ACADEMIC REGULATIONS

COURSE STRUCTURE

AND

DETAILED SYLLABI

for

MASTER OF TECHNOLOGY

in

POWER ELECTRONICS AND DRIVES

(For the batches admitted from 2017-2018)

CHOICE BASED CREDIT SYSTEM

SREE VIDYANIKETHAN ENGINEERING COLLEGE

(AUTONOMOUS)

(Affiliated to JNTU Anantapur, Approved by AICTE
Programs Accredited by NBA; NAAC with 'A' grade)
Sree Sainath Nagar, A.Rangampet, Near Tirupati - 517 102. A.P.

VISION

To be one of the Nation's premier Engineering Colleges by achieving the highest order of excellence in Teaching and Research.

MISSION

- To foster intellectual curiosity, pursuit and dissemination of knowledge.
- To explore students' potential through academic freedom and integrity.
- To promote technical mastery and nurture skilled professionals to face competition in ever increasing complex world.

QUALITY POLICY

Sree Vidyanikethan Engineering College strives to establish a system of Quality Assurance to continuously address, monitor and evaluate the quality of education offered to students, thus promoting effective teaching processes for the benefit of students and making the College a Centre of Excellence for Engineering and Technological studies.

SREE VIDYANIKETHAN ENGINEERING COLLEGE

(Autonomous)

Sree Sainath Nagar, Tirupati – 517 102

Department of Electrical and Electronics Engineering

Vision

To become the Nation's premiere centre of excellence in electrical engineering through teaching, training, research and innovation to create competent engineering professionals with values and ethics.

Mission

Department of Electrical Engineering strives to create human resources in Electrical Engineering to contribute to the nation development and improve the quality of life.

Imparting Knowledge through implementing modern curriculum, academic flexibility and learner centric teaching methods in Electrical Engineering

Inspiring students for aptitude to research and innovation by exposing them to industry and societal needs to creating solutions for contemporary problems

Honing technical and soft skills for enhanced learning outcomes and employability of students with diverse background through comprehensive training methodologies

Inculcate values and ethics among students for a holistic engineering professional practice.

SREE VIDYANIKETHAN ENGINEERING COLLEGE

(AUTONOMOUS)

SREE SAINATH NAGAR, TIRUPATI-517 102

Department of Electrical and Electronics Engineering
M.Tech – Power Electronics and Drives

Program Educational Objectives:

Within a few years of graduation, post graduates of M. Tech in Power Electronics and Drives would

1. enroll for doctoral studies or engage in research activities of societal importance.
2. assume key positions in research divisions, industry and academia.
3. advance professionally through continuing education, ethics and values.

Program Outcomes:

After Successful completion of the Programme, post graduates of M. Tech in Power Electronics and Drives will be able to

1. Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesis existing and new knowledge, and integration of the same for enhancement of knowledge. (**Scholarship of Knowledge**)

2. Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context. (**Critical Thinking**)

3. Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise. (**Problem Solving**)

4. Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering. (**Research Skill**)

5. Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations. (**Usage of modern tools**)

6. Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and

further the learning of themselves as well as others. (**Collaborative and Multidisciplinary work**)

7. Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after considerisation of economical and financial factors. (**Project Management and Finance**)

8. Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions. (**Communication**)

9. Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously. (**Life-long Learning**)

10. Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society. (**Ethical Practices and Social Responsibility**)

11. Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback. (**Independent and Reflective Learning**)

PROGRAM SPECIFIC OUTCOMES:

After Successful completion of the Programme, post graduates of M. Tech in Power Electronics and Drives will

PSO1. demonstrate specialized knowledge in the operation and control of Power Electronic converters & Drives with an ability to combine existing and recent practices.

PSO2. analyze and solve complex problems in the field of Power Electronics & Drives to meet the needs of industry and society.

PSO3. demonstrate research competence in the field of Power Electronics & Drives to develop innovative products to meet the industrial needs.

PSO4. apply modern tools, latest technologies and resources to provide solutions to complex engineering problems related to Power Electronics & Drives.

The Challenge of Change

"Mastery of change is in fact the challenge of moving human attention from an old state to a new state. Leaders can shift attention at the right time and to the right place. The real crisis of our times is the crisis of attention. Those who lead are the ones who can hold your attention and move it in a purposeful way. Transformation is nothing but a shift in attention from one form to another. The form of a beautiful butterfly breaks free from a crawling caterpillar. If you pay enough attention, you would be able to see how the butterfly hides within the caterpillar. The leader points out a butterfly when the follower sees only a caterpillar".

- Debashis Chatterjee

SREE VIDYANIKETHAN ENGINEERING COLLEGE

(Autonomous)

(Affiliated to J.N.T. University Anantapur, Anantapuramu)

ACADEMIC REGULATIONS

CHOICE BASED CREDIT SYSTEM

M. Tech. Regular Two Year Degree Program

(for the batches admitted from the academic year 2017–18)

For pursuing Two year degree program of study in Master of Technology (M.Tech) offered by Sree Vidyanikethan Engineering College under Autonomous status and herein after referred to as SVEC (Autonomous):

1. **Applicability** : All the rules specified herein, approved by the Academic Council, shall be in force and applicable to students admitted from the academic year 2017-2018 onwards. Any reference to "College" in these rules and regulations stands for SVEC (Autonomous).

2. **Extent:** All the rules and regulations, specified hereinafter shall be read as a whole for the purpose of interpretation and as and when a doubt arises, the interpretation of the Chairman, Academic Council is final. It shall be ratified by Academic Council in the forth coming meeting. As per the requirements of statutory bodies, Principal, SVEC (Autonomous) shall be the Chairman, Academic Council.

3. **Admission** :

3.1. **Admission into the Two Year M. Tech. Degree Program of study in Engineering:**

3.1.1. Eligibility:

- A candidate seeking admission into the two year M. Tech Degree Program should have

  (i) Passed B.Tech / B.E or equivalent Program recognized by JNTUA, Anantapuramu, for admission as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE).

  (ii) A minimum percentage of marks in the qualifying degree as prescribed by the AICTE / UGC or Government at the time of admission.

  (iii) Rank / score secured in the PGECET / GATE examination conducted by APSCHE/ MHRD for allotment of a seat by the convener PGECET, for admission.

3.1.2. **Admission Procedure**:

Admissions are made into the two year M.Tech. Degree Program as per the stipulations of APSCHE, Government of Andhra Pradesh:

(a) By the Convener, PGECET (for Category–A Seats)

(b) By the Management (for Category-B Seats).

4. **Programs of study offered leading to the award of M.Tech. Degree and Eligibility:**

Following are the two year postgraduate degree Programs of study offered in various branches at in SVEC (Autonomous) leading to the award of M.Tech. degree and eligibility to get admission into the Programs:

Name of the specialization	Offered by the Department	Name of the Degree / Branch eligible for Admission
Electrical Power Systems	EEE	BE / B.Tech / AMIE in Electrical & Electronics Engineering / Electrical Engineering or equivalent
Power Electronics and Drives		BE / B.Tech / AMIE in Electrical & Electronics Engineering / Electrical Engineering or equivalent
Digital Electronics and Communication Systems	ECE	BE / B.Tech in ECE / AMIE in ECE, AMIE (Electronics & Telecommunication Engineering) / AMIETE (Electronics & Telematics Engineering) / Electronics & Computer Engineering / Electronics/ Electronics & Telematics or equivalent
Communication Systems		
VLSI		BE / B.Tech / AMIE in ECE / EEE / CSE / Electronics & Computer Engineering / ETE / IT / CSIT / Electronics and Control Engineering / Instrumentation Engineering / Instrumentation Technology / EIE / Electronics Engineering / Bio-Medical Engineering / AMIETE (Electronics & Telematics Engineering) / Electronics or equivalent
Computer Science	CSE	BE / B.Tech / AMIE in CSE / CSIT / IT / CSSE, M. Sc. (Computer Science), M. Sc. (Information Systems), M. Sc. (Information Technology), MCA or equivalent.
Computer Networks and Information Security		
Software Engineering	IT	

5. Duration of the Program:

5.1 Minimum Duration: The program will extend over a period of two years leading to the Degree of Master of Technology (M.Tech) of the JNTUA, Ananthapuramu. The two academic years will be divided into four semesters with two semesters per year. In first year, each semester shall normally consist of 22 weeks (≥90 working days) having – 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. In second year, each semester shall consists of 18 weeks and the entire year is for project work. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as suggested by UGC, and Curriculum/ Course Structure as suggested by AICTE are followed.

5.2 Maximum Duration: The student shall complete all the passing requirements of the M.Tech degree program within a maximum duration of 4 years including Gap year, this duration reckoned from the commencement of the semester to which the student was first admitted to the program.

I SEMESTER (22 weeks)	**INSTRUCTION PERIOD**: I Spell: 7 Weeks; II Spell: 9 Weeks	16 Weeks
	Internal Examinations: I Mid : 1 week; II Mid : 1 week	2 Weeks
	Preparation & Practical Examinations	2 Week
	External Examinations	2 Weeks
	Semester Break	2 Weeks
II SEMESTER (22 weeks)	**INSTRUCTION PERIOD**: I Spell : 7 Weeks ; II Spell : 9 Weeks	16 weeks
	Internal Examinations: I Mid : 1 week; II Mid : 1 week	2 Weeks
	Preparation & Practical Examinations	2 Week
	External Examinations	2 Weeks
	Summer Vacation	4 Weeks
III SEMESTER	Project Work Phase – I	19 Weeks
IV SEMESTER	Project Work Phase – II	19 Weeks
	Project Work Viva-Voce examinations	2 Weeks

6. **Course Structure:** Each Program of study shall consist of:

- Professional core courses:

  The list of professional core courses are chosen as per the suggestions of the experts, to impart knowledge and skills needed in the concerned specialization of study.

- Professional elective courses:

  Professional elective courses shall be offered to the students to diversify their spectrum of knowledge and skills. The elective courses can be chosen based on the interest of the student to broaden his individual knowledge and skills.

- Audit Courses: Audit courses shall be offered to the students to diversify their knowledge.

Contact periods: Depending on the complexity and volume of the course the number of contact periods per week shall be assigned.

7. **Credit System:** All Courses are to be registered by a student in a Semester to earn Credits. Credits are assigned based on the following norms given in Table 1.

Table 1

Course	Periods/Week	Credits
Theory	01	01
Practical	04	02
Seminar	--	02
Project Work Phase-I	--	--
Project Work Phase-II	--	28

i. As a norm, for the theory courses, **one credit** for one contact period per week is assigned.
ii. As a norm, for practical courses **two credits** will be assigned for four contact periods per week.
iii. For courses like Project/Seminar, where formal contact periods are not specified, credits are assigned based on the complexity of the work to be carried out.
iv. There are no credits for audit courses.

Other student activities like NCC, NSS, Sports, Study Tour, Guest Lecture etc. will not carry Credits.

The two year curriculum of any M. Tech Degree Program of study shall have total of **86** credits (28 credits in I Semester, 30 credits in II Semester and 28 credits in IV Semester).

8. Choice Based Credit System (CBCS):

Choice Based Credit System (CBCS) is introduced based on UGC guidelines in order to promote:

- Student centered learning
- Cafeteria approach
- Students to learn courses of their choice
- Learning at their own pace
- Interdisciplinary learning

- A student is introduced to "Choice Based Credit System (CBCS)"
- The total credits for the Programme is 86.
- A student has choice of registering for credits from the theory courses offered in the program ensuring the total credits in a semester are between 24 and 34.
- In I Semester, the student has the option of registering for one additional theory course from the latter semester or dropping one existing theory course from the current semester within the course structure of the program. In II Semester also, the student has the option of registering for one additional theory course from the previous semester if dropped earlier within the course structure of the program. However the maximum number of credits the student can register in a particular semester cannot exceed 33 credits.
- Grade points, based on percentage of marks awarded for each course will form the basis for calculation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average).
- All the registered credits will be considered for the calculation of final CGPA.

9. Course Enrollment and Registration

9.1 Each student, on admission shall be assigned to a Faculty Advisor (Mentor) who shall advice and counsel the student about the details of the academic programme and the choice of courses considering the student's academic background and career objectives.

9.2 The enrollment of courses in I Semester will commence on the day of admission. If the student wishes, the student may drop or add courses (vide clause 8) within **three** days before commencement of I semester class work and complete the registration process. The student shall enroll for the courses with the help of the student's Faculty Advisor (Mentor). The enrollment of courses in II Semester will commence 10 days prior to the last instructional day of the I semester and complete the registration process for all the remaining theory courses as per program course structure, duly authorized by the Chairman, Board of studies of concern department.

9.3 If any student fails to register the courses in a semester, he shall undergo the courses as per the program structure.

9.4 After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the Semester-end Examinations.

9.5 No elective course shall be offered by a Department unless a minimum of 8 students register for the course.

10. Massive Open Online Course (MOOC)

A Massive Open Online Course (MOOC) is an online course aimed at unlimited participation and open access via the web. MOOC is a model for delivering learning content online to any person who takes a course, with no limit on attendance.

- A student shall undergo a "Massive Open Online Course (MOOC)" for award of the degree besides other requirements.
- A student is offered this Online Course at the beginning of his II Semester of study and the course has to be completed by the end of III Semester. If the student fails to complete the course by the end of III Semester, it shall be treated as a backlog and needs to be completed before completion of the program for the award of the degree.
- The student shall confirm registration by enrolling the course within 10 days prior to the last instructional day of the I semester like other courses.
- The courses will be approved by the Chairman, Academic Council, SVEC based on the recommendations of the Chairman, Board of Studies of concerned program considering current needs.
- A student has a choice of registering for only one MOOC with the recommendation of Chairman, Board of studies of concerned program and duly approved by the Chairman, Academic Council, SVEC.
- The student shall undergo MOOC without disturbing the normal schedule of regular class work.
- One faculty member assigned by the Head of the Department shall be responsible for the periodic monitoring of the course implementation.
- No formal lectures need be delivered by the faculty member assigned to the students.
- If any student wants to change the MOOC course already registered, he will be given choice to register a new MOOC course in M. Tech. II / III Semester only, with the recommendation of Chairman, Board of studies of concerned program and duly approved by the Chairman, Academic Council, SVEC.
- Finally, the performance of the student in the course will be evaluated as stipulated by the course provider. A certificate will be issued on successful completion of the course by the course provider.
- The performance in the MOOC will not be considered for the calculation of SGPA and CGPA of the student.
- The MOOC course will be listed in the grade sheets of the student.

11. Break of Study from a Programme (Gap Year)

11.1 A student is permitted to go on break of study for a maximum period of one year.

11.2 The student shall apply for break of study in advance, in any case, not later than the last date of the first assessment period in a semester. The application downloaded from website and duly filled by the student shall be submitted to the Head of the Department. In the case of start-up for incubation of idea only, the application for break of study shall be forwarded by the Head of the Department to the Principal, SVEC. A sub-committee appointed by the principal shall give recommendations for approval.

11.3 The students permitted to rejoin the programme after break of study shall be governed by the Curriculum and Regulations in force at the time of rejoining. The students rejoining in new regulations shall apply to the Principal, SVEC in the prescribed format through Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

11.4 The total period for completion of the programme reckoned from the commencement of the I Semester to which the student was admitted shall not exceed the maximum period specified in clause 5.2 irrespective of the period of break of study in order that the student may be eligible for the award of the degree (vide clause 19).

11.5 If a student has not reported to the department after approved period of break of study without any intimation, the student is treated as detained in that semester. Such students are eligible for readmission for the semester when offered next.

12. Examination System: All components in any Program of study shall be evaluated through internal evaluation and / or an external evaluation conducted as semester-end examination.

12.1. Distribution of Marks:

<table>
<tr><th>Sl. No.</th><th>Course</th><th>Marks</th><th colspan="3">Examination and Evaluation</th><th>Scheme of examination</th></tr>
<tr><td rowspan="3">1.</td><td rowspan="3">Theory</td><td>60</td><td colspan="3">Semester-end examination of 3 hours duration (External evaluation)</td><td>The examination question paper in theory courses shall be for a maximum of 60 marks. The question paper shall be of descriptive type with 5 questions, taken one from each unit of syllabus, having internal choice and all 5 questions shall be answered. All questions carry equal marks.</td></tr>
<tr><td rowspan="2">40</td><td colspan="3" rowspan="2">Mid-term Examination of 2 hours duration (Internal evaluation).</td><td>The question paper shall be of descriptive type with 5 essay type questions out of which 4 are to be answered and evaluated for 40 marks.</td></tr>
<tr><td>Two mid-term examinations each for 40 marks are to be conducted. For a total of 40 marks, 75% of better one of the two and 25% of the other one are added and finalized.
Mid-I: After first spell of instruction (I to II Units).
Mid-II: After second spell of instruction (III to V Units).</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Laboratory</td><td>50</td><td colspan="3">Semester-end Lab Examination for 3 hours duration (External evaluation)</td><td>50 marks are allotted for laboratory examination during semester-end.</td></tr>
<tr><td rowspan="2">50</td><td>30</td><td>Day-to-Day evaluation for Performance in laboratory experiments and Record. (Internal evaluation).</td><td rowspan="2">Two laboratory examinations, which includes Day-to-Day evaluation and Practical test, each for 50 marks are to be evaluated. For a total of 50 marks 75% of better one of the two and 25% of the other one are added and finalized.

Laboratory examination-I: Shall be conducted just before I mid-term examinations.
Laboratory examination-II: Shall be conducted just before II mid-term examinations.</td></tr>
<tr><td>20</td><td>Practical test (Internal evaluation).</td></tr>
<tr><td>3</td><td>Audit Course</td><td>-</td><td colspan="3">-</td><td>Audit course will be conducted as given in 12.2.1</td></tr>
<tr><td>4</td><td>Seminar</td><td>100</td><td colspan="3">Semester-end Examination</td><td>100 marks are allotted for Seminar during semester-end evaluation by the Departmental Committee (DC) as given in 12.2.2.</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Project Work</td><td rowspan="2">400</td><td>200</td><td>External evaluation</td><td>Semester-end Project Viva-Voce Examination by Committee as detailed in 12.2.3.</td></tr>
<tr><td>200</td><td>Internal evaluation</td><td>Continuous evaluation by the DC as detailed in 12.2.3.</td></tr>
</table>

12.2 Audit Course/ Seminar/Project Work Evaluation:

12.2.1. Audit Course: For audit course, attendance shall be maintained like in case of any regular course. Students may be encouraged to submit assignments and give presentations on the course topics. There won't be any examinations for audit courses. However, the courses shall be listed in the grade sheet of the student.

12.2.2. Seminar: For the seminar, the student shall collect information through literature survey on a specialized topic and prepare a technical report, showing his understanding over the topic, and submit to the Department a week before presentation. The report and the presentation shall be evaluated at the end of the semester during the period of preparation and practicals by the Departmental Committee (DC) consisting of two senior faculty members and concerned supervisor of the department. The DC is constituted by the Principal on the recommendations of the Head of the Department. The department shall have individual DCs for each M. Tech. Program with senior faculty members and the supervisor specialized in the program.

12.2.3. Project Work:

12.2.3.1. Student shall register for the Project work with the approval of DC in the III Semester and continue the work in the IV Semester too. The DC shall monitor the progress of the project work. In III Semester, Phase–I of the Project Work has to be completed. A Student has to identify the topic of work, collect relevant Literature, preliminary data, implementation tools/ methodologies etc., and perform a critical study and analysis of the problem identified. He shall submit status report in two different phases in addition to oral presentation before the DC for evaluation and award of internal marks at the end of Phase –I. A candidate shall continue the Project Work in IV Semester (Phase – II) and submit a Project report at the end of Phase–II after approval of the DC. During Phase–II, the student shall submit status report in two different phases, in addition to oral presentation before the DC. The DC shall evaluate the project based on the progress, presentations and quality of work. A candidate shall be allowed to submit the dissertation only after passing all the courses from 1st to 3rd semesters and on recommendations of the DC. The Viva-Voce examination shall be conducted as per the IV Semester examinations schedule.

12.2.3.2 Three copies of the dissertation certified in the prescribed form by the concerned Supervisor and HOD shall be submitted to the Department. One copy is to be submitted to the Chief Controller of Examinations, SVEC (Autonomous) and one copy to be sent to the examiner. The examiner shall be nominated by the Chief Controller of the Examinations from the panel of three examiners submitted by the Department for a maximum of 5 students at a time for adjudication.

12.2.3.3 If the report of the examiner is favorable, Viva-Voce examination shall be conducted by a board consisting of the concerned Supervisor, Head of the Department and the examiner who adjudicated the dissertation. The board shall jointly evaluate the candidates project work. If the report of the examiner is not favorable, the candidate should revise and resubmit the project report followed by Viva-Voce examination.

12.2.3.4 The candidates who fail in Viva-Voce examination shall have to re-appear the Viva-Voce examination after three months. Extension of time within the total permissible limit for completing the project is to be obtained from the Chairman, Academic Council, SVEC (Autonomous).

12.2.3.5 If a candidate desires to change the topic of the project already chosen, during Phase–II, he has to re-register for Project work with the approval of the DC and repeat Phases–I & II. Marks already earned in Phase–I stand cancelled.

12.2.3.6 If a candidate unable to complete the project work after Phase–II and desires to change the topic of the project already chosen, he has to re-register for Project work with the approval of the DC and repeat Phases–I & II. Marks already earned in Phase–I & II stand cancelled.

12.3. Eligibility to appear for the semester-end examination:

12.3.1 A student shall be eligible to appear for semester-end examinations if he acquires a minimum of 75% of attendance in aggregate of all the courses in a semester.

12.3.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

12.3.3 Shortage of attendance below 65% in aggregate shall in no case be condoned.

12.3.4 Students whose shortage of attendance is not condoned in any semester shall not be eligible to take their semester-end examination and their registration shall stand cancelled.

12.3.5 A student shall not be promoted to the next semester unless he satisfies the attendance requirements of the semester, as applicable. The student may seek readmission for the semester when offered next. He will not be allowed to register for the courses of the semester while he is in detention.

12.3.6 A stipulated fee shall be payable to the college towards condonation of shortage of attendance.

12.4. Evaluation: Following procedure governs the evaluation.

12.4.1. Marks for components evaluated internally by the faculty should be submitted to the Controller of Examinations one week before the commencement of the semester-end examinations. The marks for the internal evaluation components shall be added to the external evaluation marks secured in the semester-end examinations, to arrive at total marks for any course in that semester.

12.4.2. Performance in all the courses is tabulated course-wise and shall be scrutinized by the Results Committee and moderation is applied if needed, and course-wise marks are finalized. Total marks obtained in each course are converted into letter grades.

12.4.3. Student-wise tabulation shall be done and individual grade sheet shall be generated and issued.

12.5. Personal verification / Revaluation / Recounting:

Students shall be permitted for personal verification/request for recounting/ revaluation of the semester-end examination answer scripts within a stipulated period after payment of prescribed fee. After recounting or revaluation, records shall be updated with changes if any and the student shall be issued a revised grade sheet. If there are no changes, the student shall be intimated the same through a notice.

12.6. Supplementary Examination:

In addition to the regular semester-end examinations conducted, the College may also schedule and conduct supplementary examinations for all the courses of other semesters when feasible for the benefit of students. Such of the candidates writing supplementary examinations may have to write more than one examination per day.

13. Re-Registration for Improvement of Internal Marks:

Following are the conditions to avail the benefit of improvement of internal evaluation marks.

13.1 The candidate should have completed the course work and obtained examinations results for I and II semesters.

13.2 Out of the courses the candidate has failed in the examinations due to internal evaluation marks secured being less than 50%, the candidate shall be given one

chance for a maximum of 3 theory courses for improvement of internal evaluation marks.

13.3 He should have passed all the remaining courses for which the internal evaluation marks secured more than or equal to 50%.

13.4 The candidate has to register for the chosen courses and fulfill the academic requirements.

13.5 For each course, the candidate has to pay a fee equivalent to one third of the semester tuition fee and the amount is to be remitted in the form of D.D./ Challan in favour of the Principal, Sree Vidyanikethan Engineering College payable at Tirupati along with the requisition through the concerned Head of the Department.

13.6 In the event of availing the Improvement of Internal evaluation marks, the internal evaluation marks as well as the semester-end examinations marks secured in the previous attempt(s) for the re-registered courses stand cancelled.

14. Academic Requirements for completion of M.Tech Program of study:

The following academic requirements have to be satisfied in addition to the attendance requirements for completion of M.Tech Program of study.

14.1 A student shall be deemed to have satisfied the minimum academic requirements for each theory, laboratory and project work, if he secures not less than 40% of marks in the semester-end examination and a minimum of 50% of marks in the sum total of the internal evaluation and semester-end examination taken together. For the seminar, he should secure not less than 50% of marks in the semester-end examination.

14.2 A student shall register for all the 86 credits and earn all the 86 credits. Marks obtained in the 86 credits shall be considered for the calculation of the DIVISION based on CGPA.

14.3 A student who fails to earn 86 credits as indicated in the curriculum within **four** academic years from the year of his admission shall forfeit his seat in M.Tech. Program and his admission stands cancelled.

15. Transitory Regulations:

Students who got detained for want of attendance (**or**) who have not fulfilled academic requirements (**or**) who have failed after having undergone the Program in earlier regulations (**or**) who have discontinued and wish to continue the Program are eligible for admission into the unfinished semester from the date of commencement of class work with the same (**or**) equivalent courses as and when courses are offered and they will be in the academic regulations into which they are presently readmitted.

A regular student has to satisfy all the eligibility requirements within the maximum stipulated period of **four years** for the award of M.Tech Degree.

16. Grades, Grade Point Average and Cumulative Grade Point Average:

16.1. Grade System: After all the components and sub-components of any course (including laboratory courses) are evaluated, the final total marks obtained shall be converted to letter grades on a "**10 point scale**" as described below.

Grades conversion and Grade points allotted

% of Marks obtained	Grade	Description of Grade	Grade Points (GP)
≥ 95	O	Outstanding	10
≥ 85 to < 95	S	Superior	9
≥ 75 to < 85	A	Excellent	8
≥ 65 to < 75	B	Very Good	7
≥ 55 to < 65	C	Good	6
≥ 50 to <55	D	Pass	5
< 50	F	Fail	0
Not Appeared	N	Absent	0

Pass Marks: A student shall be declared to have passed theory course, laboratory course and project work if he secures minimum of 40% marks in Semester-end examination, and a minimum of 50% marks in the sum total of internal evaluation and Semester-end examination taken together. For the seminar, he shall be declared to have passed if he secures minimum of 50% of marks in the semester-end examinations. Otherwise he shall be awarded fail grade - **F** in such a course irrespective of internal marks. **F** is considered as a fail grade indicating that the student has to pass the semester-end examination in that course in future and obtain a grade other than **F** and **N** for passing the course.

16.2. Semester Grade Point Average (SGPA):

Semester Grade Point Average (SGPA) shall be calculated as given below on a "10 point scale" as an index of the student's performance at the end of each semester:

$$\text{SGPA} = \frac{\sum(C\ X\ GP)}{\sum C}$$

where ***C*** denotes the credits assigned to the courses undertaken in that semester and ***GP*** denotes the grade points earned by the student in the respective courses.

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

16.3. Cumulative Grade Point Average (CGPA):

The CGPA for any student is awarded only when he completes the Program i.e., when the student passes in all the courses prescribed in the Program. The CGPA is computed on a 10 point scale as given below:

$$\text{CGPA} = \frac{\sum(C\ X\ GP)}{\sum C}$$

where ***C*** denotes the credits assigned to courses undertaken up to the end of the Program and *GP* denotes the grade points earned by the student in the respective courses.

17. Grade Sheet: A grade sheet (Marks Memorandum) shall be issued to each student indicating his performance in all courses registered in that semester indicating the SGPA.

18. Transcripts: After successful completion of the entire Program of study, a transcript containing performance in all academic years shall be issued as a final record. Duplicate transcripts will also be issued, if required, after payment of requisite fee. Partial transcript will also be issued upto any point of study to a student on request.

19. Award of Degree: The Degree shall be conferred and awarded by Jawaharlal Nehru Technological University Anantapur, Ananthapuramu on the recommendations of the Chairman, Academic Council, SVEC (Autonomous).

19.1. Eligibility: A student shall be eligible for the award of M.Tech Degree if he fulfills all the following conditions:

- Registered and successfully completed all the components prescribed in the Program of study to which he is admitted.
- Successfully acquired the minimum required credits as specified in the curriculum corresponding to the Program of study within the stipulated time.
- Obtained CGPA greater than or equal to 5.0 (Minimum requirement for declaring as passed).
- Has no dues to the College, Hostel, Library etc. and to any other amenities provided by the College.
- No disciplinary action is pending against him.

19.2. Award of Division: Declaration of division is based on CGPA.

Awarding of Division

CGPA	Division
> = 7.0	First Class with Distinction
> = 6.0 and < 7.0	First Class
> = 5.0 and < 6.0	Second Class

20. Additional academic regulations:

20.1 A student may appear for any number of supplementary examinations within the stipulated time to fulfill regulatory requirements for award of the degree.

20.2 In case of malpractice/improper conduct during the examinations, guidelines shall be followed as shown in the **Annexure-I**.

20.3 When a student is absent for any examination (Mid-term or Semester-end) he shall be awarded **zero** marks in that component (course) and grading will be done accordingly.

20.4 When a component is cancelled as a penalty, he shall be awarded zero marks in that component.

21. Withholding of Results:

If the candidate has not paid dues to the College/University (or) if any case of indiscipline is pending against him, the result of the candidate shall be withheld and he will not be allowed/promoted to the next higher semester

22. Amendments to regulations:

The Academic Council of SVEC (Autonomous) reserves the right to revise, amend, or change the Regulations, Scheme of Examinations, and / or Syllabi or any other policy relevant to the needs of the society or industrial requirements etc., with the recommendations of the concerned Board(s) of Studies.

23. General:

The words such as "he", "him", "his" and "himself" shall be understood to include all students irrespective of gender connotation.

Note: *Failure to read and understand the regulations is not an excuse.*

Annexure-I

GUIDE LINES FOR DISCIPLINARY ACTION FOR MALPRACTICES / IMPROPER CONDUCT IN EXAMINATIONS

Rule No.	Nature of Malpractices/ Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the course of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the course of the examination)	Expulsion from the examination hall and cancellation of the performance in that course only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that course only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the course of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses of that Semester. The Hall Ticket of the candidate is to be cancelled.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred for four consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the courses of the examination (including labs and project work) already appeared and shall not be allowed to appear for examinations of the remaining courses of that semester. The candidate is also debarred for four consecutive semesters from class work and all Semester-end examinations, if his involvement is established. Otherwise, The candidate is debarred for two consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred for two consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	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 course only.
6.	Refuses to obey the orders of the Chief Controller of Examinations/Controller of Examinations/any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that course and all other courses the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the courses of that

	Controller of Examinations or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the Controller of Examinations, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	semester. If the candidate physically assaults the invigilator/Controller of the Examinations, then the candidate is also debarred and forfeits his/her seat. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred for two consecutive semesters from class work and all Semester-end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester. The candidate is also debarred and forfeits the seat.

Note: Whenever the performance of a student is cancelled in any course(s) due to Malpractice, he has to register for Semester-end Examinations in that course(s) consequently and has to fulfill all the norms required for the award of Degree.

SREE VIDYANIKETHAN ENGINEERING COLLEGE

Sree Sainath Nagar, Tirupati – 517 102.

SVEC16 M. Tech. (PED) Course Structure

I-Semester

S. No.	Course Code	Course Title	Contact Periods per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Internal Marks	External Marks	Total Marks
1.	16MT1BS01	Applied Mathematics	4	-	-	4	4	40	60	100
2.	16MT12301	Advanced Power Semiconductor Devices	4	-	-	4	4	40	60	100
3.	16MT12302	Analysis of Inverters	4	-	-	4	4	40	60	100
4.	16MT12303	Analysis of Power Converters	4	-	-	4	4	40	60	100
5.	16MT12304	Modelling of Electrical Machines	4	-	-	4	4	40	60	100
6.	**Professional Elective-1**		4	-	-	4	4	40	60	100
	16MT12305	Electric and Hybrid-Electric Vehicles								
	16MT12306	Intelligent Controllers								
	16MT10707	Microcontrollers and Applications								
	16MT10705	Reactive Power Compensation and Management								
7.	16MT12331	Power Electronics Design Lab	-	-	4	4	2	50	50	100
8.	16MT12332	Power Electronics Simulation Lab	-	-	4	4	2	50	50	100
		Total	**24**	**-**	**8**	**32**	**28**	**340**	**460**	**800**
9.	16MT13808	Research Methodology (Audit course)	-	2	-	2	-	-	-	-

II-Semester

S. No.	Course Code	Course Title	Contact Periods per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Internal Marks	External Marks	Total Marks
1.	16MT22301	Linear and Nonlinear Control Systems	4	-	-	4	4	40	60	100
2.	16MT22302	Power Electronics in Renewable Energy Systems	4	-	-	4	4	40	60	100
3.	16MT22303	Solid State AC Drives	4	-	-	4	4	40	60	100
4.	16MT22304	Solid State DC Drives	4	-	-	4	4	40	60	100
5.	16MT22305	Special Electrical Machines	4	-	-	4	4	40	60	100
6.	**Professional Elective-2**		4	-	-	4	4	40	60	100
	16MT20701	Flexible AC Transmission Systems								
	16MT20707	High Voltage DC Transmission								
	16MT20708	Power Quality								
	16MT20709	Smart Grid Technology								
7.	16MT22331	Electric Drives Lab	-	-	4	4	2	50	50	100
8.	16MT22332	Electric Drives Simulation Lab	-	-	4	4	2	50	50	100
9.	16MT22333	Seminar	-	-	-	-	2	--	100	100
Total:			**24**	**-**	**8**	**32**	**30**	**340**	**560**	**900**
10.	16MT23810	Intellectual Property Rights (Audit Course)	-	2	-	2	-	-	-	-

III-Semester

S. No.	Course Code	Course Title	Contact Periods per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P*	Total		Internal Marks	External Marks	Total Marks
1.	16MT32301	Project Work – Phase I	-	-	-	-	-	100	--	100
2.	16MT3MOOC	MOOC	-	-	-	-	-	-	-	-
Total:			**-**	**-**	**-**	**-**	**-**	**100**	**--**	**100**

*Fulltime Project Work

IV-Semester

S. No.	Course Code	Course Title	Contact Periods per Week				Credits	Scheme of Examination Max. Marks		
			L	T	P*	Total		Internal Marks	External Marks	Total Marks
1.	16MT42301	Project Work – Phase II	-	-	-	-	28	100	200	300
Total:			**-**	**-**	**-**	**-**	28	100	200	300
Grand Total:							86	880	1220	2100

*Fulltime Project Work

M. Tech. (PED) – I Semester

(16MT1BS01) APPLIED MATHEMATICS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Course on Engineering Mathematics at UG Level.

COURSE DESCRIPTION:

Matrix theory, Calculus of variations, One dimensional random variables, Linear programming and Fourier series.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- matrix theory and eigen vectors
- functions of several variables
- probability theory and distributions
- optimization processes
- fourier series

CO2. analyze and solve problems involving
- matrix factorizations
- variations in moving boundaries
- probability distributions
- optimization methods
- power signals

CO3. design mathematical models for power signals, power electronic circuits and drives.

CO4. develop advanced skills in analyzing the complex problems involving periodic and non-periodic functions in power signals, power electronic circuits and allied areas.

DETAILED SYLLABUS:

UNIT-I: MATRIX THEORY (11 periods)

The Cholesky decomposition - Generalized Eigen vectors, Canonical basis - QR factorization – Least squares method - Singular value decomposition.

UNIT–II: CALCULUS OF VARIATIONS (11 periods)

Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.

UNIT–III: ONE DIMENSIONAL RANDOM VARIABLES (11 periods)

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT-IV: LINEAR PROGRAMMING (11 periods)

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models.

UNIT-V: FOURIER SERIES (11 periods)

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Non-periodic function: Extension to other intervals – Power signals: Exponential Fourier series – Parseval's theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm-Liouville systems – Generalized Fourier series.

Total Periods: 55

TEXT BOOKS:

1. Richard Bronson, *Matrix Operation*, Schaum's outline series, 2nd edition, McGraw Hill, 2011.

2. Gupta, A.S., *Calculus of Variations with Applications*, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. Oliver C. Ibe, *Fundamentals of Applied Probability and Random Processes*, Academic Press, (An imprint of Elsevier), 2010.
4. Taha, H.A., *Operations Research, An introduction*, 10th edition, Pearson education, New Delhi, 2010.
5. Andrews L.C. and Phillips R.L., *Mathematical Techniques for Engineers and Scientists*, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.

REFERENCE BOOKS:

1. Elsgolts, L., *Differential Equations and the Calculus of Variations*, MIR Publishers, Moscow, 1973.
2. Grewal, B.S., *Higher Engineering Mathematics*, 42nd edition, Khanna Publishers, 2012.
3. O'Neil, P.V., *Advanced Engineering Mathematics*, Thomson Asia Pvt. Ltd., Singapore, 2003.
4. Johnson R. A. and Gupta C. B., *Miller & Freund's Probability and Statistics for Engineers*, Pearson Education, Asia, 7th edition, 2007.

M. Tech. (PED) – I Semester

(16MT12301) ADVANCED POWER SEMICONDUCTOR DEVICES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Electronic Devices and Power Electronics at UG Level.

COURSE DESCRIPTION:
Construction, types, switching, operating characteristics and applications of power semiconductor devices; Design of firing, protective circuits and heat sinks for various power semiconductor devices.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- construction, operation and characteristics of various power semiconductor devices.
- applications of power semiconductor devices.
- operation of firing and protection circuits.
- thermal protection of power semiconductor devices.

CO2. analyze various characteristics of power semiconductor devices.
CO3. design firing and protective circuits for power converters.
CO4. initiate research ideas in selecting the appropriate power semiconductor devices for desired applications.
CO5. select and apply the appropriate controlling and firing circuits for different power converters.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO POWER SWITCHING DEVICES (08 periods)
Power semiconductor devices: Introduction, classifications of various power switching devices – circuit symbols and ratings. Characteristics of an ideal switch, characteristics of practical devices, switch specifications, device selection strategy and Electro Magnetic Interference (EMI).
Power diodes: Construction, steady state characteristics, switching characteristics, electrical rating, Types – schottky diodes, fast recovery diodes, silicon carbide diodes, series and parallel connected diodes.

UNIT-II: THYRISTOR (10 periods)
Construction, steady state characteristics and switching characteristics. Thyristor protection – di/dt protection, dv/dt protection, design of snubber circuits, over voltage protection, over current protection and gate protection. Heat sink – Thermal resistance and specifications. Improvements of thyristor ratings and thyristor mounting techniques.

UNIT-III: POWER TRANSISTORS (14 periods)
Power Bipolar Junction Transistor: Construction, steady state characteristics, switching characteristics and Safe Operating Area (SOA).
Power MOSFETs: Types - Depletion & Enhancement, construction, steady state characteristics and switching characteristics.
IGBTs: Construction, steady state characteristics, switching characteristics, series & parallel operation, comparison of BJT, MOSFET & IGBT and design of snubber circuit.

UNIT-IV: SPECIAL POWER DEVICES (11 periods)
Thyristors: GTOs – Construction, operation, steady state characteristics and switching characteristics. Construction and operation: BCTs, TRIAC, FET – CTHs, ETOs, IGCTs, MCTs, SITHs, ASCR, RCT, SCS and light activated thyristor. Comparisons of various thyristors.
Transistors: Construction and operation – COOLMOS and SITs.

UNIT-V: GATE DRIVE CIRCUITS **(12 periods)**

MOSFET and BJT gate drive circuits. Isolation of gate and base drives – Pulse transformer and opto-couplers. Thyristor firing circuits – R, RC firing circuits, photo – SCR isolator, pulse transformer isolation, 1:6 isolation transformer for inverter gate bias circuits, thyristor converter gating circuits and UJT firing circuits. Gate drive ICs – MOSFETs and IGBTs. Drive ICs for converters – MOS Gated Driver.

Total Periods: 55

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th edition, 2013.
2. Dr. P. S. Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 5th edition, 2012.

REFERENCE BOOKS:

1. M. D. Singh & K. B. Kanchandhani, *Power Electronics*, Tata Mc Graw – Hill Publishing Company, 18th edition, 2013.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd edition, 2007.

M. Tech. (PED) – I Semester

(16MT12302) ANALYSIS OF INVERTERS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Power Electronics at UG Level.

COURSE DESCRIPTION:

Operation and performance of single phase and three phase voltage source inverters; Voltage control of single phase and three phase inverters; Design of PWM inverter; Current Source Inverters; Multilevel inverters and resonant inverters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- operation of various configurations of inverters.
- various voltage control methods.
- Pulse Width Modulation techniques.

CO2. analyze & comprehend the operating modes of inverters under different configurations subjected to various loads.

CO3. evaluate the performance of various types of inverters and PWM controllers.

CO4. conduct investigations to provide feasible solutions for the problems in the field of power inverters.

CO5. select appropriate controlling technique for improving the performance of inverters.

DETAILED SYLLABUS:

UNIT-I: SINGLE PHASE VOLTAGE SOURCE INVERTERS (11 periods)

Introduction, classification of inverters, single phase half bridge and full bridge voltage source inverters and performance parameters of inverter. Voltage control of single phase inverters – single PWM, multiple PWM, sinusoidal PWM, modified sinusoidal PWM and phase displacement control. Uninterruptable Power Supply (UPS) – offline and online.

UNIT-II: THREE PHASE VOLTAGE SOURCE INVERTERS (13 periods)

Introduction, 180° conduction mode with R and RL load, 120° conduction mode with R-load, comparison of two conduction modes, voltage control of three phase inverter -Advanced modulation techniques - trapezoidal, staircase, stepped, harmonic injection and delta modulation.

UNIT-III: CURRENT SOURCE INVERTERS (09 periods)

Introduction, Operation of six-step thyristor inverter, commutated Inverters, Auto Sequential Current source Inverter (ASCI), current pulsations, comparison of current source inverter and voltage source inverters, PWM techniques for current source inverters.

UNIT-IV: RESONANT PULSE INVERTERS (08 periods)

Introduction, series resonant inverters with unidirectional and bi-directional switches, frequency response of series resonant inverters-series loaded, parallel loaded, parallel resonant inverters, voltage control of resonant inverters and class E resonant inverters.

UNIT-V: MULTILEVEL INVERTERS (14 periods)

Introduction, multilevel concept, types of multilevel inverter, diode clamped multilevel inverter- principle of operation and features. Flying capacitor multilevel inverter - principle of operation and features. Cascaded multi-level inverter - principle of operation and features. Applications of multilevel inverters, switching device current, DC link capacitor voltage balancing and comparison of multilevel inverters.

Total Periods: 55

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th edition, 2013.

2. Ned Mohan, T. M. Undeland and W. P. Robbin, *Power Electronics: Converters, Application and Design*, Wiley, 3rd edition, 2007.

REFERENCE BOOKS:

1. Dr. P. S. Bimbhra, *Power Electronics,* Khanna publishers, New Delhi, 5th edition, 2012.
2. M D Singh & K B Khanchandani, *Power Electronics*, Tata McGraw – Hill Publishers, New Delhi, 2nd edition, 2013.
3. P C Sen, *Modern Power Electronics*, Wheeler publishing Co, New Delhi, 1st edition, 1998.

M. Tech. (PED) – I Semester

(16MT12303) ANALYSIS OF POWER CONVERTERS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Engineering Mathematics, Electrical circuits and Power Electronics at UG Level.

COURSE DESCRIPTION:

Single phase and three phase converters - Types, operation of controlled and uncontrolled converters; Analysis of isolated and non-isolated converters; AC voltage controllers; Choppers.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- operation of various types of AC–DC and DC-DC converters, AC voltage controllers.
- Total Harmonic Distortion.
- forced commutation circuits.

CO2. analyze & comprehend the operating modes of converters with different configurations subjected to various loads.

CO3. develop skills in evaluating the performance of various power converters.

CO4. initiate research ideas to provide feasible solutions for AC-DC and DC-DC converters.

CO5. select appropriate controlling techniques for improving the performance of Chopper.

DETAILED SYLLABUS:

UNIT-I: SINGLE PHASE RECTIFIERS (12 periods)

Introduction, classification of converters, analysis of semi controlled and fully controlled converters with R, R-L, R-L-E loads, freewheeling diodes, continuous & discontinuous modes of operation and evaluation of various performance parameters. Total Harmonic Distortion (THD), power factor, effect of source impedance, extinction angle control, symmetrical angle control and SPWM control.

UNIT-II: MULTI PULSE CONVERTERS (12 periods)

Introduction, analysis of semi converter and fully controlled converters with R, R-L loads, freewheeling diodes, continuous and discontinuous modes of operation. Total Harmonic Distortion (THD), power factor improvements and effect of source impedance.

UNIT-III: NON-ISOLATED DC-DC CONVERTERS (14 periods)

Introduction, Choppers: Types – Class A, B, C, D & E operation and characteristics. Concept of duty ratio and current limit control. Performance analysis of buck, boost, buck-boost, cuk, sepic and quadratic converters.

UNIT-IV: ISOLATED DC-DC CONVERTERS (11 periods)

Introduction, Performance analysis of forward, fly-back, push-pull, half-bridge and full-bridge converters. Resonant Converters-Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS) converters. Relationship between input and output voltages, expression for filter inductor and capacitors.

UNIT-V: AC VOLTAGE CONTROLLERS AND DUAL CONVERTERS (06 periods)

Principle of phase control: Single phase and three phase controllers - Analysis with R and R-L loads. Single phase dual converters: Non-circulating and circulating modes of operation.

Total Periods: 55

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th edition, 2013.

2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd edition, 2007.

REFERENCE BOOKS:

1. P C Sen, *Modern Power Electronics*, Wheeler publishing Co, 1st edition, New Delhi, 1998.
2. Bimal K Bose, *Modern Power Electronics and Drives*, Pearson Education, 2nd edition, 2003.
3. M D Singh & K B Khanchandani, *Power Electronics*, Tata McGraw – Hill Publishers, New Delhi, 2nd edition, 2013.

M. Tech. (PED) – I Semester

(16MT12304) MODELLING OF ELECTRICAL MACHINES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on DC Machines, Transformers and Induction Machines, Synchronous Machines.

COURSE DESCRIPTION:
Modelling and analysis of DC, induction and synchronous machines in stationary and rotating reference frames

COURSEOUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate potential knowledge on modelling of DC, induction and synchronous machines.
CO2. analyze the performance of DC, induction and synchronous machines.
CO3. design DC, induction and synchronous machines meeting the needs of industry.
CO4. apply appropriate transformation technique to obtain reference frame variables.

DETAILED SYLLABUS:

UNIT-I: BASIC PRINCIPLES OF ELECTRICAL MACHINE ANALYSIS (14 periods)
Magnetically coupled circuits: Review of basic concepts, magnetizing inductance, modeling linear and nonlinear magnetic circuits.
Electromechanical energy conversion: Principles of energy flow, concept of field energy and co-energy. Derivation of torque expression for various machines using the principles of energy flow and the principle of co-energy. Inductance matrices of induction and synchronous machines.

UNIT-II: THEORY OF DC MACHINES (09 periods)
Review of the DC machine. State-space model of a DC machine, reduced order model and Transfer functions of the DC machine. Numerical problems.

UNIT-III: REFERENCE FRAME THEORY (11 periods)
Concept of space vector, types of transformation, condition for power invariance, zero-sequence component, expression for power with various types of transformation. Transformations between reference frames: Clarke and Park's Transformations, variables observed from various frames.

UNIT-IV: THEORY OF SYMMETRICAL INDUCTION MACHINES (11 periods)
Voltage and torque in machine variables, derivation of dq0 model for a symmetrical induction machine, voltage and torque equation in arbitrary reference frame variables, analysis of steady state operation. State-space model of induction machine in 'd-q' variables. Numerical problems.

UNIT-V: THEORY OF SYNCHRONOUS MACHINES (10 periods)
Equations in arbitrary reference frame. Park's transformation, derivation of dq0 model for a salient pole synchronous machine with damper windings, torque expression of a salient pole synchronous machine with damper windings and identification of various components. Numerical problems.

Total Periods: 55

TEXT BOOKS:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, *Analysis of Electric Machinery & Drive systems,* IEEE Press, 2002.
2. R. Krishnan, *Electric motor drives, Modeling, Analysis and Control,* Prentice Hall, 2001.

REFERENCE BOOKS:

1. Rik De Doncker, Duco W. J. Pulle, André Veltman, *Advanced Electrical Drives: Analysis, Modeling, Control*, Springer, 2011.
2. A.E. Fitzgerald*,* Charles Kingsley, Stephen D. Umans, *Electric Machinery*, TMH, 5th edition, 2003.

M. Tech. (PED) – I Semester

(16MT12305) ELECTRIC AND HYBRID-ELECTRIC VEHICLES

(Professional Elective-1)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Power Electronics, Special Electrical Machines and Power Semiconductor Drives at UG Level

COURSE DESCRIPTION:

Transportation vehicles and their impact in society; Concept and configurations of Electric Vehicles (EV); Principle, Types and operation of Hybrid-Electric Vehicles (HEVs); Power Electronic converters in HEVs; Different motor drives & energy storage technologies in EVs and HEVs.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- fundamental concepts of Electric Vehicles (EVs) and Hybrid-Electric Vehicles (HEVs).
- utilization of power converters in electric mobility.
- deployment of various electrical drives used in EVs and HEVs.
- battery energy storage technologies used in EVs and HEVs.
- different applications of EVs and HEVs such as aircraft, ships and locomotives.

CO2. analyze
- the practical aspects of power converters in EVs/HEVs.
- suitability of a motor drive in a vehicle application.

CO3. develop skills in evaluating the basic schemes of series & parallel HEVs and energy storage technologies in EVs/HEVs.

CO4. undertake research by implementing
- special electrical machines such as Switched Reluctance Motor and Permanent Magnet Brushless DC Motor for EVs/HEVs.
- DC-DC boost converter for HEVs.

CO5. select and apply the appropriate power converter & energy storage techniques for designing EVs and HEVs in the applications of aircraft, ships and locomotives.

CO6.demonstrate
- the effects of modern transportation on society and environment.
- the need to develop sustainable technologies in place of conventional vehicles.

DETAILED SYLLABUS:

UNIT-I: ELECTRIC AND HYBRID ELECTRIC VEHICLES (09 periods)

Environmental impact and history of modern transportation, history of transportation electrification. Electric Vehicles (EVs) - Introduction, configurations and traction motor characteristics. Hybrid-Electric Vehicles (HEVs) - Concept and architectures; Series HEV - Configuration, operation, advantages and disadvantages; HEVs - Interdisciplinary nature, challenges and key technologies.

UNIT-II: POWER ELECTRONICS IN HEVS (13 periods)

Introduction, principle of power electronics, rectifiers used in HEVs, Buck converter used in HEVs. Non-isolated bidirectional DC-DC Converter - operating principle, torque and power capability, current ripple and regenerative braking. Isolated bidirectional DC - DC converter - principle, steady state operations, output voltage and output power. Battery chargers - forward, fly back and bridge converters.

UNIT-III: ELECTRIC PROPULSION SYSTEMS (13 periods)

Introduction, typical functional block diagram and classification of electric motor drive, DC motor drives - Control methods, class A and B choppers, two and four quadrant chopper control. Induction Motor drives - Operating principle, steady - state performance, v/f control and power electronic control. PM BLDC Motor drives - Construction, advantages and

disadvantages, performance analysis and control. Switched Reluctance Motor drives - SRM basic magnetic structure, torque production, converter topologies.

UNIT-IV: ENERGY STORAGE TECHNOLOGIES (12 periods)

Battery - basic theory and characterization, battery technologies, types – lead acid batteries, nickel-based batteries and lithium-based batteries. Ultra-capacitors - Features, basic principles, performance, battery modeling based on electric equivalent circuit, Modeling of ultra -capacitors, battery charging control and flywheel energy storage system. Fuel Cells - modeling and block diagrams of hybrid fuel cell energy storage systems.

UNIT-V APPLICATIONS OF HYBRID ELECTRIC VEHICLES (08 periods)

Introduction, Hydraulic Hybrid Vehicles (HHV) - Principle and operation of regenerative braking. Hybrid off road vehicular system, electric or hybrid ships and locomotives. Military applications - Electromagnetic launchers and hybrid-powered ships.

Total Periods: 55

TEXT BOOKS:

1. Mehrdad Ehsani, Yimin Gao and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles*, CRC Press, 2nd edition, 2015.
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, *Hybrid Electric Vehicles Principles and Applications with Practical Perspectives*, Wiley, 2011.

REFERENCE BOOKS:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals,* CRC Press, 2nd edition, 2011.
2. Jack Erjavec, *Hybrid, Electric & Fuel-Cell Vehicles*, Delmar Cengage learning, 2nd edition, 2013.

M. Tech. (PED) – I Semester

(16MT12306) INTELLIGENT CONTROLLERS

(Professional Elective-1)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Engineering Mathematics, Power Electronics, Electrical machines and Control Systems at UG level.

COURSE DESCRIPTION:

Neural Networks; Fuzzy Logic Systems; Genetic Algorithms; Hybrid Intelligent Systems; Swarm Intelligence; Applications.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge of soft computing techniques to build intelligent systems.
CO2. analyze complex engineering problems with intelligent techniques.
CO3. design and develop intelligent systems for power electronic controllers.
CO4. initiate research related to applications of soft computing in the fields of power converters and allied areas.
CO5. select and apply suitable intelligent techniques for appropriate power converter fed drives

DETAILED SYLLABUS:

UNIT–I: NEURAL NETWORKS (11 periods)

Neural network architectures, perceptron model, Learning strategies – Supervised Learning – radial basis function network, back propagation network. Unsupervised learning – Kohonen's SOM. Reinforced learning. PWM generation using neural networks.

UNIT–II: FUZZY LOGIC SYSTEMS (11 periods)

Fuzzy sets– relations & operations, membership functions, fuzzification, rule base, inference mechanism, defuzzification and design of fuzzy control system, speed control of DC motor using fuzzy logic.

UNIT–III: GENETIC ALGORITHMS (10 periods)

Introduction to evolutionary computation, Genetic Algorithms (GA) – Biological background, traditional optimization and search techniques - Basic terminologies - Simple GA - flow chart – Operators in GA - encoding, selection, crossover, mutation, constraints in GA, fitness function, advantages and limitations of GA, PWM generation using GA.

UNIT–IV: HYBRID INTELLIGENT SYSTEMS (11 periods)

Introduction to hybrid intelligent systems – Adaptive neuro-fuzzy inference systems – architecture and learning. Fuzzy GA systems – rules generation. ANN learning using GA – Optimization of weights, speed control of brushless DC drive using neuro - fuzzy approach.

UNIT–V: SWARM INTELLIGENCE (12 periods)

Introduction to swarm intelligence, swam intelligence algorithms - Ant colony optimization: biological and artificial ant colony systems, applications of ant colony intelligence: Static & dynamic combinatorial optimization problems, algorithm of ant colony system, particle swarm optimization: The basic PSO method, characteristic features of PSO, PSO algorithm, optimum parameter setting for the best performance of PSO, comparison with other evolutionary computing techniques, application of PSO intelligence in renewable energy systems.

Total Periods: 55

TEXT BOOKS:

1. S.N. Sivanandam, S.N. Deepa, *Principles of soft computing*, Wiley – India Edition, 2008.
2. N.P. Padhy, *Artificial Intelligence and intelligent systems*, Oxford university press, 10th Impression, 2011.

REFERENCE BOOKS:

1. Saroj Kaushik, *Artificial Intelligence*, Cengage Learning, Fifth Indian reprint, 2013.
2. J.S.R. Jang, C.T. Sun, E. Mizutani, *Neuro - Fuzzy & Soft computing*, Pearson Education Limited, 2004.
3. Fakhreddine O. Karray, Clarence De Silva, *Soft computing & Intelligent systems design, Theory, tools and applications,* Pearson Education Limited, 2009.

M. Tech. (PED) – I Semester

(16MT10707) MICROCONTROLLERS AND APPLICATIONS

(Common to EPS & PED)

(Professional Elective-1)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Digital logic design, Microprocessors and Microcontrollers at UG level.

COURSE DESCRIPTION:

8051 Microcontroller: Architecture, Programming and Interfacing; PIC Microcontrollers: Architecture, features, programming and Interfacing

COURSE OUTCOMES: On successful completion of the course, the students will be able to

CO1. demonstrate knowledge on
- architecture of 8051 and PIC microcontroller
- salient features of 8051 and PIC

CO2. analyze and develop a suitable interface with an appropriate microcontroller for the control operations.

CO3. develop programs for stand-alone systems.

CO4. do research by identifying a suitable microcontroller for solving complex problems in the domain of Power Electronics and Drives.

CO5. use tools like PROTEUS, MPLAB, SCILAB, PIC 'C' Compiler etc., for the design, analysis and implementation of the system.

DETAILED SYLLABUS:

UNIT–I: 8051 MICROCONTROLLER (12 Periods)

Overview of 8051 microcontrollers. 8051/8052 – architecture and features. Memory – internal / external Program, Data memory and their interfacing. Data memory – Register Bank, Bit addressable space, scratch pad area. Special Function Registers (SFRs). Instruction set – Data transfer, Arithmetic, logical, branch control instructions. Addressing modes. Timers – Mode - 0, 1, 2 and 3 operations, TMOD, TCON. Timer applications – wave generation, Device control operations.

UNIT-II: 8051 INTERFACING (10 Periods)

Basics of serial communication – RS232, MAX232, Baud rate. Serial port programming - SCON, SMOD, SBUF, PCON. Interrupts – IE, TCON, IP. Applications using interrupts of 8051/8052 – wave generation. Device control operations. Interfacing – ADC, DAC, DC motor key board and PWM.

UNNIT-III: PIC MICROCONTROLLERS (11 Periods)

CISC vs RISC. Harvard vs Von Neumann architectures. PIC16F87XA architecture and features. PIC16 Memory organization – program memory, data memory. PIC Register file – General purpose registers and SFRs.

Introduction to PIC Assembly Programming, PIC Data Format and Directives. PIC programming tools. Instruction set – data transfer, arithmetic, logical, bit manipulation, branch Instructions. I/O Port Programming. Addressing modes – Immediate, Direct, Register Indirect Addressing Modes. Macros and Modules. PIC programming using MPLAB and PIC 'C' Compiler.

UNIT–IV: SERIAL, INTERRUPT, I/O PORTS AND TIMER PROGRAMMING (11 Periods)

I/O ports – Port A, TRISA, Port B, TRISB, Port C TRISC. Timer - 0, 1, 2 modules. Compare mode, capture mode. PIC Serial Port programming, PIC Interrupts, Programming Timer Interrupts, Programming the Serial Communication Interrupts, Port-B - Change Interrupt, Interrupt Priority in the PIC.

UNIT–V: PIC INTERFACING **(11 Periods)**

ADC Characteristics, ADC Programming in the PIC, DAC Interfacing, Sensor Interfacing and Signal Conditioning, Standard and Enhanced CCP Modules, Compare Mode Programming, Capture Mode Programming, PWM Programming, ECCP Programming, Relays and Opto-isolators, Stepper Motor Interfacing, DC Motor Interfacing and PWM, PWM Motor Control with CCP, DC Motor Control with ECCP.

Total Periods: 55

TEXT BOOKS:

1. Muhammad Ali MAzidi, Jancie Gillispie Mazidi, Rolin McKinlay, *The 8051 Microcontroller and Embedded Sytems using Assembly and C*, Pearson Education, 2nd edition, 2007.
2. John B. Peatman, *Design with PIC Microcontrollers*, Pearson Education, 2007.

REFERENCE BOOKS:

1. PIC16F87XA manual.
2. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, *PIC Microcontroller and Embedded Systems using assembly and C for PIC 18,* Pearson Education, 1999.
3. John B. Peatman, *Embedded design with the PIC18F452 Microcontroller*, Printice Hall, 2003

M. Tech. (PED) – I Semester

(16MT10705) REACTIVE POWER COMPENSATION AND MANAGEMENT

(Common to EPS & PED)

(Professional Elective-1)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	-	-	4

PREREQUISITES: Power Systems at UG level

COURSE DESCRIPTION:

Reactive Power compensation: Ideal compensator; Line and load compensation ; Compensating devices; Reactive power coordination; Quality of power supply; Distribution side management; Reactive power management in domestic and industrial sectors.

COURSE OUTCOMES: On successful completion of the course the students will be able to

CO1. demonstrate advanced knowledge on:
- necessity for reactive power compensation
- different methods of reactive power compensation.
- types of load patterns and loss reduction methods in distribution lines.

CO2. analyze different types of compensations

CO3. develop skills in designing a compensator for industrial applications**.**

CO4. do research in reactive power management in commercial and industrial applications

DETAILED SYLLABUS:

UNIT–I: REACTIVE POWER COMPENSATION (10 periods)

Need for Reactive Power compensation – reactive power characteristics. Ideal compensator, practical compensation – power factor correction and voltage regulation. Load compensator as a voltage regulator, phase balancing and power factor correction of unsymmetrical loads– examples.

UNIT–II: REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEMS (12 periods)

Steady state Reactive power compensation – Uncompensated line. Types of compensation, Passive shunt, series and dynamic shunt compensation–examples.

Transient state Reactive power compensation – Characteristic time periods. Passive shunt compensation. Static compensations–series capacitor compensation, compensation using synchronous condensers -examples

UNIT–III: REACTIVE POWER COORDINATION AND PLANNING (11 periods)

Reactive power coordination: Objectives, Mathematical modeling, Operation planning, transmission benefits. Basic concepts of quality of power supply: Disturbances, steady – state variations, effects of under voltages, frequency, Harmonics, radio frequency and electromagnetic interferences, IEEE /IEC standards.

Reactive power planning: Objectives, Economics Planning capacitor placement and retrofitting of capacitor banks.

UNIT–IV: REACTIVE POWER MANAGEMENT (12 periods)

KVAR requirements for domestic appliances: Purpose of using capacitors, selection of capacitors, deciding factors. Types of available capacitors – characteristics and limitations, Control of capacitors.

Demand side management: Load patterns, basic methods load shaping, power tariffs, KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels - System losses, loss reduction methods - examples.

UNIT–V: REACTIVE POWER MANAGEMENT IN INDUSTRIAL SECTORS (10 periods)

Typical layout of traction systems–reactive power control requirements. Distribution transformers, Electric arc furnaces, textile and plastic industries, furnace transformer, filter

requirements, remedial measures, and power factor of an arc furnace, role of capacitors in wind mill generator, minimum capacitance required for excitation.

Total Periods: 55

TEXT BOOKS:

1. T.J.E. Miller, *Reactive power control in Electric power systems*, John Wiley and Sons, 1982.
2. D.M. Tagare, *Reactive power Management*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

REFERENCE BOOKS:

1. Wolfgang Hofmann, Jurgen schiabbach, Wolfgang just, *Reactive power compensation: A Practical Guide,* Willey, April, 2012.

M. Tech. (PED) – I Semester

(16MT12331) POWER ELECTRONICS DESIGN LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	--	--	4	2

PREREQUISITES: Courses on Electronic Devices and Power Electronics at UG Level.

COURSE DESCRIPTION: Design and development of various power converters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate practical knowledge on:
- design and development of power converters.
- understanding of gate firing circuits.

CO2. analyze and relate physical observations and measurements of various power converters with theoretical principles.

CO3. solve engineering problems related to power converters and firing circuits to provide feasible solutions.

CO4. initiate research ideas to provide solutions for design of power converters.

CO5. select and apply
- suitable commutation circuit for various power converters.
- PWM technique for multilevel inverters.

CO6. prepare laboratory reports that clearly communicate experimental information.

CO7. practice professional code of ethics.

CO8. function effectively as an individual and as a member in the team to solve various problems.

LIST OF EXPERIMENTS:

Conduct any Two Experiments from the following:

1. Design, develop and analyze DC to DC converter using IGBTs.
2. Design, develop and analyze DC to DC converter using Power MOSFETs.
3. Design, develop and analyze DC to AC converter using IGBTs.
4. Design, develop and analyze DC to AC converter using Power MOSFETs.
5. Design, develop and analyze AC to AC converters using SCRs.
6. Design, develop and analyze AC to AC converters using TRIACs/SCRs.
7. Design, develop and analyze AC to DC converters using SCRs.
8. Design, develop and analyze AC to DC converters using SCRs and Diodes.
9. Analysis of Three Level Neutral Point Clamped Multilevel Inverter.

M. Tech. (PED) – I Semester

(16MT12332) POWER ELECTRONICS SIMULATION LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	--	--	4	2

PREREQUISITES: Courses on Electronic Devices and Power Electronics at UG Level.

COURSE DESCRIPTION: Design and analysis of various converters and inverters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on various power converters.
CO2. analyze the performance of various power converters.
CO3. evaluate the output characteristics of different types of Power converters.
CO4. initiate research ideas to provide solutions for design of power converters.
CO5. select and apply appropriate control techniques for power converters.
CO6. function effectively as an individual and as a member in the team to solve various problems.
CO7. prepare laboratory reports that clearly communicate experimental information.
CO8. practice professional code of ethics.

LIST OF EXPERIMENTS:

Conduct any TEN Experiments from the following using MATLAB

1. Simulation of single phase semi converter.
2. Simulation of single phase fully controlled converter.
3. Simulation of three phase semi converter.
4. Simulation of three phase fully controlled converter.
5. Simulation of single phase full bridge inverter.
6. Simulation of three phase full bridge inverter.
7. Simulation of sinusoidal PWM inverter.
8. Simulation of single phase and three phase AC voltage controllers.
9. Simulation of DC–DC Buck–Boost Converter.
10. Simulation of Three level Neutral Point Clamped multilevel inverter.
11. Simulation of Five level H-Bridge cascaded multilevel inverter.

M. Tech. (PED) – I Semester

(16MT13808) RESEARCH METHODOLOGY

(Common to all M. Tech. Programs)

(Audit Course)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
-	-	-	--	2	--	--

PREREQUISITES: --

COURSE DESCRIPTION:

Overview of Research, research problem and design, various research designs, data collection methods, statistical methods for research, importance of research reports and its types

COURSE OUTCOMES: On successful completion of the course, student will be able to

CO1. demonstrate knowledge on
- research design and conducting good research,
- various data collection methods,
- statistical methods in research,
- report writing techniques.

CO2. analyze various research design issues for conducting research in core or allied areas

CO3. formulate solutions for engineering problems by conducting research effectively in the core or allied areas

CO4. carryout literature survey and apply good research methodologies for the development of scientific/technological knowledge in one or more domains of engineering.

CO5. select and apply appropriate techniques and tools to complex engineering activities in their respective fields

CO6. write effective research reports.

CO7. develop attitude for lifelong learning to do research

CO8. develop professional code of conduct and ethics of research.

DETAILED SYLLABUS:

UNIT - I: INTRODUCTION TO RESEARCH METHODOLOGY (05 Periods)

Objectives and Motivation of Research, Types of Research, Research Approaches, Research Process, Criteria of good Research, Defining and Formulating the Research Problem, Problem Selection, Necessity of Defining the Problem, Techniques involved in Defining a Problem.

UNIT - II: RESEARCH PROBLEM DESIGN AND DATA COLLECTION METHODS (07 Periods)

Features of Good Design, Research Design Concepts, Different Research Designs, Different Methods of Data Collection, Data preparation: Processing Operations, Types of Analysis.

UNIT - III: STATISTICS IN RESEARCH (06 Periods)

Review of Statistical Techniques - Mean, Median, Mode, Geometric and Harmonic Mean, Standard Deviation, Measure of Asymmetry, ANOVA, Regression analysis.

UNIT - IV: HYPOTHESIS TESTING (07 Periods)

Normal Distribution, Properties of Normal Distribution, Basic Concepts of Testing of Hypothesis, Hypothesis Testing Procedure, Hypothesis Testing: t-Distribution, Chi-Square Test as a Test of Goodness of Fit.

UNIT - V: INTERPRETATION AND REPORT WRITING (03 Periods)

Interpretation – Techniques and Precautions, Report Writing – Significance, Stages, Layout, Types of reports, Precautions in Writing Reports.

Total Periods: 28

TEXT BOOK:

1. C.R. Kothari, *Research Methodology: Methods and Techniques*, New Age International Publishers, New Delhi, 2nd revised edition, 2004.

REFERENCE BOOKS:

1. Ranjit Kumar, *Research Methodology: A step-by-step guide for beginners*, Sage South Asia, 3rd edition, 2011.
2. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.

M. Tech. (PED) – II Semester

(16MT22301) LINEAR AND NON-LINEAR CONTROL SYSTEMS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Course on Control systems in UG Level.

COURSE DESCRIPTION:
Design of compensators and controllers; describing function, phase plane analysis, Lyapunov's stability analysis; Full order observer and reduced order observer; Nonlinear control design.

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

CO1. demonstrate knowledge on
- various compensators and controllers.
- stability in the sense of Lyapunov.
- nonlinear control design.

CO2. analyze the stability of nonlinear system using
- describing function approach.
- phase plane analysis.
- Lyapunov's method.

CO3. design suitable compensator and controllers using root locus and Bode plot.
CO4. solve stability problems using Lyopunov method.
CO5. select appropriate techniques for analyzing stability of the system.

DETAILED SYLLABUS:

UNIT–I: LINEAR CONTROL SYSTEM DESIGN (12 periods)
Introduction to control system design, types of compensators, design of compensators using root locus technique. Types of controllers, design of PI, PD and PID controllers using Bode plot and root locus technique.

UNIT–II: DESIGN OF CONTROL SYSTEMS IN STATE SPACE (11 periods)
Necessity of pole placement, design by pole placement, necessary and sufficient conditions for arbitrary pole placement. Determination of feedback gain matrix using direct substitution method and Ackermann's formula. Full order observer and reduced order observer.

UNIT-III: LYAPUNOV STABILITY (11 periods)
Introduction, stability in the sense of Lyapunov, basic definitions, Lyapunov's second method, Lyapunov's functions for nonlinear systems - variable gradient method, Krasooviski's method.

UNIT–IV: INTRODUCTION TO NON LINEAR SYSTEM (15 periods)
Introduction to non-linear systems, different types of physical non-linearities, describing functions, derivation of describing functions for dead zone, saturation, backlash, relay and hysteresis. Stability analysis of non-linear systems through describing functions, phase-plane analysis, singular points, methods for constructing trajectories - Isoclines' method, delta method.

UNIT–V: NON-LINEAR CONTROL DESIGN (06 periods)
Feedback linearization, Input/output linearization, sliding mode control.

Total Periods: 55

TEXT BOOKS:

1. M. Gopal, *Modern Control System Theory*, New Age International (P) Ltd., 2nd edition, 2000.
2. K. Ogata, *Modern Control Engineering*, Prentice Hall of India, 4th edition, 2006.
3. Hasan A. Khalil *Nonlinear Systems,* Prentice Hall of India, 3rd edition, 2002.

REFERENCE BOOKS:

1. A. Nagoorkani, *Advanced control theory*, RBA publications, 2nd edition, 1999.
2. I.J. Nagrath and M.Gopal, *Control Systems Engineering*, New Age International (P) Ltd., 2007.

M. Tech. (PED) – II Semester

(16MT22302) POWER ELECTRONICS IN RENEWABLE ENERGY SYSTEMS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Analysis of power converters, Analysis of inverters and Modelling of electrical machines.

COURSE DESCRIPTION:
Solar energy conversion system; Types of photovoltaic systems – Stand-alone, hybrid and grid connected systems; Wind Energy Conversion Systems; Types of WECS - stand-alone, hybrid and grid connected systems; Hybrid systems – PV-diesel, PV-wind and wind-diesel hybrid systems.

COURSE OUTCOMES: On successful completion of this course, student will be able to

CO1. demonstrate potential knowledge on
- photo-voltaic panels and wind turbines.
- various possible hybrid systems.
- operation of stand-alone and grid connected renewable energy systems.
- applications of various renewable energy systems.

CO2. analyze the performance of converters used for various conversion systems.
CO3. solve engineering problems pertaining to Renewable Energy Conversion Systems to provide feasible solutions.
CO4. initiate research to design PV system, wind energy system and controller for power converters.
CO5. select and apply appropriate controlling technique and converters for applications of various Renewable energy systems.
CO6. possess knowledge in turbines, gears and generators and contribute positively to collaborative-multidisciplinary scientific research.
CO7. follow professional code for safe and reliable operation of electrical appliances and power grid.

DETAILED SYLLABUS:

UNIT-I: POWER CONVERTERS FOR SOLAR APPLICATIONS (12 periods)
Solar: Characteristics of sunlight, semiconductors and P-N junctions, behavior of solar cells, cell properties, PV cell interconnection, block diagram of solar photo voltaic system. Principle of operation: line commutated converters (inversion-mode), boost and buck-boost converters. Selection of inverter. Multilevel inverters and its types. Battery sizing and array sizing.

UNIT-II: PHOTO VOLTAIC POWER SYSTEMS (11 periods)
Types of PV Systems: Stand-alone PV system: Charge controllers - series, shunt charge regulators and DC/DC converters, maximum power point tracking, selection of inverters, solar pumping application.
Grid Connected PV Systems: Inverter types – Line, self-commutated inverters and PV inverter with high frequency transformer, grid-compatible inverter characteristics

UNIT-III: ELECTRICAL MACHINES AND POWER CONVERTERS FOR WIND APPLICATIONS (13 periods)
Wind: Basic principle of wind energy conversion, nature of wind, power in the wind, components of Wind Energy Conversion System (WECS), performance of induction generators for WECS, classification of WECS.
Electrical Machines: Principle of operation and analysis of induction generator, permanent magnet synchronous generator, squirrel cage induction generator and doubly fed induction generator. Power converters: Three phase AC voltage controllers, AC/DC/AC converters - uncontrolled rectifiers, PWM inverters, grid interactive inverters and matrix converters.

UNIT-IV: WIND POWER SYSTEMS (11 periods)

Types of wind power systems, stand-alone WECS: Elements of a stand-alone WECS, battery charging application with block diagram.

Grid connected WECS: Soft starting technique of induction generator, control of wind turbines-fixed and variable speed wind turbines. Selection of generators for variable speed wind turbines - Synchronous generator, squirrel cage and wound rotor induction generator. Isolated grid supply system with multiple wind turbines.

UNIT-V: HYBRID ENERGY SYSTEMS (08 periods)

Need for hybrid energy systems, issues in designing the hybrid energy systems. PV and Diesel hybrid system: Types – Series, parallel and switched hybrid energy systems. Stand-alone PV and wind hybrid energy system. Hybrid wind and diesel energy systems.

Total Periods: 55

TEXT BOOKS:

1. Rashid. M. H, *Power electronics Hand book*, Academic press, 2001.
2. Mukund R Patel, *Wind and Solar Power Systems*, CRC Press, 2004.

REFERENCE BOOKS:

1. J K Kaldellis, *Stand-alone and Hybrid Wind Energy Systems: Technology, Energy Storage and Applications*, Woodhead Publishing, 2010.
2. Rai, G.D., *Non-conventional Energy Sources*, Khanna Publishers, New Delhi, 2002.

M. Tech. (PED) – II Semester

(16MT22303) SOLID STATE AC DRIVES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Analysis of inverters and modelling of electrical machines.

COURSE DESCRIPTION:

Open loop and closed loop speed control of induction motor; Synchronous motor drive; Induction motor drive, torque control, field oriented control, flux vector estimation, synchronous motor control.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- operating regions of various AC drives.
- speed control of induction motor drives.
- control of synchronous motor drives.
- field oriented control of induction machines.

CO2. analyze the operation and performance of power converter fed AC motors.

CO3. solve engineering problems pertaining to AC drives to provide feasible solutions.

CO4. initiate research to design open loop and closed loop controllers for controlling of AC motors.

CO5. select and apply appropriate power circuit configuration for the speed control of AC motor drives.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO INDUCTION MOTORS (09 periods)

Steady state performance equations. Rotating magnetic field, torque production, equivalent circuit, variable voltage, constant frequency operation, variable frequency operation, constant Volt/Hz operation. Drive operating regions, variable stator current operation, different braking methods.

UNIT-II: STATOR FREQUENCY CONTROL (12 periods)

Operation of induction motor with non-sinusoidal supply waveforms, variable frequency operation of PWM inverter fed three phase induction motors, constant flux operation & current fed operation, dynamic and regenerative braking of Current Source Inverter(CSI) and Voltage Source Inverter (VSI) fed drives.

UNIT-III: ROTOR RESISTANCE CONTROL (11 periods)

Torque-Slip characteristics, sub- and super- synchronous operation, slip control, rotor resistance control, chopper controlled resistance, equivalent resistance, TRC strategy. Characteristic relation between slip and chopper duty ratio, combined stator voltage control and rotor resistance control. Design solutions: Closed loop control scheme, slip power recovery schemes and power factor considerations.

UNIT-IV: FIELD ORIENTED CONTROL (12 periods)

Dynamic modeling of induction machines. Introduction to field oriented control of induction machines: Theory, DC drive analogy. Direct and Indirect methods. Flux vector estimation using voltage model and current model equations, merits and demerits. Direct Torque Control (DTC) of induction machines, torque expression with stator and rotor fluxes, DTC control strategy. Closed loop speed control.

UNIT-V: SPEED CONTROL OF SYNCHRONOUS MOTORS (11 periods)

Wound field cylindrical rotor motor, equivalent circuits, performance equations of operation from a voltage source. V-curves. Starting and braking. Open loop VSI and CSI fed synchronous motor. Self-control and Load commutated synchronous motor drives: Margin angle control, torque angle control, power factor control. Brush and Brushless excitation. Closed loop speed control scheme with various power controllers.

Total Periods: 55

TEXT BOOKS:

1. Gopal K.Dubey, *Power semiconductor controlled Drives*, Prentice Hall Inc., New Jersey, 1989.
2. R.Krishnan, *Electric Motor Drives- Modeling, Analysis and Control*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.

REFERENCE BOOKS:

1. Gopal K.Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 2001.
2. Bimal K.Bose, *Modern Power Electronics and AC Drives*, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2002.
3. W.Shepherd, L.N.Hulley, D.T.W.Liang, *Power electronics and motor control*, Cambridge university press, 1996.
4. M.D.Singh, *Power Electronics*, Tata McGraw-Hill publishing company Ltd., New Delhi, 2008.

M. Tech. (PED) – II Semester

(16MT22304) SOLID STATE DC DRIVES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Analysis of power converters and Modelling of electrical machines.

COURSE DESCRIPTION:

Operation, characteristics, speed control and applications of DC motors; Performance characteristics and parameters of single phase, three phase and twelve pulse converters fed DC motor; Open loop, closed loop and digital control of DC drives.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- power circuit configuration.
- steady state operation and transient dynamics of motor load system.
- characteristics of DC motors.

CO2. analyze
- the operation of converter/chopper fed DC drives.
- single phase and three phase converter fed drives.
- the closed loop control and digital control of DC drives.

CO3. design speed controllers for closed loop solid-state DC drives.

CO4. solve engineering problems pertaining to electrical drives to provide feasible solutions.

CO5. select and apply appropriate power circuit configuration of the phase controlled rectifiers and choppers for the speed control of DC drives.

DETAILED SYLLABUS:

UNIT–I: DC MOTOR FUNDAMENTALS AND MECHANICAL SYSTEMS (10 periods)

DC motor: Types, induced emf, speed-torque relations, electro-mechanical modeling, state space modeling of DC motor. Speed control: Armature and Field control, Ward Leonard Control - constant torque and horse power applications.

Characteristics of mechanical system: Dynamic equations, components of torque, types of load. Electric braking. Requirements of drives characteristics. Multi-quadrant operation.

UNIT–II: CONVERTER FED DC MOTOR DRIVES (14 periods)

Principle of phase control, fundamental relations. Analysis of series and separately excited DC motor with single-phase, three-phase and twelve pulse converters – waveforms, performance parameters and characteristics.

Steady state analysis of three phase controlled converter DC motor drive, average analysis, steady state modeling. Continuous and Discontinuous armature current operations, current ripple and its effect on performance, operation with freewheeling diode. Implementation of braking schemes, drive employing dual converter and applications. Four quadrant DC motor drive. Converter selection and its characteristics.

UNIT–III: CHOPPER CONTROL (15 periods)

Introduction to time ratio control and frequency modulation, model of chopper, input to the chopper. Class A, B, C, D and E chopper controlled DC motor: performance analysis, multi-quadrant control, chopper based implementation of braking schemes. Steady state analysis of chopper controlled DC motor drive, rating of devices, pulsating torques. Multi-phase chopper and applications.

UNIT–IV: CLOSED LOOP CONTROL OF DRIVES (09 periods)

Modeling of drive elements, equivalent circuit, transfer function of self, separately excited DC motors. Linear transfer function model of power converters, sensing and feedback elements, closed loop speed control, current and speed loops. P, PI and PID Controllers – response comparison.

UNIT–V: DIGITAL CONTROL OF DC DRIVES (07 periods)

Phase Locked Loop and micro-computer control of DC drives. Program flow chart for constant horse power and load disturbed operations. Speed detection and gate firing.

Total Periods: 55

TEXT BOOKS:

1. Gopal K. Dubey, *Power semiconductor controlled Drives*, Prentice Hall Inc., New Jersey, 1989.
2. R. Krishnan, *Electric Motor Drives- Modeling, Analysis and Control*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.

REFERENCE BOOKS:

1. Gopal K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 2001.
2. Bimal K. Bose, *Modern Power Electronics and AC Drives*, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2002.
3. M.D. Singh, *Power Electronics*, Tata McGraw-Hill publishing company Ltd., New Delhi, 2008.

M. Tech. (PED) – II Semester

(16MT22305) SPECIAL ELECTRICAL MACHINES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: Courses on Electrical Machines, Control Systems and power electronics at UG level and Modelling of electrical machines at PG level

COURSE DESCRIPTION:

Construction, operation, types, characteristics and applications of Stepper Motors, Switched Reluctance Motor, PM Brushless DC Motor, Synchronous Reluctance, Linear Induction and synchronous Motors.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on
- construction and operation of various types of special electrical machines.
- characteristics of special electrical machines.
- open loop and closed loop operation of special electrical machines.

CO2. analyze the operation and performance of special electrical machines for various operating conditions.

CO3. design suitable accessories / controllers for desired operation and control of special electrical machines.

CO4. solve engineering problems pertaining to special electrical machines to provide feasible solutions.

CO5. select and apply appropriate technique and tools for control and operation of special electrical machines in domestic and industrial applications.

CO6. apply the conceptual knowledge of special electrical machines in relevance to industry and society.

DETAILED SYLLABUS:

UNIT-I: STEPPER MOTOR (09 periods)

Types of construction and working principle of stepping motor. Various configurations for switching the phase windings, torque equation and characteristics. Open loop and closed loop control of stepper motor, applications.

UNIT-II: SWITCHED RELUCTANCE MOTOR (09 periods)

Construction details, Principle of operation – Design of stator and rotor pole arcs – torque equation and characteristics, power converter for switched reluctance motor, control of switched reluctance motor, rotor sensing mechanism.

UNIT-III: SYCHRONOUS RELUCTANCE MOTOR (09 periods)

Constructional features, Types – Axial and Radial flux motors. Principle of operation, torque-speed characteristics, Phasor diagram, Characteristics, control of SyRM, advantages and applications.

UNIT-IV: PERMANENT MAGNET BRUSHLESS DC MOTOR (09 periods)

Permanent magnet materials–hysteresis loop, analysis of magnetic circuits. Constructional details, principle of operation, BLDC square wave motor, types of BLDC motor, sensing and switching logic schemes, sensorless and sensor based control of BLDC motors.

UNIT-V: LINEAR MOTORS (09 periods)

Linear Induction Motor (LIM): Construction, principle of operation – single sided and double-sided LIM, thrust equations and performance equations based on current sheet concept, equivalent circuit of LIM, applications.

Linear Synchronous Motor (LSM): Construction, types, principle of operation, thrust equation, control and applications.

Total Periods: 45

TEXT BOOKS:

1. K. Venkata Ratnam, *Special electrical machines*, University press, New Delhi, 2009.
2. E.G. Janardhanan, *Special electrical machines*, PHI learning private limited, 2014.

REFERENCE BOOKS:

1. Takashi Kenjo, *Stepping Motors and their Microprocessor controls*, clarenden press, Oxford, 1984.
2. T. Kenjo and S. Nagamori, *Permanent-Magnet and Brushless DC Motors*, clarenden press, Oxford, 1984.
3. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drives*, clarenden press, Oxford 1989.
4. R. Krishnan, *Switched Reluctance Motor Drives – Modeling, Simulation, analysis, Design and Applications*, CRC press, Special Indian Edition, 2015.

M. Tech. (PED) – II Semester

(16MT20701) FLEXIBLE AC TRANSMISSION SYSTEMS

(Common to EPS & PED)

(Professional Elective-2)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PRE-REQUISITES: Power Electronics and Power Systems at UG level, Analysis of Power Converters and Analysis of Inverters

COURSE DESCRIPTION:

Need for Flexible AC transmission systems; objectives of shunt and series compensation, phase angle regulators; FACTS controllers: shunt, series and combined; Coordination of various FACTS controllers.

COURSE OUTCOMES: On successful completion of the course, student will be able to

CO1. demonstrate knowledge on:
- compensation schemes for real and reactive power control.
- Static Shunt, Series and Shunt-Series compensation.
- FACTS devices and controllers

CO2. analyze and adopt a suitable FACTS device for the appropriate control.

CO3. develop skills in coordination of multiple FACTS controllers in an interconnected power systems.

CO4. develop new FACTS controllers for reliable and flexible control of power system.

CO5. employ modern techniques in coordination of FACTS devices for reliable and efficient operation.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO AC TRANSMISSION SYSTEMS (08 Periods)

Overview of interconnected power system. Power flow in AC systems – Expression for real and reactive power flow between two nodes of a power system, controllable parameters. Power flow in parallel and meshed system. Overview of compensated transmission lines – shunt and series compensation. Conventional controllers for real and reactive power flows – merits and demerits.

FACTS – benefits, types of FACTS controllers.

UNIT-II: STATIC SHUNT COMPENSATION (12 Periods)

Expression for real and reactive power flow with mid-point voltage regulation. Variable impedance type static VAR generators - V-I characteristics and control schemes of TCR, TSR, TSC. Q_D-Q_O characteristic and control scheme of TSC-TCR. Switching converter type VAR generators – V-I characteristics and control schemes of STATCOM. Hybrid VAR generators – V-I characteristics of SVC and STATCOM, regulation of V-I slope. Applications of static shunt compensators – Voltage regulation, improvement in transient stability, prevention of voltage instability, power oscillation damping. Comparison of static shunt compensators.

UNIT-III: STATIC SERIES COMPENSATION (11 Periods)

Expression for real and reactive power flow with series line compensation. Variable impedance type series compensators: V-I characteristics and control schemes of GCSC, TSSC, TCSC-modes of operation. Sub-synchronous resonance. Switching converter type series compensator – V-I characteristics, internal and external control schemes of SSSC. Applications of static series compensators – improvement in transient stability, power oscillation damping. Comparison of static series compensators.

UNIT-IV: STATIC PHASE ANGLE REGULATORS AND COMBINED COMPENSATORS (12 Periods)

Power flow control by phase angle regulators - Concept of voltage and phase angle regulation. Operation and control of TCVR and TCPAR. Switching converter type phase angle regulators. Objectives of TCPAR - improvement of transient stability, power oscillation damping. UPFC –

Principle, expression for real and reactive power between two nodes of UPFC, independent real and reactive power flow control using UPFC, control schemes of UPFC - operating principle and characteristics of IPFC.

UNIT-V: CO-ORDINATION OF FACTS CONTROLLERS (12 Periods)

FACTS controller interactions – interaction between multiple SVC's – interaction between multiple TCSC's – SVC-TCSC interaction – co-ordination of multiple controllers using linear control techniques. Comparative evaluation of different FACTS controllers: performance comparison and cost comparison, Control coordination using Genetic Algorithm, Future direction of FACTS technology.

Total periods: 55

TEXT BOOKS:

1. Narain G. Hingorani, Laszi Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems,* Wiley-IEEE Press, 1999.
2. R. Mohan Mathur and Rajiv k. Varma, *Thyristor based FACTS controllers for Electrical Transmission Systems,* Wiley-IEEE Press, 2002.

REFERENCE BOOKS:

1. Xiao-Ping, Rehtanz, Christian, Pal, Bikash, *Flexible AC Transmission Systems: Modeling and Control*, Springer Power Systems Series, 2006.
2. T.J.E. Miller, *Reactive Power control in electric systems*, Wiley, 1982.

M. Tech. (PED) – II Semester

(16MT20707) HIGH VOLTAGE DC TRANSMISSION

(Common to EPS & PED)

(Professional Elective-2)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PRE-REQUISITES: Power Electronics and Power Systems at UG level, Analysis of Power Converters and Analysis of Inverters.

COURSE DESCRIPTION:

HVDC Transmission: Capabilities, Applications and planning; Analysis and control of power converter; Harmonics and Filters; Types of Multi-Terminal DC Systems and control; Faults and Protection.

COURSE OUTCOMES: On successful completion of the course the students will be able to

CO1. demonstrate knowledge on:
- HVDC transmission systems.
- operation of static converters and its analysis.
- different types of faults and protection schemes in HVDC systems.

CO2. analyze various static converters operation in HVDC systems, harmonics, filters and MTDC systems.

CO3. evaluate the performance of HVDC systems under various operating conditions.

CO4. develop new control techniques for HVDC converter systems.

CO5. follow professional code of ethics.

DETAILED SYLLABUS:

UNIT–I: INTRODUCTION TO HVDC TRANSMISSION (10 periods)

HVDC Transmission– Comparison of HVAC and HVDC transmission, types of DC Links, power handling capabilities of HVDC lines, applications of HVDC Transmission, planning for HVDC transmission, modern trends in DC Transmission, basic conversion principles.

UNIT–II: STATIC POWER CONVERTOR ANALYSISIS AND CONTROL (12 periods)

Static Power Converters: Static converter configuration- 6 pulse & 12 pulse converters, converter station and terminal equipment. Rectifier and inverter operation, converter bridge characteristics, equivalent circuit for converter.

Control of HVDC converter: Principle of DC link control – constant current, constant extinction angle and constant ignition angle control. Individual phase control and equidistant firing angle control.

UNIT–III: HARMONICS AND FILTERS (11 periods)

Generation of harmonics in HVDC systems, IEEE/IEC standards, methods of harmonics elimination, harmonic instability problems, Causes for instability, remedies for instability problems. Design of AC filters, single frequency tuned filter, Double frequency tuned filter, high pass filter, cost consideration of AC harmonic filter, DC filters.

UNIT–IV: MULTI-TERMINAL DC LINKS AND SYSTEMS (10 periods)

Introduction – Potential applications of MTDC systems – Types of MTDC systems – series, parallel and series-parallel systems, their principle of operation and control - Protection of MTDC systems.

UNIT–V: FAULTS AND PROTECTION: (12 periods)

Over voltages due to disturbance on DC side, over voltages due to DC and AC side line faults – Converter faults, over current protection– Valve group and DC line protection. Over voltage protection of converters – Surge arresters.

Total Periods: 55

TEXT BOOKS:

1. K.R.Padiyar, *High Voltage Direct current Transmission*, New Age International (P) Ltd, Publishers, 2nd edition, 2011.
2. Sunil S. Rao, *EHV-AC, HVDC Transmission & Distribution Engineering*, Khanna Publishers, 3rd edition, 2001.

REFERENCE BOOKS:

1. E.Uhlman, *Power Transmission by Direct Current*, Springer Verlag, Berlin, Heedelberg, 1975.
2. E. W. Kimbark, *Direct current Transmission*, John Wiely& sons, New York.
3. Jos Arillaga, *HVDC Tranmission*, the Institute of Electrical Engineers, 2nd edition, London UK, 1998.

M. Tech. (PED) – II Semester

(16MT20708) POWER QUALITY

(Common to EPS & PED)

(Professional Elective-2)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: --

COURSE DESCRIPTION:

Power Quality concepts; harmonics and voltage regulation using conventional methods; power quality enhancement using custom power devices; power quality issues in distributed generation.

COURSE OUTCOMES: On successful completion of the course the students will be able to

CO1. demonstrate knowledge on:
- various power quality issues and mitigation.
- operating conflicts in distributed generation.

CO2. analyze
- harmonic distortion due to commercial and industrial loads.
- the suitability of various custom power devices.

CO3. evaluate various power quality indices.

CO4. initiate research to develop/design new schemes and techniques for power quality enhancement.

CO5. apply the appropriate principles and techniques for integration of distributed generation and utilities.

DETAILED SYLLABUS:

UNIT-I: FUNDAMENTALS OF POWER QUALITY (12 Periods)

Definition of Power Quality, Classification of Power Quality Issues, Power Quality Standards, Categories and Characteristics of Electromagnetic Phenomena in Power Systems: Impulsive and Oscillatory Transients, Interruption, Sag, Swell, Sustained Interruption, Under Voltage, Over Voltage, Outage. Sources and causes of different Power Quality Disturbances.

UNIT-II: HARMONICS & APPLIED HARMONICS (12 Periods)

Harmonic Distortion, Voltage Vs Current Distortion, Harmonics Vs Transients, Power System Qualities under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads.

Applied Harmonics**:** Effects Of Harmonics, Harmonic Distortion Evaluations, Principles of Controlling Harmonics, Devices for Controlling Harmonic Distortion.

UNIT-III: VOLTAGE REGULATION USING CONVENTIONAL METHODS (08 Periods)

Principles of Regulating the Voltage, Devices for Voltage Regulation: Utility step-voltage regulators, Ferro-resonant transformers, Magnetic synthesizers, On-line UPS systems, Motor-generator sets, Static VAR compensators, shunt capacitors, series capacitors.

UNIT-IV: POWER QUALITY ENHANCEMENT USING CUSTOM POWER DEVICES (13 Periods)

Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL) -Solid State Breaker (SSB) -Solid State Transfer Switch (SSTS).

Compensating Type: Dynamic Voltage Restorer, Distribution STATCOM and Unified Power Quality Conditioner –operation, realization and control of DVR, DSTATCOM and UPQC –load compensation. Power quality monitoring-Power quality monitoring standards.

UNIT V: POWER QUALITY ISSUES IN DISTRIBUTED GENERATION (10 Periods)

DG Technologies, Perspectives on DG benefits- Interface to the Utility System - power quality issues affected by DG - Operating Conflicts: Utility fault-clearing, Reclosing, Interference with relaying, Voltage regulation issues, Islanding - siting DG.

Total periods: 55

TEXT BOOKS:

1. Roger C. Dugan, Mark E. Mc. Granaghan, Surya Santosoh and H. Wayne Beaty, *Electrical Power Systems Quality*, 2nd edition, TATA Mc Graw Hill, 2010.
2. Arindam Ghosh, Gerard Ledwich, *Power Quality Enhancement Using Custom Power Devices,* Springer, 2002.

REFERENCE BOOKS:

1. Math H J Bollen, *Understanding Power Quality Problems*, IEEE Press, 1998.
2. C. Sankaran, *Power Quality*, CRC press, 2000.

M. Tech. (PED) – II Semester

(16MT20709) SMART GRID TECHNOLOGY

(Common to EPS & PED)

(Professional Elective-2)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	--	--	4

PREREQUISITES: --

COURSE DESCRIPTION:

Concept of smart grid; various information and communication technologies for Smart Grid; Smart metering; Demand side integration; Energy management systems

COURSE OUTCOMES: On successful completion of the course the students will be able to

CO1. demonstrate knowledge in
- Smart grid initiatives and technologies
- Information and communication technologies for the smart grid.
- Sensing, measurement, control and automation.

CO2. apply skills in fault calculation and state estimation.

CO3. apply various information security tools in the smart grid technology.

CO4. extend research activities on implementation of smart grid.

CO5. develop usage of modern techniques to integrate renewable energy sources into the smart grid.

DETAILED SYLLABUS:

UNIT–I: SMART GRID (07 periods)

smart grid introduction, ageing assets and lack of circuit capacity, thermal constraints, operational constraints, security of supply, national initiatives, early smart grid initiatives, active distribution networks, virtual power plant, other initiatives and demonstrations, overview of the technologies required for the smart grid.

UNIT–II: COMMUNICATION TECHNOLOGIES FOR THE SMART GRID (13 periods)

Data Communications: Introduction, Dedicated and Shared Communication Channels, Switching Techniques, Circuit Switching, Message Switching, Packet Switching, Communication Channels, Wired Communication, Optical Fiber, Radio Communication, Cellular Mobile Communication, Layered Architecture and Protocols, the ISO/OSI Model, TCP/IP

Communication Technologies: IEEE 802 Series, Mobile Communications, Multi-Protocol Label Switching, Power line Communication, Standards for Information Exchange, Standards for Smart Metering, Modbus, DNP3, IEC 61850

UNIT–III: INFORMATION SECURITY FOR THE SMART GRID (11 periods)

Introduction, Encryption and Decryption, Symmetric Key Encryption, Public Key Encryption, Authentication, Authentication Based on Shared Secret Key, Authentication Based on Key Distribution Center, Digital Signatures, Secret Key Signature, Public Key Signature, Message Digest, Cyber Security Standards, IEEE 1686: IEEE Standard for Substation Intelligent Electronic Devices(IEDs) Cyber Security Capabilities, IEC 62351: Power Systems Management and Association Information Exchange – Data and Communication Security.

UNIT–IV: SMART METERING AND DEMAND SIDE INTEGRATION (13 periods)

Introduction, smart metering – evolution of electricity metering, key components of smart metering, smart meters: an overview of the hardware used – signal acquisition, signal conditioning, analogue to digital conversion, computation, input/output and communication. Communication infrastructure and protocols for smart metering - Home area network, Neighborhood Area Network, Data Concentrator, meter data management system, Protocols for communication. Demand Side Integration- Services Provided by DSI, Implementation of DSI, Hardware Support, Flexibility Delivered by Prosumers from the Demand Side, System Support from DSI.

UNIT–V: TRANSMISSION AND DISTRIBUTION MANAGEMENT SYSTEM (11 periods)

Data Sources, Energy Management System, Wide Area Applications, Visualization Techniques, Data Sources and Associated External Systems, SCADA, Customer Information System, Modeling and Analysis Tools, Distribution System Modeling, Topology Analysis, Load Forecasting, Power Flow Analysis, Fault Calculations, State Estimation, Applications, System Monitoring, Operation, Management, Outage Management System, Energy Storage Technologies, Batteries, Flow Battery, Fuel Cell and Hydrogen Electrolyzer, Flywheels, Super conducting Magnetic Energy Storage Systems, Super capacitors, Energy storage for wind power, Agent-based control of electrical vehicle battery charging.

Total Periods: 55

TEXT BOOKS:

1. Janaka Ekanayake, Liyanage, Wu, Akihiko Yokoyama, Jenkins, *Smart Grid,* Wiley Publications, 2012.
2. James Momoh, *Smart Grid: Fundamentals of Design and Analysis,* Wiley, IEEE Press, 2012.
3. Bharat Modi, Anuprakash, Yogesh Kumar, *Fundamentals of Smart Grid Technology* by S.K Kataria & Sons

REFERENCE BOOKS:

1. Raj Samani, *Applied Cyber Security and the Smart Grid,* Syngress Publishers, 2012.
2. Jean Claude Sabonnadiere, Nouredine Hadjsaid, *Smart Grids,* Wiley Blackwell.
3. Peter S.Fox Penner, *Smart Power: Climate Changes, the Smart Grid, and the future of electric utilities,* Island Press, 2014.

M. Tech. (PED) – II Semester

(16MT22331) ELECTRIC DRIVES LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	--	--	4	2

PREREQUISITES: Courses on Analysis of inverters and converters.

COURSE DESCRIPTION: Design and development of various AC and DC drives.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate practical knowledge on design and development of power converter fed drives.
CO2. analyze and relate physical observations and measurements of various power converter fed drives with theoretical principles.
CO3. solve engineering problems related to power converter fed drives to provide feasible solutions.
CO4. initiate research ideas to provide solutions for design of power converter fed drives.
CO5. select and apply suitable controlling techniques for various power converter fed drives.
CO6. prepare laboratory reports that clearly communicate experimental information.
CO7. practice professional code of ethics.
CO8. function effectively as an individual and as a member in the team to solve various problems.

DETAILED SYLLABUS:

Conduct any Two Experiments from the following:

Design of

1. Single phase half-wave converter fed DC motor.
2. Single phase Semi converter fed DC drive.
3. Single phase full controlled fed DC drive.
4. Single phase inverter fed induction motor drive.
5. Speed control of stepper motor.
6. Speed control of universal motor using AC voltage controller.
7. Step up chopper fed DC drive.
8. Step down chopper fed DC drive.
9. Speed control of single phase induction motor using AC voltage controller.
10. AC/DC/AC converter fed induction motor.

M. Tech. (PED) – II Semester

(16MT22332) ELECTRIC DRIVES SIMULATION LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	--	--	4	2

PREREQUISITES: Courses on Analysis of inverters and Analysis of converters.

COURSE DESCRIPTION: Design and analysis of various converter fed drives.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate knowledge on various power converter fed drives.
CO2. analyze the operating characteristics of various power converter fed drives.
CO3. provide feasible solutions pertaining to electric drives.
CO4. initiate research related to applications of electric drives.
CO5. select and apply appropriate speed control techniques for power converter fed drives.
CO6. prepare laboratory reports that clearly communicate experimental information.
CO7. practice professional code of ethics.
CO8. function effectively as an individual and as a member in the team to solve various problems.

DETAILED SYLLABUS:

Conduct any TEN Experiments from the following using MATLAB

Simulation of

1. Single phase half-wave converter fed DC motor.
2. Single phase Semi converter fed DC drive.
3. Single phase full controlled fed DC drive.
4. Single phase inverter fed induction motor drive.
5. Speed control of stepper motor using microcontroller.
6. Speed control of universal motor using AC voltage controller.
7. Step up chopper fed DC drive.
8. Step down chopper fed DC drive.
9. Speed control of single phase induction motor using AC voltage controller.
10. AC/DC/AC converter fed induction motor.

M. Tech. (PED) – II Semester

(16MT22333) SEMINAR

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
--	100	100	--	--	--	2

PREREQUISITES: --

COURSE DESCRIPTION:

Identification of seminar topic; literature survey; preparation of technical report and presentation.

COURSE OUTCOMES: On successful completion of the course, student will be able to

CO1. demonstrate capacity to identify an advanced topic for seminar in core and allied areas.
CO2. extract information pertinent to the topic through literature survey.
CO3. comprehend the extracted information through analysis and synthesis critically on the topic.
CO4. contribute to multidisciplinary scientific work in the field of Power systems.
CO5. manage time and resources effectively and efficiently.
CO6. plan, organize, prepare and present effective written and oral technical report on the topic.
CO7. engage in lifelong learning for development of technical competence in the field of Power Systems.
CO8. understand ethical responsibility towards environment and society in the field of Electrical engineering.
CO9. adapt to independent and reflective learning for sustainable professional growth in Electrical power systems.

M. Tech. (PED) – II Semester

(16MT23810) INTELLECTUAL PROPERTY RIGHTS

(Common to all M. Tech. Programs)

(Audit Course)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
-	-	-	-	2	-	-

PREREQUISITES: -

COURSE DESCRIPTION:

Introduction to Intellectual Property; Trade Marks; Law of Copy Rights; Law of Patents; Trade Secrets; Unfair Competition; New Development of Intellectual Property.

COURSE OUTCOMES: On successful completion of the course, student will be able to

CO1. demonstrate knowledge on
- Intellectual Property,
- Trade Marks & Secrets,
- Law of Copy Rights, Patents,
- New development of Intellectual Property.

CO2. analyze the different forms of infringement of intellectual property rights.
CO3. solve problems pertaining to Intellectual Property Rights.
CO4. stimulate research zeal for patenting of an idea or product.
CO5. write effective reports required for filing patents.
CO6. develop life-long learning capabilities.
CO7. develop awareness of the relevance and impact of IP Law on their academic and professional lives.
CO8. develop attitude for reflective learning.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO INTELLECTUAL PROPERTY (05 Periods)

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT-II: TRADE MARKS (05 Periods)

Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

UNIT-III: LAW OF COPY RIGHTS (06 Periods)

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT-IV: TRADE SECRETS (06 Periods)

Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

UNIT-V: NEW DEVELOPMENT OF INTELLECTUAL PROPERTY (06 Periods)

New developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property, international - trade mark law, copy right law, international patent law, international development in trade secrets law.

Total Periods: 28

TEXT BOOKS:

1. Deborah, E. Bouchoux, *Intellectual property right*, cengage learning.
2. Prabuddha Ganguli, *Intellectual property right - Unleashing the knowledge economy*, Tata Mc Graw Hill Publishing Company Ltd.

M. Tech. (PED) III & IV-Semester

(16MT32301 & 16MT42301) PROJECT WORK

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
200	200	300	--	--	--	28

PREREQUISITES: --

COURSE DESCRIPTION:

Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Writing of thesis and presentation.

COURSE OUTCOMES: On successful completion of the course, the student will be able to

CO1. demonstrate capacity to identify an advanced topic for project work in core and allied areas.
CO2. analyze the problem and derive an optimal solution pertinent to the chosen topic.
CO3. solve engineering problems and provide a wide range of potential solutions.
CO4. comprehend extracted information through the literature survey for design and development of engineering problems pertinent to the chosen topic.
CO5. use the techniques, skills and modern engineering tools necessary for project work.
CO6. contribute to multidisciplinary scientific work in the field of Electrical power Systems.
CO7. execute the project effectively and efficiently considering economical and financial factors.
CO8. plan, prepare and present effective written and oral technical report on the topic.
CO9. engage in lifelong learning for development of technical competence in the field of Electrical power systems and allied fields.
CO10. understand ethical responsibility towards environment and society in the field of Electrical Engineering.
CO11. adapt to independent and reflective learning for sustainable professional growth.