulation of Three Phase full bridge converter.
11. Simulation of Three Phase A.C Voltage controller.
12. Simulation model for sinusoidal pulse width modulation.
13. Simulation model for closed loop speed control of separately excited D.C motor.
14. Develop a Program to implement the pole placement technique.
15. Develop a Program to convert the given transfer function in to diagonal canonical form.

15EEPS2001: FLEXIBLE AC TRANSMISSION SYSTEMS

Lecture : 4 Hrs/ Week **Practical:** - **Internal Assessment:** 40
Credits : 4 **Final Examination:** 60

Course Outcomes: After completion of this course the student should be able to
CO1: **Study** the importance of controllable parameters and benefits of FACTS controllers.
CO2: **Design** of Static Var Compensator and its applications to power systems
CO3: **Analyze** the functional operation and control of series FACTS devices.
CO4: **Describe** the modeling, operation and control of VSC based FACTS devices.

UNIT- I
INTRODUCTION
Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.

UNIT- II
STATIC VAR COMPENSATOR (SVC)
Configuration of SVC- voltage regulation by SVC- Modelling of SVC for load flow analysis-Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

UNIT- III
THYRISTOR AND GTO THYRISTOR CONTROLLED SERIES CAPACITORS
Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of TCSC-GCSC – Modelling of TCSC and GCSC for load flow studies- modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.

UNIT- IV
VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS
Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)- Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers(UPFC and IPFC)-Modelling of UPFC and IPFC for load flow and transient stability studies- Applications.

References:

1. Mohan Mathur, R., Rajiv. K. Varma, "*Thyristor – Based FACTS Controllers for Electrical Transmission Systems*", IEEE press and John Wiley & Sons, Inc, 2002.
2. K.R.Padiyar," *FACTS Controllers in Power Transmission and Distribution*", New Age International (P) Ltd., Publishers, New Delhi, Reprint, 2008.
3. NarainG.Hingorani, Laszio. Gyugyl, "*Understanding FACTS Concepts and Technology of Flexible AC Transmission System*", Standard Publishers, Delhi, 2001.
4. V. K.Sood, "*HVDC and FACTS controllers- Applications of Static Converters in Power System*", Kluwer Academic Publishers, 2004.

15EEPS2002:ADVANCED POWER SYSTEM STABILITY

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: Classify power system stability concepts and model various components used in power system from stability point of view.

CO2: Analyze transient stability problems and understand methods to improve it.

CO3: Analyze small signal stability problems and understand methods of improving small signal stability

CO4: Analyze voltage stability problems and understand methods of improving voltage stability

UNIT – I

Power system stability considerations: Definitions, classification of stability, rotor angle and voltage stability, synchronous machine representation, classical model, load modeling concepts, modeling of excitation systems, modeling of prime movers.

UNIT – II

Transient stability: Swing equation, equal area criterion, solution of swing equation by numerical methods, Euler method, modified Euler's method and R-K methods. Methods of improving transient stability: High speed fault clearing, Reduction of transmission system reactance, regulated shunt compensation, Dynamic braking, Reactor switching, Single pole switching, Steam turbine fast valving, Generator tripping, controlled system separation and load shedding, High speed excitation systems, control of HVDC transmission links.

UNIT – III

Small signal stability: State space representation, eigenvalues, modal matrices, small signal stability of single machine infinite bus system, effect of field circuit dynamics, effect of excitation system, power system stabilizer. Analytical and graphical methods of calculating steady state stability limits. Two machine system without losses, Two machine system with losses, Effect of saliency, saturation, governor action, inertia, equivalent synchronous reactance on steady sate stability.

UNIT – IV

Voltage stability analysis: Voltage stability, voltage collapse and voltage security, Voltage stability of Single machine connected to infinite bus system – PV curves – VQ curves. Transmission system reactive power compensation and control; Power system loads; Generation characteristics; Voltage stability with HVDC links; Power system planning and operating guidelines

References:

1. PrabhaKundur., " Power system stability and control", Tata McGraw Hill
2. Kimbark E.W. " Power system stability – Vol III, synchronous machines", John Wiley & Sons
3. Taylor C.W. " Power systems voltage stability", TMH
4. AbhijitCHakrabarti, "Power System Analysis Operation and Control" PHI, Third Edition.
5. K.R. Padiyar, " Power systems Dynamics stability and control", Interline publishing pvt., ltd., Bangalore.

15EEPS2003:POWER SYSTEM OPERATION AND CONTROL

Lecture : 4 Hrs/ Week **Practical:** - **Internal Assessment:** 40
Credits : 4 **Final Examination:** 60

Course Outcomes: After completion of this course the student should be able to
CO1: Dispatch load economically among thermal plants
CO2: Dispatch load economically among thermal and hydro plants
CO3: **Model** and analyze LFC, AGC for multi area power systems
CO4: **Control** voltage using different methods; **Explain** for power system operation and control via Power System control Centres and SCADA

UNIT-I
Economic dispatch: Introduction, Characteristics of thermal, nuclear and hydro-generator UNITs.Economic dispatch problem – Thermal system dispatch with network losses – line loss formula.The Lambda iteration method– base point and participation factors – first order gradient method.
Unit Commitment - Introduction; Constraints-Thermal and Hydro; Solution methods-Priority list and Lagrange relaxation methods

UNIT-II
Hydro-Thermal Scheduling
Introduction,Hydro-Thermal Coordination, Scheduling of Hydro UNITs in a hydro-thermal system, Coordination of run-off river plant and steam plant, log-term coordination, short-term coordination- constant hydro generation method, constant thermal generation method, maximum hydro efficiency method; General mathematical formulation of long term hydro-thermal scheduling – solution of problem-discretization principle, solution technique, algorithm; Solution of short-term hydro-thermal scheduling problems – Kirchmayer’s method; Advantages of hydro-thermal scheduling

UNIT-III
Load frequency control: Importance, Definition of control area – single area control – Block diagram representation – steady state analysis – dynamic response – proportional plus integral control of single area block diagrams – AGC multi area system – modeling – static and dynamic response – tie line bias control – Inter connected systems; pole placement and optimal control (LQR) design applications of single area power system

UNIT-IV
Voltage control: Importance, sources and sinks of reactive power, modeling of AVR (Automatic Voltage Regulator) loop components, Excitation system stabilizer- Rate feedback and PID controllers, AGC including excitation system; Methods of voltage control- Excitation control (AVR), Shunt capacitors/reactors, series capacitors, Synchronous phase modifier, Tap changing and booster transformer – load compensation – line compensation
Computer control of power systems: Energy control centres – various levels – SCADA system – computer configuration functions – monitoring – data acquisition and controls – EMS system

References:
1. Hadi Saadat, “Power System Analysis” TMH
2. I J Nagrath& DP Kothari Modern power system analysis, 4/E, TMH

3. Allen J. Wood and Bruce F. Wollenberg "Power Generation, Operation & Control" 2nd edition, John Wiley and Sons.
4. J.J.Grainger, W.D.Stevenson JR, Power system analysis, Tata McGraw Hill, 2007.
5. AbhijitChakrabarti&SUNITaHalder, " Power System Analysis Operation and Control " 2/E, PHI
6. *S*. Sivanagaraju and G. Sreenivasan, "Power System Operation and Control", Pearson

15EEPS2004: ADVANCED POWER SYSTEM PROTECTION

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After the completion of the course the student will be able to:
CO1: **Implement** various microprocessor based relays.
CO2: **Analyze and design** Static relay schemes
CO3: **Develop** modelsof Digital relays
CO4: **Apply** AI methods to Power system protection.

UNIT -I
Microprocessor Base Relays:
Basics of Electromagnetic Relays, their disadvantages and advantages. Microprocessor Based Relays: Over Current relay, impedance relay, directional relay, reactance relay, Mho relay, offset Mho relay.

UNIT –II
Static Relays:
Basic Block diagram – Advantages of Static Relays – Comparators – Phase and amplitude Comparators. Operating principles–Static Over current relays – Differential relays – distance relays – Pilot relaying and Carrier current protection schemes – Protection of Transmission lines – 3–zone protection schemes – carrier aided distance schemes. Transformer protection – mal operation of relays – Harmonic Restraint relay

UNIT – III
Digital relays:
Developments in computer relaying mathematical basis for protective relaying algorithms, Differential equation based technique, Fourier based algorithms, Wavelet transforms based technique, Numerical Over current Protection, numerical Distance protection, Numerical Differential protection

UNIT – IV
AI Based Numerical Protection:
Application of ANN to over current protection, Application of ANN to Transmission line protection, Neural Networks Based Directional Relay, ANN modular approach for fault detection, classification and location, ANN Fuzzy based approach for fault classification Power transformer protection based on ANN & Fuzzy logic.

References:
1. Power System Protection – Static relays T.S.MadhavaRao, TMH, 2010.
2. Power System Protection and Switchgear 2/e, Badri Ram, TMH.
3. Digital Protection for Power Systems A.T.Johns and S.K.Salman, 1995.

15EEPS2005/1:HVDC TRANSMISSION SYSTEMS

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: **Analyze** the operation of current source and voltage source converters.

CO2: **Describe** the control principles of HVDC converters and **analyze** the harmonics of converters.

CO3: **Assess**the importance of grounding of HVDC systems and MTDC systems.

CO4: **Modeling** of HVDC system and **analysis** of converter faults, protection, AC-DC interactions.

UNIT- I

Introduction

HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration-Line commutated converters, Voltage source converters

Static Power Converters : 3-pulse, 6-pulse and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers- Analysis of Voltage source converters

UNIT-II

Harmonics and control of HVDC systems

Harmonics in HVDC Systems, Harmonic elimination- AC and DC filters, Filter design

Control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control, Control of VSC converters- General philosophy, different control levels, DC link control coordination control capability of VSC transmission

UNIT- III

Grounding and MTDC systems

Grounding and Ground electrodes for HVDC systems-Advantages and problems with ground return, Current field in the earth near an electrode, Resistance of an electrode, Distribution of current field between the electrodes, Natural current field due to earth's magnetic field, Effect of ground return on buried objects, Requirement of Electrodes, Basic parameters of design of ground electrodes, Design of land electrodes.

Multi-terminal DC links and systems; Types of MTDC systems, Control and Protection of MTDC Systems Study of MTDC Systems, Multi in-feed DC Systems, MTDC using VSC.

UNIT- IV

Converter faults protection and modeling

Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, DC circuit breakers. Over voltage protection of converters, surge arresters.

Modeling and analysis of ac-dc system interactions-

Component models for the analysis of AC/DC systems -Introduction, System Models, General Converter Models, Model of Converter Controller, Modeling of a DC Network, Modeling of AC Network, Power flow analysis of AC/DC systems with case study, interaction of AC/DC systems

References:

1. K.R.Padiyar, "*High Voltage Direct current Transmission*", New Age International (P) Ltd., Publishers, New Delhi, Reprint, 2010.
2. S Kamakshaiah,V.KamaRaju," *HVDC Transmission*", MC.Graw Hill Education Private Ltd, New Delhi, fifth Reprint, 2013
3. E.W. Kimbark, "*Direct current Transmission*", Wiley Inter Science – New York,
4. J.Arillaga, "*H.V.D.C.Transmission*", Peter Peregrinus ltd., London UK 1983.
5. Acha, Enrique, et al. FACTS: modelling and simulation in power networks. John Wiley & Sons, 2004.
6. Aik, Denis Lee Hau, and GoranAndersson. "Influence of load characteristics on the power/voltage stability of HVDC systems. I. Basic equations and relationships." Power Delivery, IEEE Transactions on 13.4 (1998): 1437-1444.

15EEPS2005/2: DIGITAL CONTROL SYSTEMS

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: Sample and **Analyze** discrete control systems using z-transforms.

CO2: **Analyze** stability of discrete control systems.

CO3: **Design** discrete control systems via pole placement.

CO4: **Design** observers for discrete control systems

UNIT-I

Discrete data and digital Control Systems – basic elements, advantages and disadvantages, examples, Impulse sampling and data hold – transfer functions of Zero order hold and First order hold. Reconstructing original signals from sampled signals – sampling theorem; ideal low pass filter, frequency response characteristics of the Zero order hold.

The Z-transform, Z transforms of some elementary functions; Important properties and theorems of the Z- transform, The inverse Z-transform, S-transform method for solving difference equations, the pulse transfer function, realization of digital controllers.

UNIT-II

Mapping between the s-plane and the z-plane - the Jury stability test - stability analysis by use of the bilinear transformation and Routh stability criterion. Liapunov stability analysis of discrete time systems.

Transient response specifications, steady state error analysis. Design based on frequency response method, Analytical design method.

UNIT-III

Concept of the state space method; State space representations of discrete time systems, solving discrete time state space equations. Discretization of continuous time state space equations;

Controllability – Observability - Principle of Duality, Design via pole placement necessary and sufficient condition.Ackerman's formula, Dead Beat response.

UNIT-IV

State observers – necessary and sufficient condition for state observation, full order state observer,minimum order state observer.

Microprocessor and DSP control: Microprocessor control of control systems, single-board controllers with custom-designed chips, DMC – 105 board, digital signal processors – TMS 320 DSPs, development system and support tools; Effects of finite word length and quantization on controllability and closed loop pole placement; Effect of quantization - least upper bound on quantization error.

References:

1. Discrete-time Control Systems, 2nd edition K.OGATA, Pearson Education Asia.
2. Digital Control Systems: 2nd edition, B.C.KUO, Oxford University Press

2005/3: DEREGULATED POWER SYSTEM

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: Describe the operation of deregulated electricity market systems

CO2: Analyze typical issues in electricity markets and how these are handled world-wide in various markets

CO3: Analyze various types of electricity market operational and control issues using new mathematical models

CO4: Illustrate about reforms in Indian power sector and Availability based tariff.

UNIT-I

Introduction, Deregulation of electric utilities, Competitive whole sale electricity market: Transmission expansion in new environment, Transmission open access, pricing electricity in deregulated environment

UNIT-II

Fundamentals of Deregulation: Privatization and deregulation, Motivations for Restructuring the Power industry; Restructuring models and Trading Arrangements: Components of restructured systems, Independent System Operator (ISO): Functions and responsibilities, Trading arrangements (Pool, bilateral & multilateral)

UNIT-III

Open Access Transmission Systems: Different models of deregulation: U K Model, California model, Australian and New Zealand models, Deregulation in Asia including India, Bidding strategies, forward and Future market; Operation and control: Old vs New, Available Transfer Capability, Congestion management, Ancillary services. Wheeling charges and pricing: Wheeling methodologies, pricing strategies

UNIT-IV

Reforms in Indian power sector, Framework of Indian power sector, National and Transnational Grids, The Independent Power Plants: Orissa Reform Model, Accelerated Power Development and Reforms Program (APDRP), Public-Private Partnership, The Availability Based Tariff (ABT)

References:

1. Yong-Hua song, Xi-Fan wang, "Operation of Market oriented Power systems", Springer, 2003
2. "Fundamentals of Power System economics", DanielKirschen and GoranStrbac, John Wiley & Sons Ltd, 2004.
3. Operation of restructured power systems Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, Kluwer Academic Pub., 2001.

15EEPS2005/4:POWER SYSTEM STATE ESTIMATION

Lecture :	4 Hrs/ Week	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: Describe the need for state estimation in power systems
CO2: Apply the weighted least square state estimation technique to power systems
CO3: Apply the alternative weighted least square state estimation techniques to power systems
CO4: Conduct network observability analysis for power systems

UNIT-I
Introduction to state estimation: Need for state estimation – Measurements – Noise - Measurement functions - Measurement Jacobian – Weights - Gain matrix - State estimation as applied to DC networks - Comparison of Power flow and State Estimation problems - Energy Management System.

UNIT-II
Weighted least square estimation: Modeling of transmission lines - Shunt capacitors and reactors - Tap changing and phase shifting transformers - loads and generators - Building network models - Maximum likelihood estimation - Measurement model and assumptions - WLS State Estimation Algorithm - Measurement functions - Measurement Jacobian matrix - Gain matrix - Cholesky decomposition and performing forward and backward substitutions - Decoupled formulation of WLS State estimation - DC State estimation model - Role of Phasor Measurement UNITs (PMU) in state estimation.

UNIT-III
Alternative formulation of WLS state estimation: Weakness of normal equation formulation, Orthogonal factorization, Hybrid method, Method of Peters and Wilkinsons, Equality constraints WLS State estimation, Augmented matrix approach, Blocked formulation and comparison of techniques.

UNIT-IV
Network observability analysis: Network and graphs, Network matrices, loop equations, Methods of Observability analysis, Numerical Method based on Nodal Variable formulation and branch variable formulation, Topological Observability analysis, Determination of critical measurements – Role of PMU in network observability.

References:

1. Ali Abur and Antonio Gomez Exposito ,"Power System State Estimation Theory and Implementation", Marcel Dekker, Inc., New York . Basel, 2004.
2. J J Grainger and W D Stevension, "Power System Analysis", McGraw-Hill, Inc., 1994.
3. A Monticelli, "State Estimation in Electric Power Systems", Kluwer Academic Publishers, 1999.
4. Mukhtar Ahmad, "Power System State Estimation", Lap Lambert Acad Publishers, 2013.
5. Felix L. Chernousko, " State Estimation for Dynamic Systems", CRC Press, 1993.
6. Naim Logic, "Power System State Estimation" ,LAP Lambert Acad. Publ., 2010.

15EEPS2006/1:SMART GRID DESIGN AND ANALYSIS

Lecture :	--	**Practical:**	-	**Internal Assessment:**	40
Credits :	2			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: Analyze the concepts and design of Smart grid
CO2: Apply various communication and measurement technologies in smart grid
CO3: Analyze stability of smart grid.
CO4: To learn the renewable energy resources and storages integrated with smart grid

UNIT-I
Smart grid concepts & architectural designs
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.
General view of the Smart grid market drivers - Stakeholder Roles and Functions - Measures - Representative Architecture - Functions of Smart Grid Components - Wholesale energy market in smart grid - smart vehicles in smart grid.

UNIT-II
Smart grid communications and measurement technology
Communication and standards - Communication and Measurement - Monitoring, Introduction to Smart Meters, Advanced Metering infrastructure (AMI)– (GIS and Google Mapping Tools) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection. Wide area monitoring systems (WAMS)

UNIT-III
Performance analysis tools for smart grid design
Introduction to Load Flow Studies - Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods - Load Flow State of the Art: Classical, Extended Formulations, and Algorithms –Load flow for smart grid design-Contingencies studies for smart grid.
Stability analysis tools for smart grid
Voltage Stability Analysis Tools - Voltage Stability Assessment Techniques-Voltage Stability Indexing-Application and Implementation Plan of Voltage Stability in smart grid-Angle stability assessment in smart grid-Approach of smart grid to State Estimation-Energy management in smart grid.

UNIT-IV
Renewable energy integration, storage & monitoring technologies
Renewable Energy Resources-Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug in Hybrid Electric Vehicles -PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources(Power Quality & EMC)- Web based Power Quality monitoring (Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over

Power line (BPL), IP based Protocols), Power Quality Audit, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

References:

1. James Momoh, "*Smart Grid: Fundamentals of design and analysis*", John Wiley & sons Inc, IEEE press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "*Smart Grid: Technology and Applications",* John Wiley & sons inc, 2012.
3. Fereidoon P. Sioshansi, *"Smart Grid: Integrating Renewable, Distributed & Efficient Energy",* Academic Press, 2012.
4. Clark W.Gellings, *"The smart grid: Enabling energy efficiency and demand response",* Fairmont Press Inc, 2009.

15EEPS2006/2: RENEWABLE POWER GENERATION TECHNOLOGIES

Lecture :	--	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: Aware of various forms of renewable energy.
CO2: Assess the cost of generation for conventional and renewable energy plants
CO3: Analyze suitable power controller for wind and solar applications
CO4: Develop mathematical models of renewable energy sources

UNIT-I
SOLAR ENERGY TECHNOLOGY
Recent trends in energy consumption – World energy scenario – Energy sources and their availability – Need to develop new energy technologies – Solar radiation and measurement – Solar cells and their characteristics – Electrical storage with batteries – Production and transfer of solar energy – Sun-Earth angles – Availability and limitations of solar energy – Solar thermal collectors – General description and characteristics – Flat plate collectors – Short term and long term collector performance – Solar concentrators – Design, analysis and performance evaluation. – Analysis of PV systems, Maximum Power point tracking algorithm.

UNIT-II
WIND ENERGY CONVERSION SYSTEM
Basic principle of wind energy conversion - nature of wind -Wind survey in India Site selection considerations– Power in the wind –components of a wind energy conversion system -Types of wind power conversion systems – Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis Performance of Induction Generators for WECS – Classification of WECS.

UNIT-III
BIO-MASS ENERGY
Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Concept of Bio-energy**:** Photosynthesis process, Biomass resources Bio based chemicals and materials Thermo-chemical Conversion: Pyrolysis, Combustion, Gasification, Liquification. Bio-Chemical Conversion: Aerobic and Anaerobic conversion, Fermentation etc.
Bio-fuels: Types of Bio-fuels, Bio fuel applications, Ethanol as a fuel for I.C. engines, Importance of biogas technology, Different Types of Biogas Plants. Aerobic and anaerobic bioconversion processes, various substrates used to produce Biogas. Removal of CO2 and H2O, Bio-hydrogen production.

UNIT-IV
GEOTHERMAL,OTEC AND HYBRID ENERGY SYSTEMS:
Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy. Ocean Thermal Electricity

Conversion (OTEC) ;Electricity generation from Waves : Shoreline and Floating wave systems.

Hybrid energy systems: wind-diesel system ,wind-PV system, biomass-PV-diesel system, geothermal -tidal and OTEC systems.

References:

1. Rai G.D., “Non – Conventional Energy Sources”, Khanna Publishers, 1993.
2. Rai G.D., “Solar Energy Utilisation”, Khanna Publishers, 1993.
3. Gary L. Johnson, “Wind Energy Systems”, Prentice Hall Inc., 1985.
4. Chakraverthy A, “Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes”, Oxford & IBH publishing Co, 1989.
5. Hand Book of Batteries and Fuel cells, 3rd Edition, Edited by David Linden and Thomas.B. Reddy, McGraw Hill Book Company, N.Y. 2002
6. Bansal N K, Kleeman and Meliss, *“Renewable energy sources and conversion Techniques”*, Tata McGraw hill, 1990.

15EEPS2006/3:ENERGY MANAGEMENT AND AUDITING

Lecture :	--	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: Describe the concept of energy audit, types, index and cost risk analysis with depreciation Techniques

CO2: Describe the analysis of load management, conservation of energy, power factor Improvement methods, energy efficient motors

CO3: Analyze energy saving studies on lighting system

CO4: Analyze the energy efficient controls and optimization

UNIT-I

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach,Energy audit instruments

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate ofreturn, Cash flows, Risk and sensitivity analysis; Financing options, Energy performancecontracts and role of ESCOs.

UNIT-II

Electrical System

Electricity billing, Electrical load management and maximum demandControl, Power factor improvement and its benefit, Selection and location of capacitors,Performance assessment of PF capacitors, Distribution and transformer losses.

Electric Motors

Types, Losses in induction motors, Motor efficiency, Factors affectingMotor performance, Rewinding and motor replacement issues, Energy saving opportunitieswith energy efficient motors &energy performance assessment of motors, variable speed drives

UNIT-III

Lighting System

Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues &energy performance assessment of lighting system

UNIT-IV

Energy Efficient Technologies- In Unit-Electrical Systems

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of eachTechnology.

References:

1. V. K. Mehta, Electrical Power, Khanna & Khanna Publishers,NewDehli
2. S. L. Uppal, Electrical Power, Khanna & Khanna Publishers,NewDehli
3. H. Partab, Art & Science of utilization of Electrical Energy DhanapatRai & Sons,New

Dehli

4. W.R.Murphy, G.Mckay.Energy Management: Elsevier,a division of (Butterworths).Reed Elsevier India Pvt. Ltd
5. Handbook on Energy efficiency W.C. Turner (John Wiley and,*S*ons A Wileinterscience publication)
6. www.bee-india.comBEE Reference book: no.1/3/4.

15EEPS2006/4: DISTRIBUTED GENERATION AND MICROGRID

Lecture :	--	**Practical:**	-	**Internal Assessment:**	40
Credits :	4			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to
CO1: Illustrate the concept of distributed generation
CO2: Analyze the impact of grid integration.
CO3: Study concepts of Micro-grid and its configuration

UNIT-I

Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, and Planning of DGs – Siting and sizing of DGs – optimal placement of DG sources in distribution systems.

UNIT-II

Grid integration of DGs – Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG UNITs. Energy storage elements: Batteries, ultra-capacitors, flywheels.

UNIT-III

Impact of grid integration- Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT-IV

MICROGRIDS

Concept and definition of microgrid, microgrid drivers and benefits, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids.Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues.

References:

1. H. Lee Willis, Walter G. Scott, 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000.
2. M.GodoySimoes, Felix A.Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press.
3. Robert Lasseter, Paolo Piagi, ' Micro-grid: A Conceptual Solution', PESC 2004, June 2004.
4. AmirnaserYezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modelling, Control and Applications", IEEE John Wiley Publications, 2009.
5. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.

15EEPS2051: POWER SYSTEMS LAB – II

Lecture :	--	**Practical:**	3Hrs/ Week	**Internal Assessment:**	40
Credits :	2			**Final Examination:**	60

Total a list of 12 experiments are given. Minimum of 8 experiments are to be conducted by the students.

List of experiments

1. Active and Reactive power control of SMIB
2. Characteristics of microprocessor based relays
3. Characteristics of numerical Impedance relay
4. Impulse test on insulator
5. Capacitance and loss tangent measurement of dielectrics
6. Performance of transmission lines using VAR compensation
7. Operation and performance analysis of Induction generator in the grid connected / self-excited modes
8. Characteristics of DC-DC buck &boost converter
9. Performance of single phase H-bridge Inverter
10. Short circuit analysis using AC network analyzer
11. Performance characteristics of energy efficient Induction motor
12. High voltage measurement using different electrodes

15EEPS2052: SIMULATION LAB – II

Lecture :	--	**Practical:**	3Hrs/ Week	**Internal Assessment:**	40
Credits :	2			**Final Examination:**	60

Total a list of 15 experiments are given. Minimum of 8 experiments are to be conducted by the students.

List of experiments

1. Load flow study using MiPower.
2. Contingency studies using load flows for generator & line outages using MiPower.
3. Transient Stability Studies using MiPower.
4. Voltage Instability Analysis
5. Solution of Economic load dispatch problem without and with losses using MATLAB/MiPower.
6. Simulation of single area and multi area LFC using MATLAB/SIMULINK.
7. AVR and Governor Modelling using Mipower
8. Small Signal Stability enhancement using PSS
9. Dynamic VAR Compensation Using SVC
10. Load Model and Load Shedding
11. Available Transfer Capability computation
12. Reactive Power Optimization
13. Observability Analysis and State Estimation
14. Harmonic Analysis using MiPower
15. Modelling and simulation SVC for stability studies.

15EEPS2053: SEMINAR

Lecture :	--	**Practical:**	3Hrs/ Week	**Internal Assessment:**	40
Credits :	2			**Final Examination:**	60

Course Outcomes: After completion of this course the student should be able to

CO1: Identify and analyze the real time power system problems

CO2: Acquire awareness on latest technology and current trends in the field of power systems

CO3: Document and present technical reports

CO4: Participate in discussions for enhancement of knowledge

CO5: Adapt professional ethics

The students are required to give a seminar individually on the recent topic in the field of electrical engineering relevant to Power Systems. The student shall submit title of the topic at least one week before presentation after doing thorough literature survey. Each student shall deliver at least two seminars during the semester. For Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation.

For Semester end evaluation, the student shall submit a report at the end of the semester and will give a seminar before the Departmental Committee. The Departmental Committee consists of Head of the Department, supervisor and two other senior faculty members of the department. For Seminar, the evaluation is done based on rubrics for 60 marks internally

15EEPS3051: PROJECT WORK PART-A

Lecture :	--	**Practical:**	--	**Internal Assessment:**	40
Credits :	10			**Final Examination:**	60

CO1: **Identify** the real world power system problems

CO2: **Analyze**, **design** and implement solution methodologies

CO3: **Apply** modern engineering tools for solution

CO4: **Write** technical reports following professional ethics

Project Work Part-A is part of the final M.Tech project. Students have to take up literature survey, formulate the problem of the project, define the project objectives and prepare the project implementation schedule. A certified report and two seminars are to be presented by the students.

The continuous evaluation of the project work Part-A is for 40 marks. The project has to be evaluated by a review committee and the day to day assessment by the supervisor. Total of 30 marks shall be awarded on the basis of two seminars by each student in a semester. The review committee consists of HOD, Programme coordinator, respective internal guide and two senior faculty members of the department with expertise in the respective specialization nominated by HOD.

The Semester End examination of the Project Work Part-A evaluated for 60 marks at the end of third semester. The semester end examination shall be evaluated by HOD, Programme coordinator and one of the senior Professors of the Department.

15EEPS4051: PROJECT WORK PART-B

Lecture :	--	**Practical:**	--	**Internal Assessment:**	40
Credits :	14			**Final Examination:**	60

CO1: **Identify** the real world power system problems

CO2: **Analyze**, **design** and implement solution methodologies

CO3: **Apply** modern engineering tools for solution

CO4: **Write** technical reports following professional ethics

Project work, based on the problem defined in 3rd semester should be continued and implemented in 4th semester. The implementation of the project work can be done either in a reputed industry/ research organization/ parent institute. Each student must give two seminars in front of Project Review Committee. The review committee consists of HOD, Programme coordinator, respective internal guide and two senior members of faculty of the department with expertise in the respective specialization nominated by HOD. The committee will meet two times after commencement of the project semester (IV) to review the project (first: in the middle of semester and second: after completion of the project, i.e before thesis write up).

A certified report on the project work should be submitted to the department based on the Project documentation guide lines given by the department. Project part – B shall be evaluated by a project evaluation committee consisting of the Head of the Department, project internal guide and an external examiner approved by the Principal from a panel submitted by the HOD. The rubrics for evaluation of semester end examination shall be defined by the Project review committee for Part B.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1: Graduates will contribute to academia and/or industry in the field of electrical power

PEO2: Graduates will solve complex power system problems which are **economically feasible and socially acceptable**

PEO3: Graduates will exhibit **professionalism**, team work communication skills, and adapt to current trends by engaging in **lifelong learning**

PROGRAM OUTCOMES

PO1: The graduates have an ability to apply higher order thinking for enhancement of knowledge by acquiring in-depth knowledge of electrical power systems.

PO2: Ability to analyze complex engineering problems critically and synthesize information independently to make intellectual (or) create advances.

PO3: Able to think laterally and arrive at an optimal solution to engineering problems considering health and environmental factors.

PO4: Able to conduct research pertinent to unfamiliar problems individually/ in team to generate a new scientific (or) technological knowledge.

PO5: Ability to use modern Engineering and IT tools to solve complex power system problems.

PO6: An ability to contribute effectively either individually (or) in group on collaborative multidisciplinary scientific research tasks.

PO7: Ability to manage projects efficiently by consideration of economical and financial factors

PO8: Able to communicate effectively in writing, in personal presentation and in conversation of technical project information.

PO9: Ability to adapt lifelong learning skills to improve knowledge and competency.

PO10: Ability to acquire professional ethics and contributing research outcomes for sustainable development of society.

PO11: Ability to adapt independent and reflective learning methods.