ACADEMIC REGULATIONS

Course Structure & Detailed Syllabus
of
POWER SYSTEMS
for
M.Tech. Regular Two Year Degree Program
(For the batches admitted from 2022-2023)

KSRM College of Engineering (Autonomous):: Kadapa

(Approved by AICTE, Affiliated to JNTUA, Anantapuramu, Accredited by NAAC)

(An ISO 9001-2008 Certified Institution)

K.S.R.M College of Engineering, Kadapa-516003, AP

Vision

To evolve as centre of repute for providing quality academic programs amalgamated with creative learning and research excellence to produce graduates with leadership qualities, ethical and human values to serve the nation.

Mission

- To provide high quality education with enriched curriculum blended with impactful teaching-learning practices.
- To promote research, entrepreneurship and innovation through industry collaborations.
- To produce highly competent professional leaders for contributing to Socio-economic development of region and the nation.

Department of Electrical and Electronics Engineering

Vision

To emerge as a department of excellence in the domain of Electrical and Electronics Engineering producing globally competent engineers with research acumen having moral and social values.

Mission

- To offer education with skill-based curriculum through innovative pedagogy, enabling the students to engage in lifelong learning.
- To establish industry interactions for creating research-oriented culture to invoke the desire among the students for pursuing successful career.
- **M3:** To maintain sustainable environment of learning in which students acquire knowledge and imbibed with social and ethical values.

Program Educational Objectives

Program Educational Objectives of the Electrical and Electronics Engineering provides the following wide aspects in connection with the Vision and Mission of the department.

- To pursue higher studies or be employed in Electrical and Electronics Engineering or relevant disciplines.
- To analyze real life problems and design Electrical and Electronics Engineering systems with appropriate solutions that are technically sound, economically feasible and socially acceptable.
- To exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning

Regulations for PG Programs in Engineering (R22PG)
(Effective from 2022-23)

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Regulations for PG Programs in Engineering (R22PG)

1.0 Nomenclature

1.1 *Academic Year*: Academic Term of, approximately, one year duration that usually starts in June/July and ends in April/May next
1.2 *Semester*: Either of two Academic Terms that make up an Academic Year
1.3 *Major*: A specific field of study
1.4 *Minor*: An area outside of, or complementary to, a Major
1.5 *Subject*: An area of knowledge that is studied as part of a Course
1.6 *Core*: A subject that is mandatory for a Major course of study
1.7 *Elective*: A subject that is selected for study to suit one's individual needs
1.8 *Audit Subject*: A subject that is studied to meet certain requirements but has no credits assigned to it
1.9 *Humanities subjects*: Subjects that describe and interpret human achievements, problems and historical changes at individual and societal levels covering the disciplines of literature, history, and philosophy
1.10 *Social Sciences subjects*: Subjects that describe the mental and behavioural activities of individuals, groups, organizations, institutions, and nations covering the disciplines of anthropology, economics, linguistics, political science, and psychology
1.11 *Exam*: A test to measure one's progress, knowledge, or ability in a subject
1.12 *Credit*: A numerical weight given to a subject
1.13 *Grade*: A numerical or alphabetic designation measuring the level of achievement in an exam
1.14 *Attendance*: Physical presence of oneself in a classroom/laboratory for purpose of a scheduled academic instruction
1.15 *Course*: A series of subjects that constitute a Major field of study
1.16 *Branch*: Same as Course
1.17 *Program*: Same as Course
1.18 *Specialization*: Same as branch
1.19 *Degree*: An academic title conferred to honour distinguished achievement

2.0 Short Title and Application

2.1 These rules and regulations may be called as R22PG and come into force from Academic Year 2022-23 and exist until superseded by new regulations
2.2 These rules and regulations are applicable to all post graduate courses in engineering and technology leading to Master's Degree in Technology (M. Tech)
2.3 The Specializations offered, at present, are:
  2.3.1 Geotechnical Engineering, Code - 12
  2.3.2 Power Systems, Code - 07
  2.3.3 Renewable Energy, Code - 99
  2.3.4 Embedded Systems and VLSI, Code - 84
  2.3.5 Artificial Intelligence and Data Science, Code - 98

2.4 The Institute may offer new Specializations in future to which these rules and regulations will be applicable.

3.0 Suspension and Amendment of Rules

3.1 Academic Council has the authority to suspend a rule temporarily.

3.2 Academic Council has the authority to amend a rule.

3.3 For affirmative action on any suspension or amendment of a rule, an affirmative vote of three-fifths of the members present and voting shall be required in Academic Council.

4.0 Requirements for Admission

4.1 At present, admissions into first semester of various Specializations are governed by Government and the Affiliating University. The eligibility criteria and procedure for admission are prescribed by Government and Affiliating University.

4.2 A student is not allowed change of Specialization after admission.

4.3 A student must fulfil medical standards required for admission.

4.4 The selected students are admitted into first semester after payment of the prescribed fees.

5.0 Structure of the M. Tech course

5.1 *Duration*: The duration of M. Tech degree course is four semesters

5.2 *Working Days*: Calendar for any semester shall be announced at least four weeks before its commencement. Minimum number of working days is 90 per semester.

5.3 *Curriculum*: Each Specialization shall have core, elective and audit subjects. The curriculum for each Specialization shall be approved by its corresponding Board of Studies and then by the Academic Council.

5.4 *Credits*: All subjects that are assessed for marks have credits assigned to them. The credits assigned to subjects shall be given in curriculum. The total number of credits for entire course is 70 for all Specializations. The distribution of total credits semester-wise is given in Table 1.

Table 1 Semester-wise Total Credits:

Semester	Total Credits
First Semester	18
Second Semester	18
Third Semester	18
Fourth Semester	16
Total for entire course	**70**

5.5 The curriculum and syllabus is given in Annexure-1 and Annexure-2 respectively

5.6 Responsibility and Advising: It is the responsibility of the student to understand and know the regulations and requirements to earn the degree. Each student admitted in to the degree programs is assigned to a Faculty Advisor who assists

the student in designing an effective program of study. Students should consult their Faculty Advisors for selection of electives and for general advice on academic program.

5.7 All subjects/courses offered for the M.Tech. degree programme are broadly classified as follows:

S.No.	Broad Course Classification	Course Category	Description
1.	Core Courses	Foundational & Professional Core Courses (PC)	Includes subjects related to the parent discipline/department/branch of Engineering
2.	Elective Courses	Professional Elective Courses (PE)	Includes elective subjects related to the parent discipline/department/ branch of Engineering
		Open ElectiveCourses (OE)	Elective subjects which include inter - disciplinary subjects or subjects in an area outside the parent discipline which are of importance in the context of special skill development
3.	Research	Research Methodology & IPR	To understand importance and process of creation of patents through research
		Technical Seminar	Ensures preparedness of students to undertake major projects/Dissertation, based on core contents related to specialization
		Co-curricular Activities	Attending conferences, scientific presentations and other scholarly activities
		Dissertation	M.Tech. Project or Major Project
4.	Audit Courses	Mandatory noncredit courses	Covering subjects of developing desired attitude among the learners is on the line of initiatives such as Unnat Bharat Abhiyan, Yoga, Value educationetc.

6.0 Registration and Enrolment

6.1 Prior to opening of each semester, every student shall register for all the credit-bearing and audit subjects listed in curriculum of the semester. Excepting first semester, the registration for a semester shall be done during a specified week after end examinations of previous semester. In first semester, the registration shall be done within six working days from date of opening. Recommendation of Faculty Advisor is needed for registration.

6.2 Late registration will be permitted with a fine, decided from time to time, up to six working days from the last date specified for registration.

6.3 A student will be eligible for registration for a semester if she or he i) is promoted to that semester, ii) has cleared all fees to the Institute, library and hostel of previous semester, and iii) is not disqualified for registration by a disciplinary action of the Institute.

6.4 A student will be enrolled and allowed to attend the classes on successful registration and payment of necessary fees to Institution, library, and hostel.

6.5 Registration and enrolment will be controlled by the Office of the Controller of Examinations.

7.0 Assessment Procedure – Internal Tests and End Examinations

7.1 Performance of students in all subjects is assessed continuously through internal assessment tests and an End examination.

7.2 Allocation of internal assessment and End examination marks.

7.2.1 For theory subjects, the allocation is 40 marks for internal assessment and 60 marks for End examination totalling 100 marks.

7.2.2 For laboratory/project work subjects, the allocation is 50 marks for internal assessment and 50 marks for End examination totalling 100 marks.

7.2.3 For mini-project/mini-project with seminar total 100 marks are allocated for internal assessment. There shall be no end examination for this mini-project.

7.2.4 For all audit subjects the allocation is 40 marks for internal assessment and no allocation for End examination.

7.3 Internal Assessment Examinations

7.3.1 Internal assessment means performance evaluation of students by faculty members who teach the subjects.

7.3.2 For theory subjects, including audit subjects, the internal assessment shall be done by midterm tests. For each subject, two midterm tests will be conducted for 40 marks each and the internal assessment mark is the better of two marks. If any student abstains for any midterm test, she or he will be awarded zero marks for that midterm test. There shall be no choice of questions in midterm tests.

7.3.3 For laboratory/practical subjects, the internal assessment will be based on regular laboratory work over full semester. The assessment will be done by the faculty concerned. The students shall be informed sufficiently early of the procedure to be followed for internal assessment.

7.3.4 There shall be a **Technical Seminar** during II semester for internal evaluation of 100 marks. 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 Project Review Committee consisting of Head of the Department, two other senior faculty members and faculty guide of the concerned student. The student has to secure a minimum of 50% of marks, to be declared successful. If he fails to obtain the minimum marks, he has to reappear for the same as and when supplementary examinations areconducted. The Technical seminar shall be conducted anytime during the semester as per the convenience of the Project Review Committee and students. There shall be no external examination for Technical Seminar.

7.3.5 There shall be Mandatory **Audit courses** in I & II semesters for zero credits. There is no external examination for audit courses. However, attendance shall be considered while calculating aggregate attendance and student shall be declared to have passed the mandatory course/audit course only when he/she secures 50% or more in the internal examinations. In case, the student fails, a re- examination shall be conducted for failed candidates for 40 marks.

7.3.6 For subjects like project-work and industrial training, the internal assessment will be done by a concerned Department Committee consisting of two senior faculty members and faculty guide of concerned student. The assessment procedure will be informed sufficiently early to the students.

7.4 End examinations

7.4.1 End examinations shall be conducted after completion of coursework in each semester.

7.4.2 The question papers for theory subjects shall be set by faculty members outside of the Institute. The external faculty members for question paper setting will be selected by the Principal.

7.4.3 Evaluation of answer scripts shall be done by faculty members from outside of the Institute selected by the Principal.

7.4.4 For laboratory subjects, end examination shall be conducted by a committee consisting of two internal examiners. One examiner shall be recommended by Head of Department of concerned Major, and the other examiner shall be appointed by the Principal.

7.4.5 For project work viva-voce, End examination shall be conducted by a committee consisting of one internal examiner, one external examiner, and the concerned guide of the student. Internal examiner shall be appointed by Head of Department of concerned Major, and the external examiner shall be appointed by the Principal.

7.4.6 If a student abstains from End examination of any subject, for any reason, she or he shall be awarded zero marks in that subject.

7.4.7 There is no end examination for audit subjects.

8.0 Method of Assigning Letter Grades and Grade Points

8.1 For all credit-bearing subjects, performance of a student in a subject is indicated by a letter grade that corresponds to absolute marks earned in that subject. Each letter grade is assigned a numeric Grade Point that is used to compute Grade Point Average on a scale of 0 to 10.

8.2 Performance of a student in both internal assessment and End examination will be considered for awarding grades for credit bearing subjects. Total marks earned in a subject is the sum of marks obtained in internal and End examinations in that subject.

8.3 Pass grade A+ to D+ is assigned to a subject based on total marks earned in that subject provided that a student earns at least i) 35% of marks in End examination

marks and ii) 50% of marks in internal and End examination marks put together; otherwise fail grade F will be assigned to that subject.

8.4 Grade I will be assigned to a subject if a disciplinary action is pending and is not resolved before publication of results. Office of Controller of Examinations shall resolve the pending disciplinary action within six working days from the date of publication of results and change the grade to any of A+ to D+ or F.

8.5 Grade X will be assigned to a subject if a student abstains for End examination of that subject.

8.6 The absolute marks and corresponding letter grade and grade points are given in Table2

Table 2: Letter Grades and Grade Points

Absolute Marks	Letter Grade	Grade Points	Remark
90-100	S (Out Standing)	10.0	Pass
80-89	A (Excellent)	9.0	Pass
70-79	B (Very Good)	8.0	Pass
60-69	C (Good)	7.0	Pass
50-59	D (Pass)	6.0	Pass
<50	F (Fail)	0.0	Fail
Absent	AB (Absent)	0.0	Fail
---	I	0.0	Result Withheld

8.7 *SGPA*: Semester Grade Point Average indicates the performance of a student in all credit-bearing subjects of a semester. SGPA is calculated as the weighted average of Grade Points of all subjects of the semester with corresponding credits of subjects as weights. Audit subjects are not considered for SGPA calculation.

8.8 *CGPA*: Cumulative Grade Point Average indicates the performance of a student in all terms up to and including the current semester under consideration. CGPA is calculated as the weighted average of SGPAs with total credits in each semester as the weights.

8.9 *Grade Card*: All students shall be issued Grade Cards after the publication of results of a semester. Grade Card is a statement of performance of a student in a semester. It contains information about each registered subject: type of subject, allocated credits, and letter grade earned. SGPA and CGPA will also be indicated.

8.10 CGPA to Percentage Conversion:

$$\text{Percentage} = (\text{CGPA} - 0.5) * 10$$

9.0 Credit Transfer Policy

As per University Grants Commission (Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016, the University shall allow up to a

maximum of 40% of the total courses being offered in a particular Programme in a semester through the Online Learning courses through SWAYAM.

9.1 The University shall offer credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online learning courses through SWAYAM platform.

9.2 The online learning courses available on the SWAYAM platform will be considered for credit transfer. SWAYAM course credits are as specified in theplatform.

9.3 Student registration for the MOOCs shall be only through the institution, it is mandatory for the student to share necessary information with the institution.

9.4 The institution shall select the courses to be permitted for credit transfer through SWAYAM. However, while selecting courses in the online platform institution would essentially avoid the courses offered through the curriculum in the offline mode.

9.5 The institution shall notify at the beginning of semester the list of the online learning courses eligible for credit transfer in the forthcoming Semester.

9.6 The institution shall also ensure that the student has to complete the course and produce the course completion certificate as per the academic schedule given for the regular courses in that semester

9.7 The institution shall designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.

9.8 The college shall ensure no overlap of SWAYAM MOOC exams with that of the college end examination schedule. In case of delay in SWAYAM results, the university will re-issue the marks sheet for such students.

9.9 Student pursuing courses under MOOCs shall acquire the required credits only after successful completion of the course and submitting a certificate issued by the competent authority along with the percentage of marks and grades.

Note: Students shall also be permitted to register for MOOCs offered through online platforms other than SWAYAM NPTEL.

10.0 Re-registration for Improvement of Internal Evaluation Marks

A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and has failed in the end examination

10.1 The candidate should have completed the course work and obtainedexaminations results for **I, II and III** semesters.

10.2 The candidate shall be given one chance for each Theory subject and for a maximum of **three** Theory subjects for Improvement of Internal evaluation marks.

10.3 The candidate has to re-register for the chosen subjects and fulfil the academic requirements.

10.4 For reregistration the candidates have to apply to the college by paying the requisite fees, before the start of the semester in which re-registration is required

10.5 In the event of availing the Improvement of Internal evaluation marks, the internal

evaluation marks as well as the End Examinations marks secured in the previous attempt(s) for the reregistered subjects stand cancelled.

11.0 Credits for Co-curricular Activities

A Student shall earn 02 credits under the head of co-curricular activities, viz., attending Conference, Scientific Presentations and Other Scholarly Activities. Following are the guidelines for awarding Credits for Co-curricular Activities:

Name of the Activity	Maximum Credits / Activity
Participation in National Level Seminar / Conference / Workshop / Training programs (related to the specialization of the student)	1
Participation in International Level Seminar / Conference / workshop/Training programs held outside India (related to the specialization of the student)	2
Academic Award/Research Award from State Level / National Agencies	1
Academic Award/Research Award from International Agencies	2
Research / Review Publication in National Journals (Indexed in Scopus/Web of Science)	1
Research / Review Publication in International Journals with Editorial board outside India (Indexed in Scopus / Web of Science)	2
Vocational Course / Certificate Course (Minimum 36 hours)	2

Note:

i) Credit shall be awarded only for the first author. Certificate of attendance and participation in a Conference/Seminar is to be submitted for awarding credit.

ii) Certificate of attendance and participation in workshops and training programs (Internal or External) is to be submitted for awarding credit. The total duration should be at least one week.

iii) Participation in any activity shall be permitted only once for acquiring required credits under co-curricular activities.

12.0 Requirements for Completing Subjects

12.1 A student shall complete all credit-bearing and audit subjects successfully to be eligible for award of degree

12.2 *Credit-bearing subjects*: A student is considered to have completed a credit-bearing subject successfully and earned credits if she or he obtains a pass grade from A+ to D+ in that subject. If a student receives fail grade F or X in any subject, she or he must register for supplementary End examination for that subject as and when opportunity arises and improve grade to pass grade

12.3 *Audit subjects*: A student is considered to have successfully completed an audit subject if she or he earns at least 40% of marks in internal assessment marks.

Supplementary exam for audit subjects: If a student fails in audit subject, she or he shall register for supplementary examination in that subject as and when the opportunity arises and pass that subject. The supplementary exam will be conducted for 40 marks covering the entire syllabus and student is deemed to have passed in the subject if she or he earns 16 marks (40% marks) in the supplementary exam, disregard of her or his performance in internal tests.

13.0 Requirements for taking End Examinations

13.1 A student is eligible to take regular End Examinations of current semester if she or he full fills the attendance requirement.

13.2 A student shall be promoted from current semester to succeeding semester on satisfying the attendance requirement.

13.3 A student shall complete all credit-bearing and audit subjects successfully before taking End examination for project viva-voce.

13.4 Attendance Requirement

13.4.1 Attendance of students shall be recorded for credit-bearing and audit subjects as per the workload indicated in curriculum.

13.4.2 Total class-periods conducted shall be reckoned from beginning to end of a semester as published in academic calendar.

13.4.3 Aggregate Percentage of Attendance is calculated using total number of class-periods attended as numerator and total number of class-periods conducted for the concerned subject as the denominator.

13.4.5 A minimum aggregate attendance of 75% is required for promotion to succeeding semester.

13.4.6 A student can appeal to the Principal for condoning deficiency in aggregate attendance if she or he gets 65% or more aggregate attendance presenting a valid reason for deficiency. Such a student will be granted promotion if the Principal pardons the deficiency. Principal has the right to reject the appeal if it is not satisfied with the performance of the student or the reason cited for deficiency of the attendance.

13.4.7 A student earning less than 75% aggregate attendance will be denied promotion. A student who is not promoted on basis of attendance shall be removed from the rolls and shall register for the same semester when opportunity arises. The current semester record of the student is cancelled automatically.

14.0 Revaluation of End Examination Scripts

14.1 Revaluation of End Examination scripts is allowed for theory subjects only by paying requisite fee.

14.2 A Procedure for Revaluation: The script will be revaluated by an examiner appointed by the Principal. The maximum of revaluation and regular end examination marks will be awarded for that subject.

14.3 A student can apply for revaluation in a subject only once.

15.0 Supplementary End Examinations

15.1 Students are eligible to take Supplementary examinations in subjects with fail grade F or X only.

15.2 Supplementary examinations for even semester subjects will be conducted with regular examinations of odd semester subjects and vice versa.

15.3 A student will be allowed to improve grade in any theory subject provided she or he has completed coursework of all semesters but before award of provisional/final degree.

16.0 Requirements for Award of M. Tech degree

16.1 Time Limit for completion of requirements for award of degree is four calendar years from the date of admission. A student who could not complete all the requirements in this time limit shall forego admission and will be removed from the rolls of the Institute.

16.2 A student shall be eligible for award of degree provided she or he has:

16.2.1 Registered and successfully completed all required credit-bearing and audit subjects with a total of 68 credits.

16.2.2 Secured a CGPA of 5.5 or more.

16.2.3 Cleared all dues to the Institute, library and hostel.

16.2.4 No disciplinary action is pending against her or him.

8.10.5 Satisfied any other stipulation of the affiliating University.

16.3 Award of Class: Each student will be given class in degree based on CGPA as given in Table 3.

Table 3 Class of Degree

Class of Degree	Range of CGPA
Second Class	>= 5.5 but <6.5
First Class	>= 6.5 but <7.5
First Class with Distinction	>= 7.5

16.4 Consolidated Grade Card and Degree will issued under the seal of affiliating University

17.0 Transitory Regulations

17.1 A student who initially joins the Institute in a previous Regulation and has to re-join in any semester of the present Regulations, due to any reason, shall be bound by the rules of the current Regulations. Board of Studies of the concerned Major will specify, extra or otherwise, academic coursework to be undertaken by such students who re-join the current Regulations

Rules for Disciplinary Action for Malpractice / Improper Conduct inExaminations

S. No	Nature of Malpractice/Improper conduct	Punishment
1.	Possesses or keeps accessible, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in examination hall in which he is appearing but has not made use of (material shall include any marks on the body of the student which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance only in that subject.
2.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
3.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject.
4.	Gives / receives assistance or guidance from any other student orally or by communicatingbody language.	Expulsion of both from the examination hall and cancellation of the performance only in that subject.
5.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the student is appearing.	If copied material is related to the concerned subject and if that material is related to question paper then expulsion from the examination hall and cancellation of the performance in that subject and all other subjects including practical examinations and project workof that semester/year, otherwise expulsion from that subject only.
6.	Enters in a drunken state to the examination hall.	Expulsion from the examination hall and cancellation of performance in all subjects of the semester/year including practical examinations and projectwork.
7.	Smuggles in the Answer book or takes out or arranges to send out the question paper during the examination or answer book during or after the examination	Expulsion from the examination hall and cancellation of performance in all subjects of the semester / year including practical examinations and projectwork.
8.	Any outsider or impersonator found in and oroutside the examination hall.	Handing him over to the police and registering a case against him.

M. Tech. Power Systems (PS)

Course Structure and Syllabus for the 2022-23 Batch

I-Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2252101	Advanced Power System Protection	PCC	3	0	0	40	60	3
2	2252102	Power System Dynamics - I	PCC	3	0	0	40	60	3
		Professional Elective Course – I (PEC - I)							
3	2252103	Energy Conversion Systems	PEC	3	0	0	40	60	3
	2252104	Smart grid Technologies	PEC	3	0	0	40	60	3
	2252105	Wind and Solar Energy Systems	PEC	3	0	0	40	60	3
		Professional Elective Course – II (PEC - II)							
4	2252106	Electrical Power Distribution System	PEC	3	0	0	40	60	3
	2252107	Mathematical Methods in Power Engineering	PEC	3	0	0	40	60	3
	2252108	Electric and Hybrid Vehicles	PEC	3	0	0	40	60	3
5	2252109	Research Methodology and IPR	--	2	0	0	40	60	2
6	2252110	Power System Lab - I	PCC	0	0	4	50	50	2
7	2252111	Power System Simulation Lab-I	PCC	0	0	4	50	50	2
8	---	Audit Course I	AC	2	0	0	40	00	00
Total				16	00	08	340	400	18

II Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2252201	Power System Security and State Estimation	PCC	3	0	0	40	60	3
2	2252202	Power System Dynamics - II	PCC	3	0	0	40	60	3
3		Professional Elective Course – III (PEC- III)							
	2252203	Restructured Power Systems	PEC	3	0	0	40	60	3
	2252204	Energy Auditing and Management	PEC	3	0	0	40	60	3
	2252205	Electrical Machine Design	PEC	3	0	0	40	60	3
4		Professional Elective Course – IV (PEC- IV)							
	2252206	SCADA System and Applications	PEC	3	0	0	40	60	3
	2252207	Electrical Power Quality	PEC	3	0	0	40	60	3
	2252208	Power System Reliability	PEC	3	0	0	40	60	3
5	2252209	Technical Seminar	PCC	0	0	4	100	00	2
6	2252210	Power System Lab – II	PCC	0	0	4	50	50	2
7	2252211	Power System Simulation Lab-II	PCC	0	0	4	50	50	2
8	---	Audit Course II	AC	2	0	0	40	00	00
Total				14	00	12	340	340	18

III - Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1		Professional Elective Course – V (PEC- V)							
	2252301	Power System Transients	PEC	3	0	0	40	60	3
	2252302	Industrial Load Modeling and Control	PEC	3	0	0	40	60	3
	2252303	Modern Control Theory	PEC	3	0	0	40	60	3
2		Open Elective (OEC)							
	2271304	Business Analytics	OEC	3	0	0	40	60	3
	2271305	Operations Research	OEC	3	0	0	40	60	3
	2271306	Waste to Energy	OEC	3	0	0	40	60	3
3	2252307	Dissertation Phase - I	PR	0	0	20	100	00	10
4	2252308	Co-curricular Activity	R	0	0	0	--	--	2
Total				6	0	20	180	120	18

IV Semester

S. No.	Subject Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	2252401	Dissertation Phase - II	PR	0	0	32	50	50	16
		Total		0	0	32	50	50	16

Audit course I & II

S. No.	Course Code	Course Name
1	2270A01	English for Research Paper Writing
2	2270A02	Disaster Management
3	2270A03	Sanskrit for Technical Knowledge
4	2270A04	Value Education
5	2270A05	Constitution of India
6	2270A06	Pedagogy Studies
7	2270A07	Stress Management by Yoga
8	2270A08	Personality Development through Life Enlightenment Skills

List of Open Elective Courses offered to other branch students:

Course Codes	Course Name
22OE521	Internet of Things
22OE522	Programmable Logic Controller (PLC) & its Applications
22OE523	Power Electronics for Renewable Energy Systems

I – Semester

<table>
<tr><td>Course Title</td><td colspan="4">Advanced Power System Protection</td><td colspan="3">M. Tech., I Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252101</td><td rowspan="2">Professional Core (PCC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to learn about numerical relays, algorithms for numerical protection and developing mathematical approach towards protection.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Learn the importance of Digital Relays</td></tr>
<tr><td>CO 2</td><td colspan="7">Apply Mathematical approach towards protection</td></tr>
<tr><td>CO 3</td><td colspan="7">Learn to develop various Protection algorithms</td></tr>
</table>

UNIT - I

Introduction: Evolution of Digital Relays from Electromechanical Relays, Performance and Operational Characteristics of Digital Protection.

UNIT - II

Mathematical Background to Protection Algorithms: Finite Difference Techniques, Interpolation Formulas: Forward, Backward and Central Difference Interpolation, Numerical Differentiation, Curve Fitting and Smoothing, Least Squares Method, Fourier analysis, Fourier series and Fourier Transform, Walsh Function Analysis.

UNIT - III

Basic Elements Of Digital Protection: Signal Conditioning: transducers, Surge Protection, Analog Filtering, Analog Multiplexers, Conversion Subsystem Sampling Theorem, Signal Aliasing Error, Sample And Hold Circuits, Multiplexers, Analog To Digital

Conversion, Digital Filtering Concepts, The Digital Relay as a Unit Consisting Of Hardware and Software.

UNIT - IV

Sinusoidal Wave Based Algorithms: Sample and First Derivative (Mann and Morrison) algorithm. Fourier and walsh based Algorithms.

Fourier Algorithm: Full Cycle Window algorithm, Fractional Cycle Window algorithm. Walsh Function Based Algorithm. Least Squares based algorithms. Differential Equation Based Algorithms.

UNIT - V

Travelling Wave based Techniques: Digital Differential Protection of Transformers. Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems.

Reference Books:

1. A.G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", Wiley/Research studies Press, 2009.
2. A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEE Press, 1999.
3. Gerhard Zeigler, "Numerical Distance Protection", Siemens Publicis Corporate Publishing, 2006.
4. S.R.Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014.

Course Title	**Power Systems Dynamics - I**					M. Tech., I Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
2252102	**Professional Core (PCC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs						**End Exam Duration : 3Hrs**		

Course Objectives: The objective of the course is to learn concepts of system dynamics and its physical interpretation, development of mathematical models for synchronous machine, modelling of induction motor.

On successful completion of this course, the students will be able to

CO 1	Understand the modeling of synchronous machine in detail.
CO 2	Carry out simulation studies of power system dynamics using MATLAB/ SIMULINK.
CO 3	Carry out stability analysis with and without power system stabilizer
CO 4	Understand the load modeling in power system

UNIT-I

Modelling of Synchronous Machine: Synchronous machine – Park's Transformation-analysis of steady state performance, per - unit quantities-Equivalent circuit of synchronous machine.

UNIT-II

Steady State Analysis: Voltage, Current and Flux Linkage relationships, Steady state equivalent circuit, Formulation of State Space Model.

UNIT-III

Sub-Transient and transient inductance and Time Constants, Synchronous Machines Simplified model.

UNIT-IV

Excitation System: Effects of Excitation system, PSS-Block Diagram, System State matrices (Type Systems).

UNIT-V

Modelling of Induction Motors: Basic Equations, d-q Transformations, Steady State Characteristics, Equivalent Circuits, Effect of rotor resistance, Modelling of Prime Movers.

Text Books:

1. P.M. Anderson & A.A. Fouad, "Power System Control and Stability", IEEE Press.
2. Power system Stability and Control, P. Kundur, TMH.
3. Power system Analysis and Design, William D Stevenson, John J Grainger, TMH.

Reference Books:

1. Power Systems Dynamics and Stability, M.A.Pai- PHI Publications.
2. Power system dynamics, K.R. PADIYAR - B.S. Publications.

<table>
<tr><td>Course Title</td><td colspan="4">Energy Conversion Systems (PE-I)</td><td colspan="3">M. Tech., I Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252103</td><td rowspan="2">Professional Elective (PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to learn various renewable energy sources, understanding of integrated operation of renewable energy sources and Power Electronics Interface with the Grid.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Knowledge about renewable energy.</td></tr>
<tr><td>CO 2</td><td colspan="7">Understand the working of distributed generation system in autonomous/grid connected modes.</td></tr>
</table>

CO 3	Know the Impact of Distributed Generation on Power System

UNIT - I

Introduction, Distributed Vs Central Station Generation, Various non - Conventional energy sources, availability, classification merits and demerits.

UNIT - II

Introduction to solar Energy, Theory of Solar Cells, Solar cell materials, Solar Cell array, solar radiation, Flat Plate Collectors, Focussing Plate Collectors, Solar Thermal Power Plants.

UNIT - III

Introduction to wind energy, wind power and its Sources, Site Selection, criterion, Classification of rotors, wind characteristics, Performance and limitations of energy conversion Systems.

UNIT - IV

Resources of geothermal energy, Thermo dynamics of geothermal energy conversion electrical conversion, non - electrical Conversion, environmental considerations.

UNIT - V

Tidal energy – Tides and tidal power stations- modes of operation – Turbines & Generators for Tidal Power Generation.

Fuel Cells-Working Principle, types of Fuel Cells, Performance and limitations.

Text Books:

1. RanjanRakesh, Kothari D.P, Singal K.C, "Renewable Energy Sources and Emerging Technologies, 2nd Ed. Prentice Hall of India, 2011.
2. Rakosh Das Begamudre, "Energy Conversion systems", New Age International Publishers.

Reference Books:

1. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators",October 2007, Wiley-IEEE Press.
2. Roger A.Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed, 2010.
3. James F.Manwell, Jon G.McGowan, Anthony L Rogers, "Wind energy explained: Theory Design and Application", John Wiley and Sons 2nd Ed, 2010.

Course Title	**Smart Grid Technologies (PE-I)**				M. Tech., I Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**	
2252104	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs						**End Exam Duration : 3Hrs**		
Course Objectives: The objective of the course is to learn the concept of smart grid and its advantages over conventional grid, smart metering techniques, learn wide area								

measurement techniques and the problems associated with integration of distributed generation & its solution through smart grid.	
On successful completion of this course, the students will be able to	
CO 1	Understand the difference between smart grid & conventional grid.
CO 2	Apply smart metering concepts to industrial and commercial installations.
CO 3	Formulate solutions in the areas of smart sub-stations, distributed generation and wide area measurements.
CO 4	Come up with smart grid solutions using modern communication technologies.

UNIT - I

Introduction to Smart Grid, Evolution of Electric Grid-Concept of Smart Grid, Definitions-Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid.

UNIT - II

Introduction to Smart Meters, Real Time Pricing, Smart-Appliances, Automatic Meter Reading(AMR)-Outage Management System(OMS)-Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation-Smart Substations, Substation Automation, Feeder Automation.

UNIT - III

Geographic Information System (GIS)-Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Wide Area Measurement System(WAMS)-Phasor Measurement Unit(PMU).

UNIT - IV

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of inter-connection, protection & control of micro-grid.-Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines.

UNIT - V

Advanced Metering Infrastructure (AMI), Home Area Network(HAN),- Neighborhood Area Network (NAN), Wide Area Network (WAN)-Bluetooth, Zigbee, GPS, Wi-Fi, Wi-Max based communication,-Wireless Mesh Network, Basics of CLOUD Computing & Cyber-Security for Smart Grid-Broadband over Power line (BPL).

Text Books:

1. Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley IEEE, 2011.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press, 2009.

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications",Wiley 2012.
2. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions", CRC Press.
3. A.G.Phadke, "Synchronized Phasor Measurement and their Applications", Springer.

Course Title	Wind & Solar Energy Systems (PE-I)					M. Tech., I Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
2252105	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs						**End Exam Duration : 3Hrs**		

Course Objectives: The objective of the course is to learn about wind and solar systems, the factors involved in installation and commissioning of a Solar or Wind plant and the dynamics involved when interconnected with power system grid.

On successful completion of this course, the students will be able to

CO 1	Understand the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems.
CO 2	Gain the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems.
CO 3	Gain the knowledge of physics of solar power generation and the associated issues.
CO 4	Identify, formulate and solve the problems of energy crises using wind and solar energy

UNIT-I

Historical development and current status: Introduction – historical background – current status of wind power worldwide – status of wind turbine technology.

Characteristics of wind power generation – basic integration issues: consumer requirements – requirements from wind farm operators – the integration issues.

UNIT – II

Generators and Power Electronics for wind turbines: generator concepts – power electronic concepts – power electronic solutions in wind farms.

Power quality standards of wind turbines: Power Quality characteristics of wind turbines – Impact on voltage quality.

Technical regulations for inter connections: overview of technical regulations – comparison of technical regulations.

UNIT- III

Isolated systems with wind power: isolated power systems – overview of wind – diesel power systems – wind power impact on power quality.

Reactive power capability and voltage control: Relevance and design paradigm – Reactive power capability of a wind turbine – model based design of voltage control systems for wind power plants.

Economic aspects: introduction – costs for network connection and network upgrading – System operation costs in a deregulated market.

UNIT – IV

Impacts of wind power on power system stability: Power system stability and security – rotor angle stability – voltage stability – frequency stability – dynamic behavior of wind power plants.

Solar energy: merits, demerits – thermal applications.

UNIT- V

Concentrating collectors - devices for thermal collection & storages – Thermal energy storage: sensible heat storage, latent heat storage, Thermo chemical storage - solar pond: principle of working – description.

Text Books

Wind power in Power Systems by Thomas Ackerman, John Willy & Sons ltd.

Reference Books:

Solar Energy by K. Sukhatme & S.P. Sukhatme, TMH, 2nd Edition.

<table>
<tr><td>Course Title</td><td colspan="5">Electrical Power Distribution Systems (PE-II)</td><td colspan="3">M. Tech., I Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252106</td><td rowspan="2">Professional Elective (PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="6">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="9">Course Objectives: The objective of the course is to learn about power distribution system, SCADA System and Distribution Automation.</td></tr>
<tr><td colspan="9">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Gain knowledge in power distribution systems</td></tr>
<tr><td>CO 2</td><td colspan="8">Study of Distribution automation and its applications</td></tr>
<tr><td>CO 3</td><td colspan="8">Learn SCADA system</td></tr>
<tr><td>CO 4</td><td colspan="8">Apply AI Techniques to DA</td></tr>
</table>

UNIT-I

Electricity Forecasting: Power loads – connected loads – short term load forecasting - long term load forecasting – distribution of power- Distributed energy supply system – technological forecasting.

UNIT-II

Distribution Automation (DA): Need for distribution automation – characteristics of distribution system – distribution automation- feeder automation – communication requirements for DA- Remote Terminal Unit.

UNIT- III

SCADA System: Introduction- block diagram –components of SCADA – functions of SCADA – SCADA applied to DA – Advantages of DA through SCADA – Requirements and feasibility – DA Integration Mechanisms – Communication protocols in SCADA systems.

UNIT-IV

Remote Metering: Background for Automatic Meter Reading(AMR) for utility – Components of AMR systems – communication methods used for meter reading – AMR system – services and functions - Planning for AMR implementation -Optimal Switching Device placement in Radial distribution system – sectionalizing switches.

UNIT –V

AI Techniques Applied to DA: Introduction – general techniques description – genetic algorithm and its implementation – steps followed in simple Genetic algorithm – Application of GA to DA. Energy Management – Need Based Energy Management- Demand Side management -Urban and Rural Distribution Systems: Urban Distribution – Rural distribution systems.

Text Books:

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd, Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical Power Distribution Automation", University Science Press, New Delhi.
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press.

Course Title	**Mathematical Methods for Power Engineering (PE-II)**				M. Tech., I Semester		
Course Code	**Category**	**Hours / Week**		**Credits**	**Maximum Marks**		
2252107	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs					**End Exam Duration : 3Hrs**		
Course Objectives: The objective of the course is to learn the relevance of mathematical methods to solve engineering problems and how to apply these methods for a given engineering problem.							
On successful completion of this course, the students will be able to							
CO 1	Knowledge about vector spaces, linear transformation, eigen values and eigenvectors of linear operators.						

CO 2	To learn about linear programming problems and understanding the simple method for solving linear programming problems in various fields of science and technology.
CO 3	Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems.
CO 4	Understanding the concept of random variables, functions of random variable and their probability distribution.
CO 5	Understand stochastic processes and their classification.

UNIT- I

Vector spaces, Linear transformations, Matrix representation of linear transformation, Eigen values and Eigen vectors of linear operator.

UNIT- II

Linear Programming Problems, Simplex Method and Duality. Non Linear Programming problems.

UNIT -III

Unconstrained Problems, Search methods, Constrained Problems.

UNIT- IV

Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions.

UNIT - V

Independent Random Variables, Marginal and Conditional distributions, Elements of stochastic processes.

Text Books

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992.
2. Hillier F S and Liebermann G J, "Introduction to Operations Research", 8th Edition, McGraw Hill, 2009.
3. A Papoulis, S. Unnikrishna pillai, "Probability, Random Variables and Stochastic Processes", 4rd Edition, McGraw Hill., 2002.

Reference Books:

1. S.S. Rao, Engineering Optimization Theory and Practice ' Third Enlarges Edition, New age international publishers, 2013.
2. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002.
3. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994

Course Title	**Electric & Hybrid Vehicles (PE-II)**				M. Tech., I Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**	
	Professional Elective	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**

2252108	**(PEC)**	**3**	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs						**End Exam Duration : 3Hrs**		
Course Objectives: The objective of the course is to learn the upcoming technology of hybrid system, different aspects of drives application and learning the electric Traction.								
On successful completion of this course, the students will be able to								
CO 1	Acquire knowledge about fundamental concepts, principles of hybrid and electric vehicles.							
CO 2	Analyze and design of hybrid and electric vehicles.							
CO 3	To learn electric drive in vehicles / traction.							

UNIT - I

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source, Characterization - Transmission characteristics, Mathematical models to describe vehicle performance.

UNIT - II

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

UNIT - III

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives and drive system efficiency.

UNIT - IV

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics devices, Selecting the energy storage technology, Communications, supporting subsystems.

UNIT - V

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies, Comparison of different energy management strategies, Implementation issues of energy strategies.

Reference Books

1. Sira -Ramirez, R. Silva Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, “Sliding Mode Control of Switching Power Converters”.

Course Title	**Research Methodology and IPR**			M. Tech., I Semester
Course	**Category**	**Hours /**	**Credits**	**Maximum Marks**

Code		Week						
2252109	--	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs						**End Exam Duration : 3Hrs**		

Course Objectives: The objective of the course is to learn a perspective on research to the scholars so as to broaden their conceptions of what research involves and to impart knowledge on techniques related to research such as problem formulation, literature survey, information retrieval, use of statistical techniques, writing of research reports and evaluation To expose the scholars ethics in research and Intellectual Property Rights.

On successful completion of this course, the students will be able to

CO 1	Understand research problem formulation and research ethics
CO 2	Analyze research related information
CO 3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO 4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO 5	Understand that IPR protection provides an incentive to inventors for further research work

UNIT - I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT - II

Effective literature studies approaches, Plagiarism and Research ethics

UNIT -III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT - IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - V

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
2. Wayne Goddard and Stuart Melville, "Research Methodology: an Introduction".
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners".

Reference Books:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Course Title	**Power Systems Lab - I**					M. Tech., I Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
2252110	**Professional Core (PCC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		0	**0**	**3**	**2**	**50**	**50**	**100**
						End Exam Duration : 3Hrs		
Course Objectives: The objective of the course is to analyze various faults with and without impedance, determine the sequence impedance of transformer and various parameters of a 220 KV transmission line.								
On successful completion of this course, the students will be able to								
CO 1	Analyze the fault currents for various faults on un-loaded synchronous machine							
CO 2	Determine the sequence impedances of transformer and Synchronous Generators							
CO 3	Determine the ABCD parameters of a Transmission Line							

List of Experiments (Any Eight)

1. Sequence impedances of synchronous machine
2. Symmetrical faults

3. Unsymmetrical Faults (LL & SLG)
4. Unsymmetrical Faults (LLG)
5. Sequence impedances of three phase transformer.
6. Power angle characteristics of salient pole synchronous machine.
7. Ferranti effect and ABCD parameters of 220kV transmission line.
8. Transient & sub-transient reactance's of synchronous machine.
9. Regulation & Efficiency of a 220KV transmission line

<table>
<tr><td>Course Title</td><td colspan="4">Power System Simulation Lab - I</td><td colspan="3">M. Tech., I Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252111</td><td rowspan="2">Professional Core (PCC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>2</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="5"></td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to identify, analyze, illustrate and develop different models in power systems using MATLAB/ETAP Software.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Develop admittance and impedance matrices of power systems using MATLAB/ETAP Software</td></tr>
<tr><td>CO 2</td><td colspan="7">Analyze the power flow problems for simple power system networks</td></tr>
<tr><td>CO 3</td><td colspan="7">Analyze the stability analysis of power systems using MATLAB/ETAP Software</td></tr>
<tr><td>CO 4</td><td colspan="7">Evaluate the short circuit analysis using MATLAB/ETAP Software</td></tr>
</table>

List of Experiments (Any Eight)

1. Formation of Y-bus
2. Formation of Z-bus
3. Load flow analysis by Gauss-Seidel Method
4. Load flow analysis by Newton-Raphson Method
5. Load flow analysis by Fast-decoupled Method
6. Small signal stability of Single machine connected to Infinite bus system

7. Transient stability of Multi Machine System
8. Simulation of Static VAR Compensator
9. Short circuit studies
10. Harmonic analysis & tuned filter design to mitigate harmonics

M. Tech. II Semester

<table>
<tr><td>Course Title</td><td colspan="5">Power System Security and State Estimation</td><td colspan="3">M. Tech., II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252201</td><td rowspan="2">Professional Core (PCC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to
1. Understand the basic concepts of network matrices, power flow methods, state estimation, and applications of power system state estimation and structure of deregulated power system.
2. Analyze about admittance/impedance matrices, factors influencing power system security, network problems and power wheeling transactions.
3. Implement the methods for determining the bus matrices, optimal ordering, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC).
4. Develop the algorithm for orthogonal matrix, method to identify network problems and congestion management methods and electricity sector structure.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Understand the concepts of network matrices, power flow methods, contingency analysis, state estimation, and need and conditions for deregulation.</td></tr>
<tr><td>CO 2</td><td colspan="7">Analyze the bus admittance/impedance matrices methods, power system security, sensitivity factors, state estimation and electricity structure model</td></tr>
<tr><td>CO 3</td><td colspan="7">Apply the methods for evaluating the bus matrices, sparsity, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC).</td></tr>
<tr><td>CO 4</td><td colspan="7">Develop the methods for state estimation, method to identify network problems and methods for congestion management</td></tr>
</table>

UNIT-I

Power System Network Matrices: Formation of bus admittance matrices by direct inspection method and singular transformation method – Algorithm for formation of Bus impedance matrix: addition of a branch and addition of a link, removal element in

Bus impedance matrix– Sparsity programming and Optimal Ordering – Numerical problems – ∏-representation of off-nominal tap transformers.

UNIT-II

Power System Security-I: Review of power flow methods (qualitative treatment only)– DC power flow method-simple problems – Introduction to power system security – Factors influencing power system security.

UNIT-III

Power System Security-II: Introduction to contingency analysis – Contingency analysis: Detection of Network problems, linear sensitivity factors –AC power flow methods– Contingency selection– Simple problems

UNIT-IV

State Estimation in Power System: Power system state estimation – SCADA –EMS center, Methods of state estimation – Method of least squares, Orthogonal matrix–Properties– Givens rotation–Orthogonal decomposition–Bad data detection, Pseudo measurements and applications of power system state estimation – Simple problems.

UNIT-V

Security in Deregulated Environment: Need and conditions for deregulation–Electricity sector structure model – Power wheeling transactions – Congestion management methods– Available Transfer Capability (ATC) – System security in deregulation.

Text Books:

Allen J. Wood and Wollenberg B.F., Power Generation Operation and control, John Wiley & Sons, 3rd edition, 2013.

Reference Books:

P. Venkatesh, B.V. Manikandan, S. Charles Raja and A.Srinivasan, Electrical power systems analysis, security, and deregulation, PHI learning private limited, Delhi, 1st edition 2014

<table>
<tr><td>Course Title</td><td colspan="4">Power System Dynamics-II</td><td colspan="3">M. Tech., II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252202</td><td rowspan="2">Professional Core (PCC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to study of power system dynamics, Interpretation of power system dynamics phenomena and various forms of stability.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Gain valuable insights into the phenomena of power system including obscure</td></tr>
</table>

	ones
CO 2	Understand the power system stability problem
CO 3	Analyze the stability problems and implement modern control strategies.
CO 4	Simulate small signal and large signal stability problems

UNIT-I

Basic Concepts and Definitions: Concept of State, Eigen values, Eigen Vectors, Representation of State space. Small signal stability of single machine connected to infinite bus system.

UNIT-II

Effect of Damper, Flux Linkage Variation and Effect of AVR on Synchronizing and Damping Torque Components, Block diagram.

UNIT-III

Large Signal Rotor Angle Stability, Mitigation Using Power System Stabilizer, Multi-Machine Stability.

UNIT-IV

Dynamic Analysis of Voltage Stability- Modeling requirements, Static and Dynamic analysis, Voltage Collapse.

UNIT-V

Frequency Stability: Automatic Generation Control Models-Primary Speed Control and Supplementary Control, Implementation of AGC, Functional Block Diagram.

Text Book

1. P.M. Anderson and A.A. Fouad, "Power System Control And Stability", IEEE Press.
2. Power System Stability and Control, P.Kundur, TMH.

Reference Books:

1. Power System Analysis and Design, William D Stevenson, John J Grainger, TMH.
2. Power Systems Dynamics and Stability, M.A.Pai- PHI Publications.

Course Title	**Restructured Power Systems (PE – III)**				M. Tech., II Semester		
Course Code	**Category**	**Hours / Week**		**Credits**	**Maximum Marks**		
2252203	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs					**End Exam Duration : 3Hrs**		

Course Objectives: The objective of the course is to understand what is meant by restructuring of the electricity market, the need behind requirement for deregulation of the electricity market, the money, power & information flow in a deregulated power systems.

On successful completion of this course, the students will be able to	
CO 1	Understand various types of regulations in power systems.
CO 2	Identify the need of regulation and deregulation.
CO 3	Analyse technical and non-technical issues in Deregulated Power Industry.
CO 4	Identify and give examples of existing electricity markets.
CO 5	Classify different market mechanisms and summarize the role of various entities in the market

UNIT - I

Deregulation of Electric Utilities: Introduction – Traditional central utility model, reform motivations, separation of ownership and operation, competition and direct access in the electricity market, independent system operator (ISO), retail electric providers, different experiences.

UNIT -II

Competitive Wholesale Electricity Markets & Transmission Open Access: Introduction, ISO, wholesale electricity market characteristics, market model, challenges, trading arrangements, the pool and bilateral trades, multi lateral trades.

UNIT - III

Transmission Cost Allocation Methods: Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

UNIT - IV

Market Power & Ancillary Services Management: Introduction - Different types of market Power – Mitigation of Market Power – Examples - Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

UNIT - V

Available Transfer Capability (ATC) : Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow - Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

Text Books:

1. Power System Restructuring and Deregulation, Loi Lei Lai, John Wiley & Sons Ltd., England, 2001.
2. Operation of Restructured Power System, Kankar Bhattacharya, Math H.J. Boller and Jaap E. Daalder Kulwer Academic Publishers, 2001. \

Reference Books:

1. Restructured Electrical Power Systems, Mohammad Shahidehpour and Muwaffaq alomoush, Marcel Dekker, Inc., 2001.

Course Title	**Energy Auditing and Management (PE – III)**			M. Tech., II Semester
Course Code	**Category**	**Hours / Week**	**Credits**	**Maximum Marks**

2252204	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs						**End Exam Duration : 3Hrs**		
Course Objectives: The objective of the course is to understand the need for energy auditing, various loads involved based on power consumption for auditing to know about different audit instruments used in practice.								
On successful completion of this course, the students will be able to								
CO 1	Acquire the background required for engineers to meet the role of energy managers and to acquire the skills and techniques required to implement energy management.							
CO 2	Identify and quantify the energy intensive business activities in an organization.							
CO 3	Able to perform basic energy audit in an organization							

UNIT - I

System approach and End use approach to efficient use of Electricity-Electricity tariff types-Energy auditing: Types and objectives - audit instruments-ECO assessment and Economic methods-Specific energy analysis-Minimum energy paths-consumption models-Case study.

UNIT - II

Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load-Load Matching and selection of motors-Variable speed drives; Pumps and Fans-Efficient Control strategies - Optimal selection and sizing-Transformer Loading/Efficiency analysis-Reactive Power management-Capacitor-Sizing-Degree of Compensation-Capacitor-losses-Location-Placement-Maintenance,-Case-study.

UNIT - III

Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study-Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes-Electronic ballast-Power quality issues-Luminaries, case study.

UNIT - IV

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study-Electric loads of Air conditioning &Refrigeration-Energy conservation measures- Cool storage-Types-Optimal operation case study.

UNIT - V

Electric water heating-Geysers-Solar Water Heaters-Power Consumption in Compressors-Energy conservation measures-Electrolytic Process-Computer Controls- software-EMS.

Text Books

1. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub; (1998).
2. Howard E. Jordan, .Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2ndedition (1994).

Reference Books:

1. Giovanni Petrecca, Industrial Energy Management: Principles and Applications., The Kluwerinternational series -207,1999.
2. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006.
3. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009.

Course Title	**Electrical Machine Design (PE – III)**					M. Tech., II Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
2252205	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs						**End Exam Duration : 3Hrs**		
Course Objectives: The objective of the course is to study the modelling analysis of rotating machine, learning electromagnetic energy conversion and rating of machines.								
On successful completion of this course, the students will be able to								
CO 1	To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used							
CO 2	Ability to model and design all types of rotation machines including special machines							

UNIT-I

The Design problem – Introduction, design specifications, limitations in design, Modern trends in design of electrical machines.

Thermal state in electrical Machines – Salient features of heating curves – cooling of rotating machines – Methods of cooling - cooling system - Induced & forced ventilation, Radial and Axial Ventilation - Cooling of turbo alternators: Hydrogen cooling, Direct cooling, Air cooled. - Types of Duties and Ratings.

UNIT - II

Design of transformers – Types of transformer – core construction, output equation, principle of design of core, windings, yoke main dimensions (H & W) for single phase: core type, shell type. 3-phase – core type transformers estimation of no load current of transformer - Design of tank with tubes.

UNIT- III

General concepts of rotating machines – Output equation of dc machines, ac machines, separation of D & L, choice of specific loadings.

Design of D.C machines – Choice of no. of poles, selection of no. of armature slots, choice of winding, estimation of conductor cross section of armature, design of field systems: tentative design of field winding of dc machines.

UNIT- IV

Design of 3-phase induction motor – Separation of D & L, Choice of Ampere conductors and B_{av}.

Stator design – Selection of no of stator slots, turns per phase, design of conductor cross section.

Rotor design - Selection of no of rotor slots, principles of design of squirrel cage rotor, design of slip ring rotor.

Relation between D&L for best power factor – Methods of improving Starting Torque - Losses & Efficiency.

UNIT- V

Design of synchronous machines – Separation of D & L, choice of Ampere conductors & B_{av} - Short Circuit Ratio (SCR) and its significance.

Armature design – choice of no. of stator (Armature) slots, turns/phase, conductor cross section for both salient pole and cylindrical pole machines.

Introduction to computer aided design – different approaches.

Text Books

Sawhney. A. K., "A course in Electrical Machine Design", Dhanpat Rai & Co.

Reference Books:

Clayton. A. E. & NN Hancock, "The performance and design of Direct Current machines", CBS publishers & Distributors.

<table>
<tr><td>Course Title</td><td colspan="5">SCADA Systems and Applications (PE – IV)</td><td colspan="3">M. Tech., II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252206</td><td rowspan="2">Professional Elective (PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to understand what is SCADA and its functions, various communication used in SCADA and its applications.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Understand the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.</td></tr>
<tr><td>CO 2</td><td colspan="7">Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.</td></tr>
<tr><td>CO 3</td><td colspan="7">Gain knowledge about single unified standard architecture IEC 61850.</td></tr>
</table>

CO 4	Learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
CO 5	Learn and understand about SCADA applications in transmission and distribution sector, industries etc.

UNIT - I

Introduction to SCADA-Data acquisition systems-Evolution of SCADA-Communication technologies.

UNIT - II

Monitoring and supervisory functions-SCADA applications in Utility Automation-Industries SCADA.

UNIT - III

SCADA System Components-Schemes- Remote Terminal Unit (RTU)-Intelligent Electronic Devices (IED)-Programmable Logic Controller (PLC)-Communication Network, SCADA Server, SCADA/HMI Systems.

UNIT - IV

SCADA Architecture-Various SCADA architectures, advantages and disadvantages of each System-Single unified standard architecture -IEC 61850.

UNIT - V

SCADA Communication-various industrial communication technologies-wired and wireless methods and fiber optics-SCADA Applications: Utility applications.

Text Books

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004.
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.

Reference Books:

1. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.
2. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
3. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well 1999.

Course Title	**Electrical Power Quality (PE – IV)**					M. Tech., II Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
2252207	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**

Mid Exam Duration: 2Hrs	End Exam Duration : 3Hrs
Course Objectives: The objective of the course is to understand the different power quality issues to be addressed, the recommended practices by various standard bodies like IEEE, IEC, etc on voltage & frequency, harmonics and STATIC VAR Compensators.	
On successful completion of this course, the students will be able to	
CO 1	Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads.
CO 2	Develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components.
CO 3	Understand active power factor correction based on static VAR compensators and its control techniques.
CO 4	Analyze series and shunt active power filtering techniques for harmonics.

UNIT - I

Introduction-power quality-voltage quality-overview of power quality Phenomena-classification of power quality issues-power quality measures and standards-flicker factor transient phenomena-occurrence of power quality problems.

UNIT - II

Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-Triplen harmonics-important of harmonic introducing devices-SMPS-Three phase power converters- arcing devices- saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

UNIT - III

Modeling of networks and components under non-sinusoidal Conditions- transmission and distribution systems-Shunt capacitors-transformers-electric machines-ground systems -loads that cause power quality problems-power quality problems created by drives and its impact on drive.

UNIT - IV

Power factor improvement- Passive Compensation-Passive Filtering, Harmonic Resonance-Active Power Factor Correction- Single Phase Front End,-Control Methods for Single Phase APFC & Three Phase APFC and Control Techniques, PFC-Based on Bilateral Single Phase and Three Phase Converter.

UNIT - V

Dynamic Voltage Restorers for sag , swell and flicker problems.

Grounding and wiring introduction-grounding requirements-reasons for grounding

Text Books:

1. G.T. Heydt, “Electric power quality”, McGraw-Hill Professional, 2007.
2. Math H. Bollen, “Understanding Power Quality Problems”, IEEE Press, 2000.

Reference Books:

1. J. Arrillaga, “Power System Quality Assessment”, John wiley, 2000.
2. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,”Power system Harmonic Analysis”, Wiley, 1997.

<table>
<tr><td>Course Title</td><td colspan="5">Power System Reliability (PE – IV)</td><td colspan="3">M. Tech., II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252208</td><td rowspan="2">Professional Elective (PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to learn the basic reliability concepts, density and distribution functions, random variables and networks, reliability functions and time dependent reliability evaluation of different networks, markov modelling and component repairable models for frequency and duration and reliability applications to generation, transmission and distribution systems.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Understand the basic reliability concepts, network modelling.</td></tr>
<tr><td>CO 2</td><td colspan="7">Apply different reliability functions and time dependent reliability evaluation for different networks.</td></tr>
<tr><td>CO 3</td><td colspan="7">Understand the concepts of markov modelling and component repairable models for frequency and duration techniques</td></tr>
<tr><td>CO 4</td><td colspan="7">Apply various reliability fundamental techniques to Generation Systems</td></tr>
<tr><td>CO 5</td><td colspan="7">Analyze bulk power system Reliability evaluation techniques and inter connected system reliability</td></tr>
<tr><td>CO 6</td><td colspan="7">Apply basic reliability techniques to distribution system reliability for radial and parallel configurations.</td></tr>
</table>

UNIT -I

Basic Probability Theory and Distribution-Basic probability theory-rules for combining probabilities of events, Bernoulli's trials, Probability Density and Distribution Functions, Binomial and Poisson's Distribution- Expected Value and Standard Deviation.

Network Modeling and Reliability Analysis -Analysis of Series, Parallel, Series – Parallel Networks, Complex Networks – Decomposition Method, Cut set and Tie set methods. Reliability Functions – f(t), R(t), F(t), h(t) and their relationships – Exponential Distribution – Expected Value and Standard Deviation of Exponential Distribution - Reliability Analysis of Series –Parallel Networks using Exponential Distribution – Bath Tub Curve, Reliability Measures - MTTF, MTTR, MTBF

UNIT- II

Markov Modeling – Markov Chains – Concept of STPM, Evaluations of Limiting State Probabilities – Markov Processes on Components Repairable System – Time Dependent

Probability Evaluation using Laplace Transform Approach – Evaluation of Limiting State Probabilities using STPM – Two Component Reliability Models.

Frequency and Duration Concept – Evaluation of Frequency of Encountering State, Mean Cycle Time for One and Two Component Repairable Models – Evaluation of Cumulative Probability and Cumulative Frequency of Encountering of Merged States.

UNIT - III

Generating System Reliability Analysis – I - Generation system model – Capacity Outage Probability Tables – Recursive Relation for Capacitive Model Building – Sequential Addition Method – Unit Removal – Evaluation of Loss of Load and Energy Indices – Examples.

Generating System Reliability Analysis – II – Frequency & Duration Methods – Evaluation of Equivalent Transitional Rates of Identical and Non-identical Units – Evaluation of Cumulative Probability and Frequency of Non--identical generating Units – Two Level Daily Load Representation – Merging Generation and Load Models - Examples

UNIT - IV

Bulk Power System Reliability Evaluation - Basic configuration – conditional probability approach – system and load point reliability indices –weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures.

Inter Connected System Reliability Analysis - Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads –Expression for cumulative probability and cumulative frequency.

UNIT - V

Distribution System Reliability Analysis- I (Radial Configuration) - Basic Techniques, Radial Networks, Evaluation of Basic Reliability Indices, Performance Indices, Load Point and System Reliability Indices, Customer Oriented, Load and Energy Oriented Indices – Examples.

Distribution System Reliability Analysis- II (Parallel Configuration) - Basic techniques – inclusion of bus bar failures, scheduled maintenance – temporary and transient failures – weather effects – common mode failures –Evaluation of various indices – Examples

Text Books

1. Reliability Evaluation of Engineering System – R. Billinton, R. N. Allan, Plenum Press, New York, Reprinted in India by B. S. Publications, 2006
2. Reliability Evaluation of Power Systems – R. Billinton, R. N. Allan, Plenum Press, New York, Reprinted in India by B. S. Publications, 2006.

Reference Books:

Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978. (First Edition).

Course Title	**Technical Seminar**					M. Tech., II Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
	Project (PROJ)	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**

2252209		**2**	**0**	**0**	**2**	**100**	**00**	**100**

Course Objectives: The main objective of the seminar helps to develop in an emerging field at the intersection of multidisciplinary understandings of culture and education. The students also explore and develop in new perspectives.	
On successful completion of this course, the students will be able to	
CO 1	Understand the theme of the seminar.
CO 2	Identify and discuss current real-world issues.
CO 3	Distinguish and integrate differing forms of knowledge and academic disciplinary approaches with that of the student's own academic discipline and apply a multidisciplinary strategy to address current, real-world issues.
CO 4	Improve oral and written communication skills
CO 5	Explore an appreciation of the self in relation to its larger diverse social and academic contexts.
CO 6	Apply principles of ethics and respect in interaction with others.

Course Title	**Power Systems Lab - II**				M. Tech., II Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**	
2252210	**Professional Core (PCC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		0	**0**	**4**	**2**	**50**	**50**	**100**
						End Exam Duration : 3Hrs		

Course Objectives: The main objective of power system lab is to understand the solar, wind and biomass generating systems and characteristics of various relays.	
On successful completion of this course, the students will be able to	
CO 1	Understand the solar, wind and biomass generating systems
CO 2	Analyze the characteristics of various relays
CO 3	Analyze the control techniques of a transmission lines

List of Experiments

(Any **Eight** of the following experiments has to be carried out)

1. Characteristics of over current relay.
2. Characteristics of Directional Over Current Relay
3. Voltage control of 220kV transmission line.
4. Current control of 220kV transmission line.
5. Characteristics of differential current relay.
6. Over voltage/under voltage relay.
7. Negative sequence relay.
8. Study of rooftop solar system.
9. Field visit to wind generation system.
10. Study of Bio-mass generation plant.

<table>
<tr><td>Course Title</td><td colspan="5">Power Systems Simulation Lab - II</td><td colspan="3">M. Tech., II Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252211</td><td rowspan="2">Professional Core (PCC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td><td>50</td><td>50</td><td>100</td></tr>
<tr><td colspan="6"></td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="9">Course Objectives: The main objective of the course is to develop models of power system network, different types of compensators and controllers using MATLAB/ETAP Software.</td></tr>
<tr><td colspan="9">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Model LFC and AVR for single and two area power systems using MATLAB/ ETAP Software</td></tr>
<tr><td>CO 2</td><td colspan="8">Analyze the FACTS controllers using MATLAB/ETAP Software</td></tr>
<tr><td>CO 3</td><td colspan="8">Analyze voltage stability issues using MATLAB/ETAP Software</td></tr>
<tr><td>CO 4</td><td colspan="8">Analyze the rectifiers and converters for power system applications using MATLAB/ETAP Software</td></tr>
</table>

List of Experiments

(Any **Eight** of the following experiments has to be carried out)

1. Single Area Load Frequency Control with and without PI controller.
2. Two area load frequency control system.

3. Simulation of swing equation.
4. Simulation of AVR system.
5. Simulation of Excitation system stabilizer.
6. Simulation of FACTS controllers.
7. Simulation of Power Quality problems.
8. Three -phase fully controlled rectifiers.
9. Three- phase inverter with PWM controller.
10. Buck & Boost converters for power system applications.

M. Tech., III Semester

<table>
<tr><td>Course Title</td><td colspan="5">Power System Transients (PE – V)</td><td colspan="3">M. Tech., III Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252301</td><td rowspan="2">Professional Elective (PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="6">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="9">Course Objectives: The objective of the course is to understand the energy demand scenario, the modeling of load and its ease to study load demand industrially, analyze Electricity pricing models and reactive power management in Industries.</td></tr>
<tr><td colspan="9">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Gain knowledge about load control techniques in industries and its application.</td></tr>
<tr><td>CO 2</td><td colspan="8">Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO</td></tr>
<tr><td>CO 3</td><td colspan="8">Apply load management to reduce demand of electricity during peak time</td></tr>
<tr><td>CO 4</td><td colspan="8">Apply different energy saving opportunities in industries</td></tr>
</table>

UNIT - I

Electric Energy Scenario-Demand Side Management- Industrial Load Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers

Classification of Industrial Loads, Continuous and Batch processes -Load Modelling.

UNIT - II

Electricity pricing – Dynamic and spot pricing -Models, Direct load control- Interruptible load control, Bottom - up approach- scheduling- Formulation of load Models, Optimization and control algorithms - Case studies.

UNIT - III

Reactive power management in industries-Controls-power quality impacts Application of filters Energy saving in industries.

UNIT - IV

Cooling and heating loads, load profiling, Modelling- Cool storage, Types-Control strategies, optimal operation, and Problem formulation- Case studies.

UNIT - V

Operating and control strategies, Power Pooling- Operation models, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries.

Text Books:

1. C.O. Bjork "Industrial Load Management - Theory, Practice and simulations", Elsevier, the Netherlands, 1989.
2. C.W. Gellings and S.N. Talukdar, Load management concepts. IEEE Press, New York, 1986, pp. 3-28.
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981.

Reference Books

1. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Inter science Publication, USA, 1989.
2. I.J. Nagarath and D.P. Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995.
3. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.

<table>
<tr><td>Course Title</td><td colspan="4">Industrial Load Modelling & Control (PE – V)</td><td colspan="3">M. Tech., III Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252302</td><td rowspan="2">Professional Elective (PEC)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="5">Mid Exam Duration: 2Hrs</td><td colspan="3">End Exam Duration : 3Hrs</td></tr>
<tr><td colspan="8">Course Objectives: The objective of the course is to understand the energy demand scenario, modeling of load and its ease to study load demand industrially, analyze electricity pricing models and study reactive power management in Industries.</td></tr>
<tr><td colspan="8">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="7">Gain knowledge about load control techniques in industries and its application.</td></tr>
<tr><td>CO 2</td><td colspan="7">Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO</td></tr>
</table>

CO 3	Apply load management to reduce demand of electricity during peak time
CO 4	Apply different energy saving opportunities in industries

UNIT - I

Electric Energy Scenario-Demand Side Management- Industrial Load Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers

Classification of Industrial Loads, Continuous and Batch processes -Load Modelling.

UNIT - II

Electricity pricing – Dynamic and spot pricing -Models, Direct load control- Interruptible load control, Bottom - up approach- scheduling- Formulation of load Models, Optimization and control algorithms - Case studies.

UNIT - III

Reactive power management in industries-Controls-power quality impacts Application of filters Energy saving in industries.

UNIT - IV

Cooling and heating loads, load profiling, Modelling- Cool storage, Types-Control strategies, optimal operation, and Problem formulation- Case studies.

UNIT - V

Operating and control strategies, Power Pooling- Operation models, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries.

Text Books:

1. C.O. Bjork "Industrial Load Management - Theory, Practice and simulations", Elsevier, the Netherlands, 1989.
2. C.W. Gellings and S.N. Talukdar, Load management concepts. IEEE Press, New York, 1986, pp. 3-28.
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981.

Reference Books

1. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Inter science Publication, USA, 1989.
2. I.J. Nagarath and D.P. Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995.
3. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.

Course Title	**Modern Control Theory (PE – V)**				M. Tech., III Semester		
Course Code	**Category**	**Hours / Week**		**Credits**	**Maximum Marks**		
2252303	**Professional Elective (PEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2Hrs					**End Exam Duration : 3Hrs**		

Course Objectives: The objective of the course is to understand the linear system and its functions, the stability analysis of linear systems and implement the same in MATLAB.	
On successful completion of this course, the students will be able to	
CO 1	Learn linear system modelling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective.
CO 2	Gain knowledge on carrying out detailed stability analysis of both linear and nonlinear systems.
CO 3	Design observers and controllers for linear systems.
CO 4	Analyse and design pole placement method using MATLAB

UNIT- I

Introduction Concept of State, State Variables and State Model, State model for Linear Continuous Time Systems, transfer function and transfer function matrix, MATLAB programs.

UNIT- II

State Transition Matrix and its properties, solution for homogeneous and non-homogeneous state equations.

UNIT- III

Controllability, complete controllability of continuous time systems, observability, complete observability of continuous time systems, principle of duality.

UNIT- IV

Introduction, design of Pole placement by state feedback using MATLAB, Full order and reduced order observers

UNIT-V

Lyapunov stability analysis: Introduction, Lyapunov stability criterion, direct method of lyapunov and the linear systems.

Text Books:

1. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc., Englewood Cliffs, N.J., 1965.
3. K. Ogata, "Modern Control Engineering, (second edition)", Prentice Hall Inc., Englewood Cliffs, N.J., 1990.

Reference Books

1. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. C.T. Chen, "Linear System Theory and Design", New York: Holt Rinehart and Winston, 1984.
3. R.C. Dorf, and R. T. "Bishop, Modern Control Systems", Addison Wesley Longman Inc., 1999.

<table>
<tr><td>Course Title</td><td colspan="5">Dissertation Phase - I</td><td colspan="3">M. Tech., III Semester</td></tr>
<tr><td>Course Code</td><td>Category</td><td colspan="3">Hours / Week</td><td>Credits</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">2252307</td><td rowspan="2">Major Project (PR)</td><td>L</td><td>T</td><td>P</td><td>C</td><td>Continuous Internal Assessment</td><td>End Exam</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>20</td><td>10</td><td>100</td><td>00</td><td>100</td></tr>
<tr><td colspan="9">Course Objectives: The objective of the course is to
• Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
• Acquire and apply new knowledge as needed, using appropriate learning strategies.
• Apply knowledge of probability and statistics to applications in electrical engineering.</td></tr>
<tr><td colspan="9">On successful completion of this course, the students will be able to</td></tr>
<tr><td>CO 1</td><td colspan="8">Survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research</td></tr>
<tr><td>CO 2</td><td colspan="8">Use different experimental techniques and software/ computational/analytical tools</td></tr>
<tr><td>CO 3</td><td colspan="8">Design and develop an experimental set up/ equipment/testing.</td></tr>
<tr><td>CO 4</td><td colspan="8">Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing the work</td></tr>
</table>

General Description

1. The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech.
3. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the examiners panel set by Head and PG coordinator.
6. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

Course Title	Dissertation Phase - II					M. Tech., IV Semester		
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
2252401	**Major Project (PR)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		0	**0**	**32**	**16**	**50**	**50**	**100**
Course Objectives: The objective of the course is to develop attitude of lifelong learning and will develop interpersonal skills to deal with people working in diversified field, write technical reports and research papers to publish at national and international level and develop strong communication skills to defend their work in front of technically qualified audience.								
On successful completion of this course, the students will be able to								
CO 1	Survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research							
CO 2	Use different experimental techniques and software/ computational/analytical tools							
CO 3	Design and develop an experimental set up/ equipment/testing.							
CO 4	Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing the work							

Open Elective courses offered to other branches for M. Tech., III Semester

Course Title	Internet of Things					M. Tech., III Semester		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
22OE523	**Open Elective Course (OEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration : 2Hrs						**End Exam Duration : 3Hrs**		
Course Objectives: The objective of the course is to learn the basic concepts of Internet of Things and its applications.								

Course Outcomes: On successful completion of this course, the students will be able to:	
CO 1	Understanding IoT technology
CO 2	Learning basic IoT Elements
CO 3	Understanding basics of python programming
CO 4	Working with Arduino and Raspberry pi board

UNIT-I

Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT-Things in IoT, IoT Protocols, Logic Design of IoT-Functional Blocks, Communication Models ,IoT Enabled Technologies-Wireless Sensor Networks, Communication protocols, Embedded Systems, IoT Levels and Templates

UNIT-II

Elements of IoT: What is an IOT Device, Basic Building blocks of an IT Device, Sensors, Actuators, Details of Arduino-About Board Peripherals, Details of Raspberry Pi-About Board Peripherals.

UNIT-III

Logic Design: Introduction to Python, Python Data Types-Numbers, Strings ,Lists, Tuples, Dictionaries, Type Conversions, Control Flow, Functions, Modules

UNIT-IV

IoT Application Development: Programming Arduino- Controlling LED, Interfacing an LED and Switch ,Interfacing a Light Sensor. Programming Raspberry Pi- Controlling LED, Interfacing an LED and Switch, Interfacing a Light Sensor.

UNIT-V

Case Studies of IoT: Smart Lighting, Smart Irrigation, Weather Monitoring System, Smart Parking

Text Books:

1. "INTERNET OF THINGS a Hand on Approach" by Arshdeep Bahga,Vijay Madisetti, Universities Press.
2. "Getting Started with the Internet of Things" by Cuno Pfister, O Reilly Media

Reference Books

1. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
2. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
3. Adrian McEwen, "Designing the Internet of Things", Wiley
",

Course Title	Programmable Logic Controller (PLC) & its Applications				M. Tech., III Semester		
Course Code	Category	Hours/Week			Credits	Maximum Marks	
22OE522	Open Elective (OEC)	L	T	P	C	Continuous Internal Assessment	End Exam	Total
		3	0	0	3	30	70	100
Mid Exam Duration : 2Hrs						End Exam Duration : 3Hrs		

Course Objectives: The main objective of the course is to learn PLC basics, architecture, programming, about digital logic gates, PLC registers, functions and Analog PLC operations and various applications to PLC.

Course Outcomes: On successful completion of this course, the students will be able to,

CO 1	Understand PLC and its basics, architecture, connecting devices and programming.
CO 2	Apply Ladder logic for various Industrial Applications.
CO 3	Analyze PLC logical and arithmetic operations.
CO 4	Design Control Circuits for various Applications.

UNIT I

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming Equipment, programming formats, construction of PLC ladder diagrams, Devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.

UNIT II

Digital Logic Gates: Programming in the Boolean algebra system, conversion examples. Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system.

UNIT III

PLC Registers: Characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers.

PLC Functions: Timer functions & Industrial applications, counter function & industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

UNIT IV

Data Handling Functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

UNIT V

Analog PLC Operation: Types of PLC Analog Modules and Systems, PLC Analog Signal Processing, BCD or Multibit Data Processing, Analog output application examples, PID

Modules, PID Tuning, Typical PID Functions, PLC Installation, Troubleshooting and Maintenance.

Text Books:

1. Programmable Logic Controllers by W. Bolton, 5th Edition, Newnes, Elsevier, 2010.
2. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI.
3. Programmable Logic Controllers-Principles and Applications by Niit,PHI.
4. Programmable Logic Controllers-Programing methods and Applications by John R.Hackworth,Frederick D. Hackworth,1st Edidition, Pearson Publications.

Reference Books:

1. Programmable Logic Controllers- Programming Method and Applications–JR.Hackworth & F.D. Hackworth Jr. - Pearson, 2004.
2. Programmable Logic Controllers: An Emphasis on Design & Application, Kelvin T.Erickson, Dogwood Valley Press, 2011.
3. Programmable Logic Controllers-Principles and Applications by John W. Webb, Ronald AR eis, 5th Edition, PHI.
4. Programmable Logic Controllers- An Emphasis on Design and Application by KelvinT. Erickson,

Course Title	**Power Electronics For Renewable Energy Systems**				M. Tech., III Semester		
Course Code	**Category**	**Hours/Week**		**Credits**	**Maximum Marks**		
22OE523	**Open Elective (OEC)**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**Total**
		3	**0**	**0**	**3**	**40**	**60**	**100**
Mid Exam Duration: 2 Hrs					**End Exam Duration : 3 Hrs**		

Course Objectives:

• To create awareness on various non-conventional energy sources

• To understand role of power converters for solar PV systems

• To gain knowledge on wind energy conversion systems

• To know the grid connection and its issues

• To attain knowledge on importance of hybrid power systems

On successful completion of this course, the students will be able to

CO 1	Understand the various Non-Conventional sources of energy
CO 2	Acquire knowledge on various power converters for Solar energy system
CO 3	analyze the Power converter utilized by the wind energy conversion system
CO 4	Understand the concepts of grid connection and its issues.
CO 5	Recognize the hybrid operation of wind and PV systems and features of MPPT tracking

UNIT I

INTRODUCTION TO RENEWABLE ENERGY RESOURCES

World and Indian energy scenario - Wind, Solar, Hydro, and Geothermal: Availability and Power extraction - Environmental impacts of Renewable energy sources.

UNIT II

POWER CONVERTERS FOR SOLAR PV SYSTEM

Solar Photovoltaic System – P-V and I-V Characteristics –Different factors affecting PV output-Necessity of MPPT's- different types of MPPT- Buck, Boost, buck-boost converters - Isolated and Non isolated converters -Standalone PV system – Solar PV system calculation for specific applications- Battery Charging- Charge Controllers

UNIT III

POWER CONVERTERS FOR WIND ENERGY SYSTEM

Wind Energy Conversion System - Power Converters for Wind: AC voltage Controller - Matrix converter – Bi directional converter- flyback converter - Standalone operation of fixed

and variable speed wind energy conversion systems - Static Kramer Drive for DFIG – Static Scherbius using cycloconverters for DFIG – Rating of Converter for WECS

UNIT IV

GRID CONNECTED SYSTEM

Grid interface - Grid connection issues: leakage current, Islanding, harmonics, Active / reactive Power feeding, unbalance Grid Interactive inverter: Line Commutated Inverter – Self Commutated Inverter – Selection of inverter – Rating of Inverters for Grid connected System.

UNIT V

HYBRID ENERGY SYSTEM

Need for hybrid systems- Range and type of Hybrid systems- Case studies of Wind and PV system – PV-Diesel System – Wind-Diesel Hybrid System – Energy Storage Devices for Hybrid Energy System - Maximum Power Point Tracking (MPPT) - MPPT schemes.

TEXT BOOKS

1. Sudipta Chakraborty, Marcelo G. Simes, and William E. Kramer, "Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration", Springer Science & Business, 2013.

2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, "Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems", CRC Press, 2013.

REFERENCES

1. Rashid .M. H "Power electronics Hand book", Academic press, 2001.

2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.

3. Rai. G.D, "Non conventional energy sources", Khanna publishes, 2009.

4. Gray, L. Johnson, "Wind energy system", Prentice Hall INC, 1995. 5. B.H.Khan, "Non-conventional Energy sources", Tata McGraw-Hill Publishing Company, New Delhi, 2017.