ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

POWER ELECTRONICS & ELECTRIC DRIVES (PEED)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

FOR

M.TECH TWO YEAR DEGREE COURSE

(Applicable for the batches admitted from 2022-2023)

G. Narayanamma Institute of Technology and Science

(for women)

(AUTONOMOUS)

Shaikpet, Hyderabad –500104. T.S.

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

DEPARTMENT VISION

To impart quality education in Electrical and Electronics Engineering for women empowerment

DEPARTMENT MISSION

- Imparting fundamental knowledge in Electrical and Electronics Engineering through well-qualified faculty.
- Providing exposure to current technologies.
- Providing hands-on experience to meet the expectations of the industry.
- Facilitating individual and team activities to enhance personality and soft skills.

G.NARAYANAMMA INSTITUTE OF TECHNOLOGY & SCIENCE (for WOMEN)
(Autonomous)
Shaikpet, Hyderabad – 500 104

ACADEMIC REGULATIONS (R22)
for CBCS Based M.Tech. Degree Programme (Regular/Full Time PG Course) in

POWER ELECTRONICS & ELECTRIC DRIVES (PEED)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

(Effective for the students admitted into I year from the
Academic Year 2022-23and onwards)

1.0 Post-Graduate Degree Programme (PGDP) in Engineering & Technology (E & T)

G. Narayanamma Institute of Technology & Science (GNITS) - for Women, Hyderabad, affiliated to Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad, offers 2 Year (4 Semesters) Master of Technology (M. Tech.) Degree Programmes under Choice Based Credit System (CBCS), with effect from the Academic Year 2022 - 23 onwards in the following Branches of Engineering & Technology with the Specializations as listed below:

S.No.	*Branch/ Department*	*Specialization*
I.	Computer Science & Engineering	Computer Science & Engineering
II.	Electrical & Electronics Engineering	Power Electronics & Electric Drives
III.	Electronics & Communication Engineering	Digital Electronics & Communication Engineering
IV.	Electronics & Telematics Engineering	Wireless & Mobile Communications
V.	Information Technology	Computer Networks & Information Security

2.0 Eligibility for Admission

2.1 Admission to the **PGDP** shall be made either on the basis of - the Rank/Percentile earned by the candidate in the relevant qualifying GATE Examination, OR the Merit Rank obtained by the qualifying candidate at an Entrance Test conducted by the Telangana State Government (PGECET) for M.Tech. Programmes, OR an Entrance Test conducted by the Jawaharlal Nehru Technological University Hyderabad, OR on the basis of any other order of merit approved by the University, subject to the reservations as prescribed by the Government from time to time.

2.2 The medium of instruction for all the PG Programmes shall be ENGLISH only.

3.0 M.Tech. Degree Programme Structure

3.1 All M.Tech. Programmes at GNITS are of the Semester Pattern with 4 Semesters constituting 2 Academic Years, and each Academic Year has TWO Semesters (First/Odd and Second/Even Semesters). Each Semester shall be of 22 Weeks duration (inclusive of Examinations) with a minimum of 90 Instructional Days per Semester.

3.2 UGC/AICTE specified Definitions/ Descriptions are adopted appropriately for the various terms and abbreviations used in this PGDP - Academic Regulations/Norms.

3.2.1 Semester Scheme:

Each M.Tech. Degree Programme is of 2 Academic Years (4 Semesters) with each academic year divided into two Semesters of ~ 22 weeks (≥ 90 working days) each, and each semester has - 'Continuous Internal Evaluation (CIE)' and 'End Semester Examination or Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as denoted and suggested by UGC and AICTE are taken as 'references' for the present set of Regulations. The terms 'SUBJECT' or 'COURSE' imply the same meaning here, and refer to 'Theory Subject', or 'Lab/Practical Course', or 'Elective (Program Specific Elective/ Open Elective)', or 'Mini-Project', or 'Seminar', or 'Project', or 'Audit Course' as the case may be.

3.2.2 Credit Courses:

All the Subjects/Courses are to be registered by a student in a semester to earn Credits. Credits shall be assigned to each Subject/ Course in a **L: T: P: C** (**L**ecture Periods: **T**utorial Periods: **P**racticalsPeriods:**C**redits) Structure, based on the following general pattern:

- One Credit - for One hour/ Week/ Semester for Theory/ Lecture (L) Courses, and Tutorials (T); and,
- One Credit - for Two hours/ Week/ Semester for Laboratory/ Practical (P) Courses.
- Audit Courses shall not carry any Credits.

3.2.3 Subject/ Course Classification:

All Subjects/ Courses offered for the PGDP are broadly classified as:

(a) Core Courses (CoC), and

(b) Elective Courses (E*l*C)

Core Courses (CoC) and Elective Courses (E*l*C) are categorized as PS (Professional Subjects), which are further subdivided as –

(i) PC (Professional/ Departmental Core) Courses

(ii) PSE (Program Specific Elective) Courses

(iii) OE (Open Elective) Courses; and

(iv) Project Works (PW);

Specific prescribed Course by AICTE Model Curriculum (on "Research Methodology & IPR").

Audit Courses (AC - as listed by AITCTE Model Curriculum).

3.2.4 Course Nomenclature:

The Curriculum Nomenclature and Course Structure grouping for GNITS M.Tech. Degree Programmes are as listed below:

S. No.	*Broad Course Classification*	*Course Group/ Category*	*Courses Description*	*Credits*
1)	**Core Courses(CoC)**	**PC - Professional Core**	Includes Core subjects related to the Parent Department/ Branch of Engg.	**18**
2)	**Elective Courses (E*l*C)**	**PSE – Program Specific Elective**	Includes Elective subjects related to the Parent Department/ Branch of Engg.	**15**
		OE - Open Elective	Elective Courses which include subjects from other technical and/or Emerging Areas	**3**
3)	**Project Related Courses**	**PW - Project Work**	M.Tech. Project or PG Project or PG Major Project (Phase-I and Phase-II)	**26**
		Mini-Project (MP)	Mini-Project over 1 semester duration	**2**
		Seminar	Seminar based on core contents related to the Parent Department/ Branch of Engg. in identified specialization	**2**
4)	Prescribed Course	**AICTE Model Curriculum 2018**	Research Methodology & IPR	**2**
5)	Audit Courses	**AC – as per AICTE Model Curriculum 2018**	Inclusive of AICTE Suggested List	**No Credits**
Total Credits for PGDP (For the Specializations Listed)				**68**

4.0 Course Work

4.1 A student, after securing admission, shall pursue and complete the M.Tech. Degree Programme in a minimum period of 2 Academic Years (4 Semesters), and/or within a maximum period of 4 Academic Years (starting from the Date of Commencement of I Year).

4.2 Each student shall register for and secure the specified number of Credits required for the completion of the PG Degree Programme and Award of the M.Tech. Degree in the respective Branch of Engineering with the chosen Specialization.

4.3 The I Year is structured to provide typically 18 Credits in each of the I and II Semesters, and II Year comprises of 16 Credits in each of the I and II semesters,totalling to 68 Credits for the entire M.Tech. Programme.

5.0 Course Registration

5.1 A 'Faculty Advisor' shall be assigned to each M.Tech. Degree Programme student with respective Specialization, and the Faculty Advisor assigned shall advise/counsel the student about the M.Tech. Programme Specialization, its Course Structure and Curriculum, Choice/ Option for Subjects/ Courses, based on the competence, progress, pre-requisites and interest of the student.

5.2 The Academic/Examination Section of the College invites 'Registration Forms' from the students apriori (before the beginning of the Semester) through 'ONLINE SUBMISSIONS' ensuring 'DATE and TIME Stamping'. The ONLINE Registration Requests for any 'CURRENT SEMESTER' shall be completed BEFORE the commencement of SEEs (Semester End Examinations) of the 'PRECEDING SEMESTER'.

5.3 A student can apply for ONLINE Registration, ONLY AFTER obtaining the 'WRITTEN APPROVAL' from her assigned Faculty Advisor, which should be submitted to the College Academic/Examination Section through the Head of the Department (a copy of the same being retained with the Head, Faculty Advisor and the Student).

5.4 A student shall Register for Subjects/Courses of 'her CHOICE' with a total of 18 Credits per semester in the I Year as structured in the Programme Curriculum, which will be treated as the Minimum Work Load; she may also seek registration for a maximum of 3 additional/extra credits from those specified for the II Year I Semester (Maximum Work Load thus limited to 21 C) based on her interest, competence, progress, and 'pre-requisites' as indicated for various Subjects/ Courses in the Department Course Structure (for the relevant Specialization) and the Syllabus contents for various Subjects/ Courses, as applicable. All the remaining Credits shall be registered in the II Year-I and II Semesters.

5.5 Thechoice for the 'Additional Subjects/ Courses' in the I Year (in any semester, above the typical 18 Credit norm, and within the Maximum Permissible Limit of 21 Credits, as applicable) must be indicated clearly in the ONLINE Registration, which needs the specific approval and the signature of the Faculty Advisor/Counsellor assigned and the Head of the Department on the hard-copy.

5.6 If the student submits ambiguous choices or multiple options or erroneous entries during ONLINE Registration for the Subject(s)/Course(s) under a given/specified Course Group/Category as listed in the Course Structure for that particular PGDP Specialization, ONLY the first mentioned Subject/ Course in that Category will be taken into consideration, as applicable.

5.7 The Subject/Course Options exercised through ONLINE Registration are final and CANNOT be changed, and CANNOT be inter-changed; further, alternate choices shall also not be considered. However, if the Subject/Course that has already been listed for Registration (by the Head of Department) in a semester could not be offered due to any unforeseen or unexpected reasons, then the student may be allowed to have alternate choice - either for a new Subject (subject to offering of such a Subject), or for another existing Subject (subject to availability of seats), which may be considered. Such alternate arrangements shall be made by the Head of the Department, with due notification and time-framed schedule, within the FIRST WEEK from the commencement of Class-work for that semester.

5.8 The Dropping of Subjects/ Courses in any semester of the I Year may be permitted, ONLY AFTER obtaining prior approval and signature from the Faculty Advisor (subject to retaining the minimum of specified 18 Credits) 'within 15 Days of Time' from the beginning of the current semester.

6.0 Class Strength

6.1 The typical student strength for each semester shall be 12 (or as per JNTUH / AICTE Approved Intake).

6.2 A Subject/Course may be offered to the students, ONLY IF a minimum of 50% of the students of a PG Specialization opt for the same.

6.3 In case of the options for Subjects/Courses coming from students of other Departments /Branches/ Disciplines also, PRIORITY shall be given to the student of the 'Parent Department' first.

7.0 Attendance Requirements

7.1 A student shall be eligible to appear for the Semester End Examination (SEE) of any Subject, if she acquires a minimum of 75% of attendance in that Subject for that semester.

7.2 The condoning of shortage of attendance up to 10% in each Subject (for 65% and above, and below 75% attendance cases) of a semester may be granted by the College Academic Committee (CAC) on genuine and valid grounds based on the student's representation with supporting evidence.

7.3 A stipulated fee per Subject/Course shall be payable towards condoning of shortage of attendance.

7.4 The Shortage of Attendance below 65% in any Subject shall in NO case be condoned.

7.5 A student, whose shortage of attendance is not condoned in any Subject(s) in any semester, is considered as 'Detained Student in that Subject(s)', and is not eligible to take End Examination(s) in the Subject(s) detained in that semester; and she has to seek Re-registration for those Subject(s) in subsequent semesters, and attend the same as and when offered.

7.6 Every studentshall put in the minimum required attendance (as specified in Clauses 7.1-7.3) in at least 3 theory subjects and 2 lab courses – (i) in I Year I Semester, for promotion to I Year II Semester, and similarly - (ii) in I Year II Semester along with the Mini-Project, for promotion to II Year I Semester.

7.7 A student shall not be promoted to the next semester unless she satisfies the attendance requirements of the present semester, as applicable. In such cases, she may seek readmission into that semester (and register for all semester subjects), as and when offered. When she fulfils the attendance requirements in the present semester, she shall not be eligible for readmission (or re-register) into the same class/semester again.

8.0 Academic Requirements

The following Academic Requirements have to be satisfied, in addition to the Attendance Requirements mentioned in Clause 7.0 …

8.1 A student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to each Subject/ Course, if she secures not less than

- 40% marks (24 out of 60 marks)in the Semester End Examination (SEE),
- 40% marks in the Internal Examinations (16 out of 40 marks allotted foe CIE) and
- A minimum of 50% of marks (50 out of 100 marks) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of Letter Grades, this implies securing C Grade or above in that Subject.

8.2 A student shall be deemed to have satisfied the Academic Requirements and earned the Credits allotted to - Mini-Project/ Seminars, if she secures not less than 50% of the total marks allocated. The student would be treated as failed, if she - (i) does not execute the Mini-Project (and submit the report) as specified by the Supervisor, or (ii) does not present the Seminars as required, or (ii)

secures less than 50% of Marks (< 50 marks) in evaluations. She may reappear once for each of the 'Mini-Project/ Seminars' evaluations, as and when they are scheduled again; if she fails in such 'one reappearance' evaluation also, she has to reappear for the same in the next subsequent semester(s), as and when they are scheduled.

8.3 A student shall register for all Subjects covering 68 Credits as specified and listed in the Course Structure for the chosen M.Tech. Degree Specialization, put up all the Attendance and Academic requirements for securing 68 Credits obtaining a minimum of C Grade or above in each Subject, and 'earn all 68 Credits securing SGPA ≥5.0 (in each semester) and final CGPA (i.e., CGPA at the end of PGDP is to be ≥5.0), to successfully complete the PGDP. **THERE IS NO EXEMPTION OF CREDITS IN ANY CASE**

8.4 The Marks and the Letter Grades obtained in all those Subjects covering the specified 68 Credits alone shall be considered for the calculation of final CGPA, which shall be indicated in the Grade Card of the II Year II Semester.

8.5 If a student registers for some more 'extra Subjects' (in the parent Department or other Departments/ Branches of Engg.) other than those listed Subjects totalling to 68 Credits as specified in the Course Structure, the performances in those 'extra Subjects' (although evaluated and graded using the same procedure as that of the required 68 Credits) shall not be taken into account while calculating the SGPA and CGPA. For such 'extra Subjects' registered, the Letter Grade alone shall be indicated in the Grade Card as a performance measure, subject to the completion of the Attendance and Academic Requirements as stated in Clauses 7.0 and 8.1 – 8.4 above.

8.6 The students who fail to earn 68 Credits as per the specified Course Structure, and as indicated in Clauses 8.1- 8.5, within 4 Academic Years from the Date of Commencement of their I Year, shall forfeit their seats in M.Tech. Programme, and their admissions shall stand cancelled.

8.7 When a student is detained due to the shortage of attendance in any Subject(s) in any semester, no Grade Allotment shall be done for such Subject(s), and SGPA/ CGPA calculations of that semester shall not include the performance evaluations of such Subject(s) in which she gets detained. However, she becomes eligible for re-registration of such Subject(s) (in which she gets detained) in the subsequent semester(s), as and when offered next, with the Academic Regulations of the Batch into which she gets readmitted, by paying the stipulated fees per Subject to the College. In all these re-registration cases, the student shall have to secure a fresh set of Internal Marks (CIE) and Semester End Examination Marks (SEE) for performance evaluation in such Subject(s), and subsequent SGPA/ CGPA calculations.

8.8 A student, eligible to appear for the End Semester Examination (ESE) in any Subject, but is absent at it or failed (failing to secure C Grade or above), may reappear for that Subject at the supplementary examination (Supplementary SEE) as and when conducted. In such cases, her Internal Marks (CIE) assessed earlier for that Subject/ Course will be retained, and added to the marks to be obtained in the supplementary examination (Supplementary SEE) for the evaluation of her performance in that Subject.

9.0 Evaluation - Distribution and Weightage of Marks

9.1 The performance of a student in each semester shall be evaluated Subject-wise (irrespective of the Credits assigned) with a maximum of 100 marks for the Theory or Practicals or Mini-Project, or Seminar etc; further, Phase-I and Phase-II of the M.Tech. Project Work (in II Year I and II semesters) shall also be evaluated for 100 marks each. These evaluations shall be based on 40% CIE and 60% SEE, and a Letter Grade corresponding to the % of marks obtained shall be given.

9.2 For all the Subjects/ Courses as mentioned in 9.1**,** the distribution shall be: 40 marks for CIE (Continuous Internal Evaluation), and 60 marks for the SEE (Semester End Examination).

9.3 **a)** In CIE, for theory subjects, during a semester, there shall be two mid-term examinations. Each Mid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a total duration of 2 hours as follows:

1. Mid-Term Examination for 30 marks:
   a. Part - A: Objective/quiz paper for 10 marks.
   b. Part – B: Descriptive paper for 20 marks.

   The objective/quiz paper is set with 10 questions for a total of 10 marks. The descriptive paper shall contain 6 full questions out of which, the student has to answer 4 questions, each carrying 5 marks. The average of the two Mid Term Examinations shall be taken as the final marks for Mid Term Examination (for 30 marks). The remaining 10 marks of Continuous Internal Assessment (out of 40) are distributed as:
2. Assignment for 5 marks. (Average of 2 Assignments each for 5 marks)
3. Subject Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned subject for 5 marks.

   While the first mid-term examination shall be conducted on 50% of the syllabus, the second mid-term examination shall be conducted on the remaining 50% of the syllabus.

   Five (5) marks are allocated for assignments (as specified by the subject teacher concerned). The first assignment should be submitted before the conduct of the first mid-term examination, and the second assignment should be submitted before the conduct of the second mid-term examination. The average of the two assignments shall be taken as the final marks for assignment (for 5 marks).

   Subject Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned subject for 5 marks before II Mid-Term Examination.

- The Student, in each subject, shall have to earn 40% of marks (i.e. 16 marks out of 40 marks) in CIE, 40% of marks (i.e. 24 marks out of 60) in SEE and Overall 50% of marks (i.e. 50 marks out of 100 marks) both CIE and SEE marks taking together.
- *The student is eligible to write Semester End Examination of the concerned subject, if the student scores ≥40% (16 marks) of 40 Continuous Internal Examination (CIE) marks.*
- *In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 40% of CIE marks (16 marks out of 40 internal marks), his performance in that subject in SEE shall stand cancelled inspite of appearing the SEE.*

b) 60 marks are allocated for Semester End Examination (SEE), which is of 3 hours duration. The SEE Question Paper will have two parts: Part-A is for 10 marks and is compulsory - it consists of 10 questions of 1 mark each (2 questions from each unit) and Part-B is for 50 marks – it consists of 5 questions of 10 marks each, for each question there will be 'either/ or' choice, which means that there will be two questions from each unit and the student should answer one of these two.

9.4 For the Lab./Practical Subjects, there shall be a Continuous Internal Evaluation (CIE) during the semester for 40 marks, and Semester End Examination (SEE) at the end of the semester for 60

marks. Out of the 40 marks for Internals, day-to-day work assessment in the laboratory shall be evaluated for 20 marks; the performance in an Internal Lab./Practical Test (10 marks) and viva-voce (10 marks) shall be evaluated for a total of 20 marks. The Semester End Examination (SEE) for Lab./ Practicals shall be conducted at the end of the semester by the Lab. Teacher concerned and another faculty member of the same Department as assigned by the Head of the Department.

The Student, in each subject, shall have to earn 40% of marks (i.e. 16 marks out of 40 marks) in CIE, 40% of marks (i.e. 24 marks out of 60) in SEE and Overall 50% of marks (i.e. 50 marks out of 100 marks) both CIE and SEE marks taking together.

The student is eligible to write Semester End Examination of the concerned subject, if the student scores ≥40% (16 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned subject but not scored minimum 40% of CIE marks (16 marks out of 40 internal marks), his performance in that subject in SEE shall stand cancelled inspite of appearing the SEE

9.5 **a)** There shall be a Mini-Project, preferably in collaboration with an Industry with the relevant specialization to be registered and executed during the I Year II Semester, for about sixteen weeks duration. It shall also carry 100 marks, out of which CIE shall be for 40 marks, and SEE shall be for 60 marks. Marks earned under CIE for the 'Mini-Project' shall be awarded by the Mini-Project Guide/Supervisor (based on the continuous evaluation of student's performance during the Mini-Project execution period).

b) The Mini-Project work shall be submitted in a Technical Report form, and a presentation of the same shall be made before a Committee, and the 'Mini-Project' shall be evaluated by the Committee for 60 Marks (SEE).The Committee shall consist of the Head of the Department, the Supervisor of Mini-Project, and a Senior Faculty Member of the Department. Performance evaluation of the 'Mini-Project' shall be included in the I Year II Semester Grade Card.

9.6 **Electives:** 5 Program Specific Elective (PSE) Courses and 1 Open Elective (OE) Course are offered in the 4 Semester PG Degree Programme at GNITS, as per AICTE Model Curriculum. Students are to choose each Elective Course from the corresponding Set of Electives given, and the evaluation of the Elective Course shall be the same as that for the Theory Course/Subject.

9.7 There shall be Seminar Presentations in the I Year, I and II Semesters. For the Seminar, the student shall collect the information on a technical topic, prepare a Technical Report and submit the Technical Report to the Department at the time of Seminar Presentation. Each Seminar Presentation (along with the Technical Report submitted) shall be evaluated for 100 marks by Two Faculty Members assigned by the Head of the Department. There shall be no SEE or external examination for the Seminar.

9.8 Every student shall be required to execute her M.Tech. Project under the guidance of the Supervisor assigned to her by the Head of the Department, and shall submit her dissertation on a topic relevant to her PG specialization.

a) The M.Tech. Project shall start immediately after the completion of the I Year II Semester, and shall be divided and carried out in 2 phases: Phase–I during II Year I Semester, and Phase–II during II Year II Semester. The student shall prepare and submit two independent Project Work Reports - Project Work Report-I shall include the Project Work carried out under Phase–I, and the Project Work Report-II (Final Report) shall include the Project Work carried out under Phase–I and Phase–II put together.

b) In Phase-I of the Project Work,the student shall carry out the literature survey, select an appropriate topic and submit a Project Proposal within 6 weeks (immediately after her I Year II Semester End Examinations), for approval by the Project Review Committee (PRC). The PRC shall be constituted by the Head of the Department, and shall consist of the Head of the Department, Project Supervisor, and a Senior Faculty Member of the Department. The student shall present her Project Work Proposal to the PRC (PRC-I Presentation), on whose approval she can 'REGISTER for the M.Tech Project'. Every student shall compulsorily register for her M.Tech. Project Work, preferably within the 6 weeks of time frame as specified.

c) After the Registration, the student shall carry out the work, and periodically submit 'a periodic progress report' to her Supervisor throughout the Project period. The PRC shall monitor the progress of the Project Work and review, based on the PRC-II and PRC-III presentations and performance evaluations – the first one at the middle of the II Year I Semester, and the second one at the end of the II Year I Semester (before the I Semester End Examinations). The student shall also submit the Project Work Report-I to the PRC at PRC-III, for the PRC considerations and evaluations.

d) 100 marks are allocated for each Phase (Phase-I and Phase-II) of the Project Work, out of which 40 marks shall be for CIE (Continuous Internal Evaluation/CIE), and 60 Marks will be for SEE (Semester End viva-voce Examination).

e) The marks earned under CIE for the Phase-I of the Project shall be awarded by the Project Guide/Supervisor (based on the continuous evaluation of student's performance, all her PRC presentations during the Project Work Phase-I period and Project Work Report-I). For SEE marks of Project Phase-I, the Project Work Report-I shall be examined, and viva-voce shall be conducted at the end of the II Year I Semester (along with PRC-III) by the PRC, and the corresponding SEE marks shall be awarded.

f) The Phase-II of the Project shall be carried out in the II Year II Semester, and the student's progress and performance evaluation shall be carried out through PRC-IV (at the middle of the semester), and PRC-V (at the end of the II semester) presentations. The student shall submit the Project Work Report-II (Final Project Report or Dissertation Draft Copy) to the PRC at PRC-V, for the PRC-V considerations and evaluations. Marks earned under CIE for Phase-II of the Project shall be awarded by the Project Guide/Supervisor (based on the continuous evaluation of student's performance, all her PRC presentations during the Project Work Phase-II period and Project Work Report-II). Marks earned under SEE for Phase-II Work shall be awarded by the External Examiner, after the evaluation of the M.Tech. dissertation and the final viva-voce examination of the M.Tech. Project Work.

g) After the PRC-V presentation, the PRC shall evaluate the entire performance of the student and declare the Project Work as 'Satisfactory' or 'Unsatisfactory'. Every Final Project Work Report (that has been declared 'satisfactory') shall undergo 'Plagiarism Check' as per the University/ College norms to ensure the plagiarism content to be below the specified level of 30%, to be acceptable for submission. In case of the unacceptable plagiarism levels, the student shall resubmit the Modified Project Work Report/Dissertation, after carrying out the necessary modifications/ additions to her Project Work/Report as suggested by the PRC, within the specified time.

h) If any student could not be present for any PRC at the scheduled time (after approval and registration of her Project Work at the PRC-I), or her progress is considered as 'not satisfactory' at any scheduled PRC, she will have to reappear (within one month period) for the same PRC presentation and evaluation at a later date/time as suggested by the PRC.

i) A student is allowed to submit her M.Tech. Project Dissertation 'only after the completion of 40 weeks from the date of approval/registration' of her Project, and after obtaining all the approvals from the PRC. The extension of time, within the total permissible limits of completion of the PGDC may be considered by the PRC on sufficient valid, genuine grounds.

j) The student shall be allowed to submit her M.Tech. Project Dissertation, only on the successful completion of all the prescribed PG Subjects (Theory and Labs.), Mini-Project, Seminars etc. (securing C Grade or above), and after obtaining all approvals from PRC. In such cases, the M.Tech. Dissertation will be sent to an External Examiner nominated by the Principal of the College, from the panel of 3 names of external faculty members (Professors or Associate Professors, outside the college) suggested by the Head of Department, on whose approval, the student can appear for the M.Tech. Project viva-voce Examination, which shall be conducted by a Board, consisting of the PG Project Supervisor, Head of the Department, and the External Examiner who adjudicated the M.Tech. Project Work and Dissertation. The Board shall jointly declare the Project Work Performance as 'satisfactory', or 'unsatisfactory'; and in successful cases, the External Examiner shall evaluate the Student's Project Work presentation and performance for 60 Marks (SEE).

k) If the adjudication report of the External Examiner is 'not favourable', then the student shall revise and resubmit her M.Tech Dissertation after one semester, or as per the time specified by the External Examiner and/ or the PRC. If the resubmitted report is again evaluated by the External Examiner as 'not favourable', then that Dissertation will be summarily rejected. Subsequent actions for such rejected dissertations may be considered, only on the specific recommendations of the External Examiner and/ or PRC.

l) In cases, where the Board declared the Project Work Performance as 'unsatisfactory', the student is deemed to have failed in the Project viva-voce Examination, and she may reappear for the viva-voce Examination as per the Board's recommendations. If she fails in the second viva-voce Examination also, she shall not be considered eligible for the Award of the Degree, unless she is asked to revise and resubmit her Project Work by the Board within a specified time period (with in 4 years from the date of commencement of her I Year I Semester).

10.0 Re-Admission / Re-Registration

10.1 Re-Admission for Discontinued Students:

The student who has discontinued the M.Tech. Degree Programme on account of any reasons whatsoever, may be considered for 'Readmission' into the same Degree Programme (with same specialization) with the Academic Regulations of the Batch into which she get readmitted, with prior permission from the authorities concerned, subject to Clause 4.1.

10.2 Re-Registration for Detained Students:

When any student is detained in a Subject(s) on account of the shortage of attendance in any semester, she may be permitted to re-register for the same Subject(s) in the 'same category' (Core or Elective Group) or equivalent Subject(s) if the same Subject is not available, as suggested by the BoS Chair of that Department, as and when offered in the sub-sequent semester(s), with the Academic Regulations of the Batch into which she seeks re-registration, with prior permission from the authorities concerned, subject to Clause 4.1.

11.0 Grading Procedure

11.1 The marks shall be awarded to indicate the performance of each student in each Theory Subject, or

Lab/Practicals, or Mini-Project, or Seminar, or Project etc., and based on the % of marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Clause 9.0, a corresponding Letter Grade shall be given.

11.2 A Letter Grade does not imply any specific % of marks.

11.3 As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured (Class Intervals)	*Letter Grade (UGC Guidelines)*	*Grade Points (GP)*
90% and above (≥ 90% , ≤ 100%)	O (Outstanding)	10
Below 90% but not less than 80% (≥ 80%, < 90%)	A^+(Excellent)	9
Below 80% but not less than 70% (≥ 70%, < 80%)	A(Very Good)	8
Below 70% but not less than 60% (≥ 60%, <70%)	B^+(Good)	7
Below 60% but not less than 55% (≥ 55%, < 60%)	B(above Average)	6
Below 55% but not less than 50% (≥ 50%, < 55%)	C(Average)	5
Below 50% (< 50%)	F(FAIL)	0

11.4 A student obtaining F Grade in any Subject shall be considered 'failed'. If a student fails to appear for SEE of any Subject (s) for any reason whatsoever, she is deemed to have 'failed', and she will get F Grade in all such failed Subject (s). She will be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), in the subsequent semesters, as and when offered. In such cases, her Internal marks (CIE marks) in those Subject(s) will remain same as those she obtained earlier.

11.5 In general, a student shall not be permitted to repeat any Subject(s) with the sole intention of 'Grade Improvement' or 'SGPA/ CGPA Improvement'. However, she has to repeat all those Subject(s), in which she got 'detained due to lack of required attendance' (as listed in Clauses 8.7 and 10.2), through Re-Registration at a later date.

11.6 A student earns Grade Points (GP) in each Subject on the basis of the Letter Grade obtained by her in that Subject. Then, the corresponding 'Credit Points' (CP) are computed by multiplying theGrade Points with Credits for that particular Subject/Seminar/Comprehensive Viva-voce/Project.

Credit Points (CP) = Grade Points (GP) x Credits

11.7 The student passes the Subject/ Seminar/ Comprehensive Viva-voce/Project only when she gets GP ≥ 5 (C Grade or above).

11.8 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (SCP) secured from ALL the Subjects/ Seminar/ Comprehensive Viva-voce/Project registered in a Semester by the Total Number of Credits registered during that Semester. SGPA is rounded off to TWO Decimal Places. SGPA is thus computed as

$$\textbf{SGPA} = \{ \sum_{i=1}^{N} C_i G_i \} / \{ \sum_{i=1}^{N} C_i \} \quad \textbf{.... For each semester},$$

where 'i' is the Subject indicator index (takes into account all Subjects in a Semester), 'N' is the no. of Subjects 'REGISTERED' for the Semester, C_i is the no. of Credits allotted to the i^{th} Subject,

and G_j represents the Grade Points (GP) corresponding to the Letter Grade awarded for that i^{th} Subject.

11.9 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in ALL registered courses in ALL Semesters, and the Total Number of Credits registered in ALL the Semesters. CGPA is rounded off to TWO Decimal Places. CGPA is thus computed from the Second Semester onwards, at the end of each Semester, as per the formula

$$\textbf{CGPA} = \{ \sum_{j=1}^{M} C_j G_j \} / \{ \sum_{j=1}^{M} C_j \} \quad \textbf{.... For all S Semesters registered}$$

(ie., upto and inclusive of S semesters, S ≥ 2),

where 'M' is the TOTAL no. of Subjects (as specifically required and listed under the Course Structure of that PGDC Specialization) the student has 'REGISTERED' from the 1st Semester onwards up to and inclusive of the Semester S (obviously M > N), 'j' is the Subject indicator index (takes into account all Subjects from 1 to S Semesters), C_i is the no. of Credits allotted to the j^{th} Subject, and G_j represents the Grade Points (GP) corresponding to the Letter Grade awarded for that j^{th} Subject. After Registration and completion of the I Year I Semester however, the SGPA of that Semester itself may be taken as CGPA, as there are no cumulative effects.

11.10 For the Merit Ranking or Comparison Purposes or any other listing, ONLY the 'ROUNDED OFF' values of the CGPAs shall be used.

11.11 For the calculations listed in Clauses 11.6 – 11.10, performance in the failed Subjects/ Courses (securing F Grade) shall also be taken into account, and the Credits of such Subjects/Courses shall also be included in the multiplications and summations.

11.12 Passing Standards:

a) A Student shall be declared successful or 'passed' in a semester, only when she gets a SGPA ≥ 5.00 (at the end of that particular Semester); and a student shall be declared successful or 'passed' in the entire PGDP, only when she gets a CGPA ≥ 5.00; subject to the condition that she secures a GP ≥ 5 (C Grade or above) in every registered Subject/ Course in each semester (during the entire PGDP), for the Award of the Degree, as required.

b) After the completion of each semester, a Grade Card or Grade Sheet (or Transcript) shall be issued to all the registered students of that semester, indicating the Letter Grades and the Credits earned. The Grade Card/Grade Sheet shall show the details of the Courses Registered (Course Code, Title, No. of Credits, Grade Earned), Credits earned, SGPA, and CGPA etc.

12.0 Declaration of Results

12.1 The Computation of SGPA and CGPA are done using the procedure listed in Clauses 11.6 – 11.11.

12.2 For the Final % of Marks equivalent to the computed CGPA, the following formula may be used

% of Marks = (final CGPA - 0.5) x 10

13.0 Award of Degree

13.1 A student who registers for all the specified Subjects/ Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes all the examinations prescribed in the entire M.Tech. Programme (PGDP), and secures the required number of 68 Credits (with CGPA ≥ 5.0), within the 4 Academic Years from the Date of Commencement of the First Academic Year, shall be declared to have 'QUALIFIED' for the Award of the M.Tech. Degree in the chosen Branch of Engineering, with the Specialization considered at the time of Admission.

13.2 A student who qualifies for the Award of the M.Tech. Degree (in her chosen Branch/ Specialization) as listed in Clause 13.1, shall be placed in the following Class Divisions:

AWARD OF CLASS BASED ON FINAL CGPA (at the end of the PG Programme)

First Class with Distinction	Final CGPA 8.00 or more*
First Class	Final CGPA below 8.00 but not less than 7.00
Second Class	Final CGPA below 7.00 but not less than 6.00
Pass Class	Final CGPA below 6.00 but not less than 5.00

*** Note :**

a) A student with Final CGPA (at the end of the PG Degree Programme) ≥ 8.00, and fulfilling the following conditions -

(i) should have passed all the Subjects/ Courses within the first 2 Academic Years (or 4 Sequential Semesters) from the Date of Commencement of her First Academic Year,

(ii) should not have been detained or prevented from writing the End Semester Examinations in any semester due to shortage of attendance or any other reason, shall be placed in 'FIRST CLASS with DISTINCTION'.

A student fulfilling the conditions listed under (a) above, alone will be the eligible candidate for the 'University/College Rank' and/or 'Gold Medal' considerations.

b) A student with Final CGPA (at the end of PG Degree Programme) ≥ 8.00, but not fulfilling the above conditions, shall be placed in 'FIRST CLASS'.

13.3 A student with Final CGPA (at the end of the PG Degree Programme) < 5.00 will not be eligible for the Award of the Degree.

14.0 Withholding of Results

14.1 If a student has not paid fees to the University/College at any stage, or has pending dues against her name on account of any reason whatsoever, or if any case of indiscipline is pending against her, the result of such student may be withheld, and she shall not be allowed to into the next higher semester. The Award or issue of the Degree may also be withheld in such cases.

15.0 Transitory Regulations

15.1 A student who has discontinued for any reason, or has been detained for want of attendance or lack of required credits as specified, or who has failed in her M.Tech. Degree Programme after the PGDP period of 2 years, may be considered eligible for readmission - to the same PGDP with same set of Subjects/ Courses (or equivalent Subjects/ Courses as the case may be), and/or to the same Program Specific Electives (or from same set/category of Electives or equivalents as suggested), as and when they are offered (within the time-frame of 4 years from the Date of Commencement of her I Year I Semester), along with the Academic Regulations of the Batch into which she gets readmitted.

16.0 Student Transfers

16.1 There shall be no Branch/ Specialization transfers after the completion of the Admission Process.

17.0 Scope

i) Where the words "Subject" or "Subjects", occur in these regulations, they also imply "Course" or "Courses".

ii) The Academic Regulations should be read as a whole, for the purpose of any interpretation.

iii) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

iv) The College may change or amend the Academic Regulations, Course Structure or Syllabi at any time, and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the College Authorities.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices / Improper conduct	Punishment
	If the student:	
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 subject of the examination (theory or practical) in which student is appearing but has not made use of (material shall include any marks on the body of the student which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other student orally or by any other body language methods or communicates through cell phones with any student 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 subject only of all the students 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 subject of the examination (theory or practical) in which the student is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year.
3.	Impersonates any other student in connection with the examination	The student who has impersonated shall be expelled from examination hall. The student is also debarred and forfeits the seat. The performance of the original student who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 , 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 subject and all the other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 subject.
6.	Refuses to obey the orders of the chiefsuperintendent/assistant –superintendent / any officer on duty or misbehaves or creates disturbance of anykind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge 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, eitherspoken or written or by signs or by visible representation, assaults the officer-in-charge, 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 tendencyto disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the student(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The students also are debarred and forfeit their seats. 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 subject and all the other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred for

		two consecutive semesters from class work and all university examinations. The continuation of the course by the student 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 subject and all other subjects the student has alreadyappeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred and forfeits the seat.
9.	If student of the college, who is not a student for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/ year. The student is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall andcancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations andproject work and shall not be permitted for the remaining examinations of the subjects of that semester/year
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the student has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the university for further action to award suitable punishment.	

M. Tech. 2 Year (4 Semesters) Regular Programme in
POWER ELECTRONICS & ELECTRIC DRIVES (PEED)
Department of Electrical & Electronics Engineering

COURSE STRUCTURE

(Applicable for the Batches admitted from the Academic Year 2022-23)

I Year **I Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PC	521AA	Advanced Power Electronics	3	0	0	3
2)	PC	521AB	Modeling and Analysis of Electrical Machines	3	0	0	3
3)	PSE1		**Program Specific Elective - 1**	3	0	0	3
		521AC	Switch Mode and Resonant Converters				
		521AD	Modern Control Theory				
		521AE	Dynamics of Electrical Machines				
4)	PSE2		**Program Specific Elective - 2**	3	0	0	3
		521AF	Reactive Power Compensation Techniques				
		521AG	Hybrid Electric Vehicles				
		521AH	Digital Signal Processors				
5)	PC	52101	Advanced Power Electronics Lab	0	0	3	1.5
6)	PC	52102	Electrical Systems Simulation Lab	0	0	3	1.5
7)	PW	521AJ	Research Methodology and IPR	2	0	0	2
8)	PW	52103	Seminar – 1	0	0	2	1
9)	AC1		Audit Course – 1	2	0	0	-
			TOTAL CREDITS				**18**

I Year **II Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PC	522AK	Advanced Electric Drives	3	0	0	3
2)	PC	522AL	HVDC and FACTS Devices	3	0	0	3
3)	PSE3		**Program Specific Elective – 3**	3	0	0	3
		522AM	Smart Grid Technologies				
		522AN	Power Quality				
		522AP	AI and ML Techniques for Power Electronics Applications				
4)	PSE4		**Program Specific Elective – 4**	3	0	0	3
		522AQ	PWM Techniques for Power Electronic Converters				
		522AR	Distributed Generation				
		522AS	Optimal and Adaptive Control				
5)	PC	52205	Advanced Electric Drives Lab	0	0	3	1.5
6)	PC	52206	Power Converters Simulation Lab	0	0	3	1.5
7)	PW	52207	Mini Project	0	0	4	2
8)	PW	52208	Seminar – 2	0	0	2	1
9)	AC2		Audit Course – 2	2	0	0	0
			TOTAL CREDITS				**18**

M. Tech. 2 Year (4 Semesters) Regular Programme in
POWER ELECTRONICS & ELECTRIC DRIVES (PEED)
Department of Electrical & Electronics Engineering

COURSE STRUCTURE

(Applicable for the Batches admitted from the Academic Year 2022-23)

II Year **I Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PSE5		**Program Specific Elective - 5**	3	0	0	3
		523AT	PLCs and FPGAs				
		523AU	Grid Integration of Renewable Energy Sources				
		523AV	Energy Storage Techniques				
2)	OE		**Open Elective**	3	0	0	3
3)	PW	52310	Project / Dissertation (Phase – I)	0	0	20	10
			TOTAL CREDITS				**16**

II Year **II Semester**

S.No.	Group	Subject Code	Subject	L	T	P	Credits
1)	PW	52411	Project / Dissertation (Phase – II)	0	0	32	16
			TOTAL CREDITS				**16**

AUDIT COURSES

1) English for Research Paper Writing-521HA/522HA
2) Disaster Management-521HB/522HB
3) SANSKRIT for Technical Knowledge-521HC/522HC
4) Value Education-521HD/522HD
5) Constitution of India-521HE/522HE
6) Pedagogy Studies-521HF/522HF
7) Stress Management by YOGA-521HG/522HG
8) Personality Development through Life Enlightenment Skills-521HH/522HH

OPEN ELECTIVES :

1. Business Analytics—523GA
2. Industrial Safety—523GB
3. Operations Research—523GC
4. Cost Management of Engineering Projects—523GD
5. Composite Materials—523GE
6. Energy from Waste—523GF
7. Power from Renewable Energy Sources. —523GG

I Year M.Tech.PEED I-Semester **L T P C**
Course Code:521AA **3 0 0 3**

ADVANCED POWER ELECTRONICS

Prerequisites: Power Electronics

Course Objectives:

1. To understand the operation of advanced power electronic switching devices.
2. To understand the control strategies of various converter topologies.
3. To analyze various power converters and identify their applications.
4. To acquire knowledge on Power Block Geometry.

Unit 1: (~10 Lecture Hours)

High power switching devices:

Power Diodes - Basic Structure and I-V Characteristics - on State Losses, Switching Characteristics. **Thyristors** – Basic Structure, V-I Characteristics

– Turn on Process, On State operation – Turn off process Switching Characteristics, Turn on Transient and di/dt limitations, Ratings of Thyristors. Snubber Requirements and snubber design. **Triacs**- Basic structure and operation, V-I Characteristics, Ratings, Snubber Requirements. **Gate Turnoff Thyristor (GTO)**- Basic Structure and operation. **Gate Commutated thyristors(GCT)**-Basic Structure and operation. GCT Switching Characteristics. **Power BJTs-** Basic Structure and I-V Characteristics. **Power MOSFETs** - Basic Structure. V-I Characteristics. **Insulated Gate Bipolar Transistor (IGBTs)**- Basic Structure and Operation. IGBT Switching Characteristics. **IGCT and ETO:** Basic Structure and Operation.

Unit 2: (~8 Lecture Hours)

Overview of Inverters and PWM Techniques:

Principle of operation of Current source Inverter , Voltage Source Inverter and Z- Source Inverter.

Multilevel Inverter configurations: Neutral Point Clamped , Cascaded H- Bridge and Flying Capacitor configurations.

Sinusoidal PWM, Third harmonic injection PWM , Space vector Pulse Width modulation: Switching states-space vectors_ dwell time calculation- modulation index-switching sequence-spectrum analysis_ even-order harmonic Elimination.

Unit 3: (~10 Lecture Hours)

Neutral Point Clamped Multilevel Inverters:

Principles of Power Blocks Geometry, Description of Power Blocks, Application of PBG in multi-level configurations: Neutral point clamped configuration, cascade configuration, Flying capacitor configuration.

Application of PBG in ac-dc-ac configurations.

Neutral point Clamped configuration- Three-level configuration, PWM implementation(Half-bridge topology), Full-bridge topologies, three –phase NPC converter, Non-Conventional arrangements by using three-level legs, Unbalanced capacitor voltage, Four-level configuration, PWM implementation(Four-level configuration), Full-bridge and other circuits (Four-level configuration), Five-level configuration.

Unit 4: (~10 Lecture Hours)

Cascade Multilevel Inverters:

Single H-bridge converter, PWM implementation of a single H-bridge converter, three-phase converter-one H-bridge converter per phase, two H- bridge converters, PWM implementation of two cascade H-bridges, Three-phase converter-two cascade H-bridges per phase, two H-bridge converters(seven and nine level topologies), three H-bridge converters, four H-bridge converters and generalization.

Unit 5: (~10 Lecture Hours)

Flying Capacitor Multilevel Inverters: Three-level configuration, PWM implementation(Half-bridge topology), flying capacitor voltage control, full- bridge topology, three-phase FC converter, Non-conventional FC converters with three-level legs, Four-level configuration, Generalization.

Text Books:

1. Euzeli Cipriano Dos Santos Jr. and Edison Roberto Cabral Da silva- A John Wiley & Sons, "Advanced Power Electronics converters" Inc, Publication – IEEE Press.
2. Bin Wu-A John Wiley & Sons, "High power converters and AC drives" Inc,Publication –IEEE Press.
3. Ned Mohan, Tore M. Undeland and Willilam P. Robbins – John Wiley and sons – "Power Electronics" Second Edition, 1995.
4. Mohammed H. Rashid, "Power Electronics" Pearson Education, Third Edition, 2017.
5. G.K.Dubey,"Thyristorised Power Controllers" Wiley Eastern Ltd. 2005- 06.

Reference Books:

1. B.K.Bose, "Power Electronics and variable frequency drives"-IEEE press- Standard publications-1st edition, 2002.
2. Robert W. Erickson, Dragan and Maksimobic, "Fundamentals of Power Electronics"–Springer.
3. M.S. Jamil Asghar "Power Electronics"- PHI Private Limited, 2011.

Online Resources:

1. http://nptel.ac.in/courses/108108077

Course Outcomes:

Subsequent to completion of the course, the student should be able to:

1. Acquire knowledge on Modern Power Switching devices.
2. Acquire knowledge about analysis and design of various Multilevel Inverter topologies.
3. Apply Power Block Geometry to various Inverter topologies.
4. Apply various modulation techniques under different operating conditions.
5. Apply Knowledge acquired to increase the levels of Inverters.
6. Achieve hardware implementation of the different types of converters.

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I Year M.Tech. PEED I-Semester **L T P C**
Course Code:521AB **3 0 0 3**

MODELING AND ANALYSIS OF ELECTRICAL MACHINES

Prerequisites: AC and DC Electrical Machines

Course objectives:

1. To understand the basic concepts of rotating machines.
2. To develop mathematical model for different rotating machines.
3. To introduce different special machines and their applications.

Unit1: (~8 Lecture Hours)
Electromagnetic Energy Conversion:
Principles of electromagnetic Energy Conversion, General expressions of stored magnetic energy, Co-energy and force/torque, example using adoubly excited system. Basic Concepts of Rotating machines– Calculation of air gap mmf and per phase machine inductance using physical machine data.

Unit2: (~10 Lecture Hours)
Modeling of DC Machines:
Basic two pole DC machine–primitive two axis machine–voltage and current equations–torque equations. Mathematical modeling of separately excited, shunt, series and compound DC motors.

Unit3: (~12 Lecture Hours)
Modeling of Induction Motors:
Symmetrical Induction machines-Introduction, Voltage equations in machine variables, Torque equation in machine variables, Equations of transformation for rotor circuits, Voltage equations in arbitrary reference-frame variables, Torque equation in arbitrary reference-frame variables, commonly used reference frames.

nit4: (~8LectureHours)
Modeling of Synchronous Motors:
Synchronous machines-Introduction, Voltage equations in machine variables, Torque equation in machine variables, Stator voltage equations in arbitrary reference-frame variables, voltage Park's equations, Torque equations in substitute variables, Rotor angle and angle between rotors.

Unit5: (~8LectureHours) **Modeling of Special Machines:**
Special Machines – Permanent magnet synchronous machine; Construction and operating principle; Analysis of Brushless DC Motor, Analysis of reluctance motor- Applications.

Text Books:

1. P.C.Krause, "Analysis of Electric Machines" Wiley IEEE Press 3rd Edition.
2. P.S.Bimbhra, "Generalized Machine theory", Khanna Publishers.
3. R.Krishnan, "Electric Motor & Drives : Modeling, Analysis and Control", Prentice Hall of India.

Reference Books:

1. CharlesKingsley,Jr., A.E.Fitzgerald, Stephen D.Umans, "ElectricMachinery".Tata McgrawHill.
2. Miller,T.J.E., "Brushless Permanent Magnet and reluctance Motor Drives",ClarendonPress.

OnlineResources:

1. http://nptel.ac.in/courses/108106023

Course Outcomes:

Students will be able to:

1. Have clear understanding of the concepts and principles involved in rotating machines.
2. Model different electrical machines with the concept of primitive two axes machine.
3. Represent the behavior of different rotating machines in terms of mathematical expressions.
4. Have knowledge of various reference frames used for mathematical modelling of AC machines with the help of different transformations.
5. Analyze the necessity and behavior of different special machines.
6. Understand and incorporate real time problems in mathematical modelling of electrical machines.

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I Year M. Tech. PEED I-Semester **L T P C**
Course Code:521AC **3 0 0 3**

SWITCHED MODE AND RESONANT CONVERTERS

(Program Specific Elective 1.1)

Prerequisite: Power Electronics, Power Electronic Converters

Course Objectives:

1. To comprehend the concepts of different power converters and their applications
2. To analyze and design switched mode regulators for various industrial applications.
3. To develop resonant power converters with better performance

UNIT-I: (~ 9 Lecture Hours)

D.C. TO D.C. CONVERTERS:

Analysis of step-down and step-up dc to dc converters with Resistive and Resistive-Inductive loads, Switched mode regulators, Analysis of Buck Regulators, Boost regulators, Buck and boost regulators, Cuk regulators, Condition for continuous inductor current and capacitor voltage, Comparison of regulators,
Multi output boost converters, Advantages, Applications, Problems, State space analysis of regulators.

UNIT-II: (~ 9 Lecture Hours)

DC POWER SUPPLIES:

Classification, Switched mode dc power supplies, Fly back Converter, Forward converter, Push-pull converter, Half bridge converter, Full bridge converter, Control circuits, Magnetic design considerations , Applications.

UNIT-III: (~ 9 Lecture Hours)

RESONANT PULSE INVERTERS:

Resonant pulse inverters, Series resonant inverters, Series resonant inverters with unidirectional switches, Series resonant inverters with bidirectional switches, Analysis of half bridge resonant inverter, Evaluation of currents and voltages of a simple resonant inverter, Analysis of half bridge and full bridge resonant inverter with bidirectional switches, Frequency response of Series resonant, Parallel resonant, Series loaded, Parallel loaded, Series and Parallel loaded inverters, Voltage control of resonant inverters, Class-E resonant inverter, Class-E resonant rectifier, Evaluation of values of 'C' and 'L' for Class-E inverter and Class-E rectifier, Numerical problems.

UNIT-IV: (~9 Lecture Hours)

RESONANT CONVERTERS:

Resonant converters, Zero current switching resonant converters, L-type and M-type ZCS resonant converter, Zero voltage switching resonant converters, Comparison between ZCS and ZVS resonant converters, Two quadrant ZVS resonant converters, Resonant dc-link inverters, Evaluation of 'L' and 'C' for a zero current switching inverter, Numerical problems.

UNIT-V: (~ 9 Lecture Hours)

POWER CONDITIONERS:

Power line disturbances, Power conditioners, Uninterruptible Power supplies, Applications

ADVANCED CONVERTERS:

Principle of operation of SEPIC converter, Matrix Converter, Luo Converter, Interleaved Converter

Text Books:

1. Mohammed H. Rashid, "Power Electronics", Pearson Education, 3rd Edition, 1st Indian reprint, 2004.
2. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics", John Wiley & Sons, 2nd Edition, 1995.
3. B.K. Bose "Modern Power Electronics and AC Drives ", Prentice Hall PTR, 2002.

Reference Books:

1. Milliman Shepherd and Lizang, "Power converters circuits", Chapter 14 (Matrix converter) pp.415-444.
2. M.H.Rashid , "Power Electronics Hand Book", Academic press, 2001.
3. Marian P. KaŸmierkowski, Ramu Krishnan, Frede Blabjerg Edition, "Control in Power Electronics", Published by Academic Press, 2002.

Course Outcomes:

After completion of subject, the student will be able to

1. Analyze the principles of operation of push full and forward converters.
2. Identify various loss components in a switched mode converter and choice of switching frequency with a view towards design of such converters.
3. Model existing and modified power converters under small signal perturbations and steady state conditions.
4. Analyze and interpret the concepts of resonant converters.
5. Analyze resonant pulse inverters.
6. Apply the concepts acquired to practical and meaningful applications.

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I Year M.Tech. PEED I-Semester **L P T C**
Course Code:521AD **3 0 0 3**

MODERN CONTROL THEORY

(Program Specific Elective 1.2)

Prerequisites: Linear control systems

Course Objectives:

1. To explain the concepts of basic and modern control system for the real time analysisand design of control systems.
2. To explain and apply concepts of state variables analysis.
3. To study and analyze non linear systems.
4. To analyze the concept of stability of nonlinear systems and categorization.

UNIT–I (~10 Lecture Hours)

Introduction to Mathematical Preliminaries:

Eigen-values, Eigen Vectors and a Canonical form representation of Linear operators – calculus of variations - fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method. The concept of state– State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.

UNIT-II (~9 Lecture Hours)

State Variable Analysis:

Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems – Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.

UNIT-III (~9 Lecture Hours)

Non Linear System analysis:

Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing

function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions. Introduction to phase- plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

UNIT-IV (~9 Lecture Hours)

Stability Analysis:

Stability in the sense of Lyapunov, Lyapunov's stability, and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback controller design through Pole Assignment – State observers: Full order and Reduced order.

UNIT-V (~8 Lecture Hours)

Design of Controllers and Observers:

Introduction, Pole Placement , Design of controller by Pole placement technique Design of servo system. State Observer, design of Regulator systems with observers, design of control systems with observers.

Introduction to optimal control - Formulation of optimal control problems. Quadratic Optimal Regulator system.

Text Books:

1. Modern Control System Theory by M.Gopal – New Age International - 1993.
2. Control System Engineering, Nagrath and Gopal - New Age International – 5th Edition, 2009.
3. Modern Control Engineering by Ogata. K – Prentice Hall – 5th Edition - 2010.

Reference Books:

1. Optimal control Theory by Donald. E. Kirck, Dover Publications -2012.

Online resources: https://nptel.ac.in/courses/108107115

Course Outcomes:

Upon the completion of the course the student will be able to:

1. Understand the concepts of mathematical preliminaries applied for Modern control theory.
2. Understand the concepts of state variable analysis.
3. Apply the knowledge of basic and modern control system for the real time analysisand design of control systems.
4. Analyze the concept of stability of nonlinear systems .
5. Apply the knowledge of state variable design for designing the controllers and observes.

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I Year M.Tech. PEED I-Semester **L T P C**
Course Code:521AE **3 0 0 3**

DYNAMICS OF ELECTRICAL MACHINES

(Program Specific Elective1.3)

Prerequisites: Electrical Machines, Circuit Theory

Course objectives:

1. To gain understanding of the dynamics of different machines.
2. To impart knowledge on the performance characteristics of different machines.
3. To determine both steady state and transient stability of the different machines subjected to disturbances in operation.

Unit 1: (~8LectureHours)
Dynamics of Separately Excited DC Generator:
Steady state analysis, Transient Analysis-Sudden step field excitation at no-load and load–Sudden short circuit of armature terminals– Sudden short circuit of field terminals, Generator operation with displaced brushes.

Unit 2: (~8LectureHours) **Dynamics of DC Motors:**
Separately Excited DC Motor–Steady state analysis, Transient analysis– Sudden application of voltage and load torque–Sudden application of inertia load, Transfer function–Dynamic behaviour. DC Series Motor: Steady state analysis–Linearization techniques for small perturbations.

Unit 3: (~10LectureHours) **Transients in Transformers:**
Excitation phenomena–Harmonics in single–phase transformers, Over current transients– Qualitative and Analytical approaches.- Estimation of inrush current, External and Internal over voltages– Transformer equivalent circuit with over voltages-Initial voltage distribution for solidly grounded neutral and isolated neutral.

Unit 4: (~10LectureHours)
Induction Machine Dynamics:
Dynamics during starting and braking–Accelerating time– Dynamics during normal operation, Operation on unbalanced supply voltages– Equivalent circuit, Operation on Single phasing–Equivalent circuit.

Unit5 : (~8LectureHours) **Synchronous Machine Dynamics:**
Electro-mechanical equation-Motor operation-Generator operation- Linearized analysis, Cyclic variations of shaft torque, Electric braking-Plugging and Dynamic braking.

Text Books:

1. Bhimbra P.S, Generalized Theory of Electrical Machines, Khanna Publishers,2002.
2. Nagrath I.J & Kothari D.P, Electric Machines, Tata McGrawHill Publishers, 2004.
3. I.Boldia & S.A.Nasar, Electrical Machine Dynamics, The Macmillan Press Ltd. 1992

Reference Books:

1. D.P. Sengupta & J.B. Lynn, Electrical Machine Dynamics, The Macmillan Press Ltd.1980
2. R.Krishnan "Electric Motor Drives, Modeling, Analysis and Control", Pear son Education, 2000
3. P.C.Kraus, Analysis of Electrical Machines, McGraw Hill Book Company, 1987

Course outcomes:

Students will be able to:

1. Model different electric machines with the help of their electrodynamic equations.
2. Analyze the performance of various machines under different operating conditions.
3. Determine stability of the machines under small signal variations and Transient conditions.
4. Predict the behavior of electric machines for sudden disturbances in their operation.
5. Have a clear understanding of the qualitative and analytical approaches for their dynamic operations.
6. Understand and resolve real time challenges in the operation of electrical machines.

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I Year M. Tech. PEED I-Semester **L T P C**
Course Code:521AF **3 0 0 3**

REACTIVE POWER COMPENSATION TECHNIQUES

(Program Specific Elective 2.1)

Prerequisites: Power Electronics, Power Systems

Course Objectives:

1. To impart knowledge on various static converters used in Transmission & Distribution Systems.
2. To gain Understanding of the static converter control strategies.
3. To Understand the reactive power compensation and it's control.
4. To design controllers for Harmonic filtering.

Unit 1: (~9 Lecture Hours)

Fundamental concepts:

Fundamentals of Load Compensation and EHV Line Compensation, Introduction of FACTS, Basic types of FACTS Controllers, Definitions of FACTS controllers, Brief description of FACTS Controllers, Summary of main Power Electronic Devices (SCR, IGBT and GTO), Similarities and Differences between them. Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion, Current Harmonics, Sources of Harmonics in Power Systems, Need for Harmonic Filtering and Power Quality Monitoring.

Unit 2: (~10 Lecture Hours)

Static Shunt Compensators:

Static VAR Compensators (SVC) - FC-TCR, TSC-TCR and their control schemes, Coordination of the power system characteristics and the SVC characteristics, Applications of SVC in power flow control and for enhancing Stability of power systems and enhancing the power carrying capacity in EHV Lines.

Static Synchronous Compensator (STATCOM) – Operating Principle of Voltage Source Inverters and STATCOM Control Schemes, Application of STATCOM for Sag/Swell mitigation in distribution systems.

Unit 3: (~10 Lecture Hours)

Static Series Compensators:

Thyristor -Controlled Series Capacitor (TCSC): Operating principle of TCSC , Control Schemes and their Protection, Application of TCSC to enhance power carrying capacity of EHV lines and power system stability improvement.

Static Synchronous Series Compensator (SSSC) :Operating principle of SSSC and their Control schemes. Application of SSSC for improving stability and damping in power systems.

Unit 4: (~8 Lecture Hours)

Harmonic in Static Converters:

Quantification of Harmonics produced in different converters employing standard Modulation Strategies (SPWM, SVM), Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type, Multi-level inverters of Cascade Type and their modulation, Current Control of Inverters.

Unit -5 (~8 Lecture Hours)

Harmonic Filtering Techniques:

Passive Harmonic Filtering :Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling, Three phase four wire shunt active filters, Hybrid Filtering using Shunt Active Filters, Dynamic Voltage Restorer and its control, Power Quality Conditioner.

Active Harmonic Filtering: Introduction to Active filers, Series Active Filtering in Harmonic Cancellation Mode, Series Active Filtering in Harmonic Isolation Mode.

Text Books:

1. Narain G. Hingorani, Laszlo Gyugyi, " Understanding FACTS Concepts and technology of Flexible AC Transmission Systems", IEEE Press , 2019 ISBN-978-81-265-3040-3.
2. E Acha,V G Agelidis, O Anaya- Lara, T.J.E. Miller, "Power Electronic Control in Electrical Systems", Elsevier, 2006.
3. B.K. Bose " Modern Power Electronics and AC Drives ", Prentice Hall PTR, 2002.
4. Ned Mohan et.al, "Power Electronics", John Wiley and Sons, 2006.

Reference Books:

1. PrabhaKundur, "Power System Stability and Control", Tata McGraw Hill, 2006.
2. G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc., 1988.
3. B. J. Baliga," Power Semiconductor Devices", Thomson, 2004
4. V. Benda, J. Gowar, D. A. Grant," Power Semiconductor Devices. Theory and Applications", John Wiley & Sons, 1994.

Online Resource: https://archive.nptel.ac.in/courses/108/107/108107114/

Course Outcomes:

After completion of the course students should be able to:

1. Apply various compensation techniques in FACTS devices.
2. Analyze various static converter control strategies
3. Identify the FACTs devices for different applications on system control.
4. Analyze / interpret harmonic filtering and design their controllers.
5. Formulate and solve problem related to static compensator.
6. Identify and reduce Harmonics in static compensator through different Harmonic filtering techniques.

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I Year M.Tech. PEED I-Semester **L T P C**
Course Code:521AG **3 0 0 3**

HYBRID ELECTRIC VEHICLES

(Program Specific Elective 2.2)

Prerequisites: Electrical Machines, Power Electronics, Control Systems.

Course Objectives:

1. Understand the Concepts and Principles of Electric Vehicle (EV).
2. Analysis of Propulsion Systems in HEV.
3. Able to identify the suitable energy storage devices and hybridization.
4. Able to understand the charging topologies in EV.

Unit 1: (~9 Lecture Hours)

History, Fundamentals and Environmental impact of Modern transportation:

History of EVs, HEVs, Fuel Cell vehicles and their impact on Environment. **Fundamentals of vehicle Propulsion and Braking:** Vehicle Resistance, Dynamic Equation, Tire Ground Adhesion and Maximum Tractive Effort, Power train Tractive effort and Vehicle speed, Vehicle performance, Operating Fuel Economy, Brake Performance.

Power train Optimization: Power train Modelling Techniques, Tank to wheel emissions, Well to Wheel Emissions.

Unit 2: (8~ Lecture Hours)

Internal Combustion Engines:

Spark Ignition Engine: Basic Structure and operation principle with Otto Cycle, Operation parameters, Basic Techniques for improving Engine performance, Efficiency and Emissions. Compression Ignition Engine, Alternative Fuels and Engines.

Unit 3: (~10 Lecture Hours)

Vehicle Transmission

Power plant Characteristics, Transmission Characteristics, Manual Gear Transmission, Automatic Transmission, continuously variable Transmission, infinitely variable transmission, Dedicated Hybrid Transmission.

Electric vehicles:

Configurations of Electric vehicles, Performance of EV, Energy Consumption.

Hybrid Electric Vehicles:

Concept of Hybrid Electric Drivetrain, Architectures of Hybrid Electric Drivetrains. Series HEV, Parallel HEV, Series-Parallel HEV.

UNIT 4: (~12 Lecture Hours)

Energy storage:

Electrochemical Batteries: Electrochemical reactions, Specific Energy, Specific Power, Energy Efficiency, Battery technologies of Lead-Acid, Nickel based batteries, Lithium based batteries, Ultracapacitors, Operating Principle and different technologies of Fuel Cells, Hybridization of Energy Sources.

Fundamentals of Regenerative Braking: Braking energy consumed in Urban Driving, braking energy vs Vehicle speed, braking energy vs braking power. braking power vs braking power vs vehicle speed, Braking energy vs vehicle deceleration rate.

Unit 5: Electric Vehicles Charging: (~8 Lecture Hours)

Charging,Standards and infrastructure, Charging Methods, Modes, Communication, Charging plugs, Vehicle-to-grid Technology, Wireless power transfer, Solar charging introduction.

Case Studies: Gasoline Engine Vehicle transmission, General Motors EV-1, Toyota Prius, Tesla Roadster.

Text books:

1. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Third Edition, CRC Press, 2018
2. T. Denton, Electric and Hybrid Vehicles, Routledge, 2016.
3. Electric Vehicle Technology Explained, James Larminie, John Lowry, John Wiley & Sons, Ltd. 2003

Reference Books:

1. Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC press, Taylor & Francis e-Library 2005
2. Introduction to hybrid vehicle system modeling and control. Liu, W. (2013). John Wiley & Sons.
3. Review paper: Brenna, M., Foiadelli, F., Leone, C. et al. Electric Vehicles Charging Technology Review and Optimal Size Estimation. J. Electr. Eng. Technol. 15, 2539–2552 (2020). doi.org/10.1007/s42835-020-00547
4. S. Onori, L. Serrao, G. Rizzoni, Hybrid Electric Vehicles: Energy Management Strategies, Springer, 2015.

Online Resource:

- https://e-amrit.niti.gov.in/home
- https://powermin.gov.in/en/content/electric-vehicle
- https://beeindia.gov.in/content/e-mobility
- https://www.iea.org/programmes/electric-vehicles-initiative
- https://www.udemy.com/course/electric-and-hybrid-vehicle- engineering/
- https://nptel.ac.in/courses/108/106/108106170/

Course Outcomes:

At the end of this course, the students will be able to

1. Understand the concepts of Electric vehicle, Hybrid Electric vehicle, and identify the appropriate usage of them.
2. Identify the configurations of Electric vehicles and their performance. Also identify the suitable battery sources for Electric vehicles.
3. Apply the concepts of electrical machines, Power Electronics for the design of Electrical Vehicles.
4. Analyze the various vehicle topologies, Drive trains, Energy storage devices.
5. Identify the Suitable charging methods and techniques to the vehicle.
6. Explore the case studies of different Vehicles.

I Year M. Tech. PEED I-Semester **L T P C**
Course Code:521AH **3 0 0 3**

DIGITAL SIGNAL PROCESSORS

(Program Specific Elective 2.3)

Prerequisites: Microprocessors and Microcontrollers

Course Objectives:

1. Tounderstand basic knowledge of digital signal processing
2. Toget associated with digital signal processors
3. Tounderstand DSP C2000 Processor timers and pwm
4. To implement TI DSP based applications

UNIT1: (~8Lecture Hours)

Introduction to DSP

Introduction: Signals – Classification – Continuous & Discrete Time Signals – Basic Operations on Signals & Sequences – Elementary Signals - Discrete Time Systems &Properties of System, Impulse response of DT-LTI system, Linear Convolution. Sampling of Continuous Time Signals – Sampling Theorem – Aliasing & it's Effects, Signal reconstruction.

UNIT2: (~8Lecture Hours)

Discrete Time systems and Z-Transforms

Discrete Time systems and implementation Concepts of Z transformation, properties of Z transformation etc., Block diagram / signal flowgraph representation of DT System, Structures for realization of FIR & IIR Systems – Direct, Cascade, Parallel & Linear phase.

UNIT3: (~10Lecture Hours)

Architecture of DSP

Architecture of DSP and C2000 family Features of Processors– Types of architecture, Concepts of DMA, MAC, Pipelining etc., introduction to DSP architecture. Peripherals available in DSP IC chips, requirements of on chip hardware for power electronics applications. Introduction to C2000 family of Microcontrollers, Comparison of C2000 real time microcontrollers like PICOLO, DELFINO, 28M3x etc., with reference to on chip peripherals, processing capacity, applications etc.

UNIT4: (~8LectureHours) **Programming with DSP Controllers**

Code Composer Studio: Introduction to CCS as IDE for TI processors, Basics of CCS, Multiprocessing with CCS, Testing Program, debugging Breakpoints, points, using file I/O, Memory map, Watch window, Integrated editor, project environment Software Development and Programming: Overview, description, object module, program loading and running, Assembler, Assembler directives, Macros, Linker, using C language Writing program for some simple objectives like initializing peripheral, timer interrupt and ISR for timer interrupt, PWM generation etc. for C2000 microcontrollers.

UNIT 5:(~10LectureHours**) DSP Functions**

TI 320F28X Digital Signal Controllers: TMS320F28X Introduction, Functional Overview, Memory map, brief description of available peripherals, register maps, device emulation registers, interrupts, system control, On chip Peripherals of TMS320F28335(or any other C2000 Family processor): Timers, PWM generation, ADC, Serial Communication, GPIO, Flash Memory

Text Books:

1. DSP-Based Electromechanical Motion Control (Power Electronics and Applications Series), Hamid A. Toliyat (Author), Steven G. Campbell, CRC press
2. TI technical documents: Code Composer Studio User's Guide, Document no. SPRU328B (Data Manual 28335), SPRS439M (TI 28335 Data sheet), SPRUI07 (Technical Reference Manual), SPRU513V (Discrete TMS320C28x Assembly Language Tools User's Guide), SPRU514V (TMS320C28x Optimizing C/C++ Compiler v20.12.0.STS) , SPRAC71A (C28x Embedded Application Binary Interface), SPRU566N (C2000 Real-Time Control Peripherals) 2021.

Reference Books:

1. The DSP Handbook Algorithms, Applications and design techniques, Andrew Bateman, Iain Paterson-Stephens, Pearson Education 2020.
2. Digital Signal Processing: Principles, Algorithms, and Applications, Dimitris Manolakis and John G Proakis, Pearson,2016

Online Resources:

a) https://onlinecourses.nptel.ac.in/noc19_ee50/preview
b) https://www.coursera.org/learn/dsp1

Course Outcomes:

Upon the completion of the course, the students will be able to

1. Understand the basics of digital systems and signals associated.
2. Architecture of DSP and their features.
3. Apply concepts of Digital Signal Processing to practical application.
4. IDE and Programming with DSP based Processors.
5. Interface sensors and other devices with DSP.
6. Understand concepts of Digital Signal Processing implementation requirements of Power Electronics systems.

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I Year M. Tech. PEED I-Semester **L T P C**
Course Code:52101 **0 0 3 1.5**

ADVANCED POWER ELECTRONICS LAB

Prerequisites:

Power Electronics Course Objectives:-

1. To analyze different types of Converters.
2. To analyze Harmonics of Single Phase Inverter.
3. To generate PWM signals for Converters.

Compulsory Experiments

1. Operation of Four-Quadrant chopper with R and R-L load.
2. To control the output Voltage of three phase half controlled converter with R and R-L load.
3. To control the output voltage of Single phase dual converter.
4. To vary the DC Voltage by using Buck and Boost Converter.
5. Single Phase AC Voltage Controller using TRIAC or SCR.
6. Analysis of Three Phase Multilevel Inverter.
7. Generation of PWM signals using FPGA.
8. Variation of Voltage and Frequency of Single Phase supply using Cyclo Converter.

Optional (Any 2 to be Conducted)

9. Harmonics analysis of Single Phase Inverter using Power Analyzer.
10. The effect of balanced non-linear load on neutral current in a three phase circuit.
11. Reduction of harmonics in a single phase Inverter using SHE-PWM technique.
12. V/F Control of three phase Inverter with R-L load.

Course Outcomes:

The students will be able to:

1. Analyze the performance of single phase AC Voltage controller and Cyclo Converter.
2. Analyze the Harmonics of Single Phase Inverter.
3. Generate PWM signals using FPGA.
4. Analyze the performance of four-quadrant chopper.
5. Reduce the selective harmonics using PWM techniques.
6. Control the Voltage using dual Converter.

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I Year M.Tech. PEED I-Semester **L T P C**
Course Code:52102 **0 0 3 1.5**

ELECTRICAL SYSTEMS SIMULATION LAB

Prerequisites: Power Electronics, Control Systems, AC& DC machines.

Course Objectives:

1. To study various Converters for different load conditions.
2. To become familiar with the simulation tools like SIMULINK, Mi-Power and PSIM.
3. To be able to analyze typical control systems using both time domain and frequency domain approach using MATLAB.
4. To gain knowledge on modeling and simulation of DC and AC Motors.

List of Experiments:

1. Simulation of buck, boost and buck-boost converter with open loop operation.
2. Single Phase Inverter using PWM controller with RL load.
3. Three phase fully controlled Converter using RL &RLE loads.
4. Three phase Inverter with SPWM Controller.
5. Simulation of z-source inverter.
6. Simulation of Separately Excited DC Motor to study the Dynamic behavior of the machine for change in Load Torque.
7. Mathematical Modeling of separately excited DC motor.
8. Modeling and Simulation of Three Phase Induction Motor in three different frames.
9. Simulation of three phase inverter with 120°, 150°, 180° mode of operation.
10. Load (Power) Flow studies using Mi-Power.
11. Stability analysis using Root locus, Bode plot and Nyquist plot.
12. Simulation and Analysis of 3-ϕ PWM inverter fed Induction Motor.
13. Resonant Converter – ZVS and ZCS operation.

Course Outcomes:

The students will be able to:

1. Analyze various types of Converters for different load conditions.
2. Carry out stability analysis using MATLAB.
3. Model & simulate different types of motors to study their dynamic behavior for change in Load Torque.
4. Acquire knowledge on various modulation techniques.
5. Acquire knowledge on mathematical modeling of different motors.
6. Apply the knowledge acquired in SIMULINK, Mi-Power and PSIM for analyzing various Systems.

List of Tools to be used:

1. MATLAB / Simulink
2. P-spice

I Year M.Tech. PEED I-Semester **L T P C**
Course Code: PW521BJ **2 0 0 2**

RESEARCH METHODOLOGY AND IPR

Prerequisites: None

Course Objectives:

1. To develop an understanding of IPR/ research methodology in the process of creation of patents through research.
2. To develop further research capabilities.

UNIT 1: (~7 Lecture Hours)

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Methods, Importantance of Research Methodology, Research Process, Criteria of Good Research.

UNIT 2: (~6 Lecture Hours)

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes, Data collection methods, Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data.

UNIT 3: (~5 Lecture Hours)

Research Report Writing: Format of the Research report, Synopsis, Dissertation, References/Bibliography/ Webliography, Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal. Introduction to the use of software tools : Grammarly, Overleaf and References function in Microsoft word.

UNIT 4: (~5 Lecture Hours)

Nature of Intellectual Property: Patents, Designs, Trade marks and Copyright. Process of Patenting and Development: technological research, innovation.

UNIT 5: (~8 Lecture Hours)

Patent Rights: Scope of Patent Rights, Licensing and transfer of technology. Patent information and databases. New Developments in IPR: Administration of Patent System.

Text Books:

1. C.R Kothari, "Research Methodology, Methods & Technique". New Age International Publishers, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011.
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
4. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.
5. Satarkar, S.V,."Intellectual property rights and copy right". ESS Publications, 2000

Reference Books:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners, 2012.
2. Halbert, "Resisting Intellectual Property", Taylor& Francis Ltd, 2007.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_hs55
   (Course Title : Patent Law for Engineers and Scientists, by Dr. Feroz Ali (IIT Madras))
2. https://onlinecourses.nptel.ac.in/noc20_hs54
   (Course Title : Patent Drafting for Beginners, by Dr. Feroz Ali (IIT Madras))

Course Outcomes(COs):

After completion of the course the student should be able to

CO1 Describe research problem formulation and outline the Research Design process.

CO2 Identify the various methods of Data Collection.

CO3 Demonstrate the ability to draft Research Report, Synopsis and Dissertation with appropriate Bibliography/ Webliography while conforming to research ethics.

CO4 Categorize various forms of Intellectual Property and list out the steps involved in Patenting.

CO5 Justify the need for Patenting and Transfer of Technology in the socio-economic growth of the society.

CO6 Develop a Research Proposal and Research Grant Proposal.

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I Year M.Tech. PEED, I-Semester **L T P C**
Course code: **2 0 0 0**

ENGLISH FOR RESEARCH PAPER WRITING

(Audit Course-1) (Common to all M.Tech Courses)

Prerequisites:

Course Objectives:

1. To understand the nuances of language and vocabulary in writing a Research Paper.
2. To develop the content, structure and format of writing a research paper.
3. To give the practice of writing a Research Paper.
4. To enable the students to evolve original research papers without subjected to plagiarism.

UNIT 1: (~7 Lecture Hours) Academic Writing

What is Research? - Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits – Limitations – outcomes.

UNIT 2: (~7 Lecture Hours) Research Format

Title – Abstract – Introduction – Discussion – Findings – Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT 3: (~6 Lecture Hours) Research Methodology

Methods (Qualitative – Quantitative) – Literature Review – Who did what – Criticizing, Paraphrasing & Plagiarism.

UNIT 4: (~6 Lecture Hours) Process of Writing a research paper

Choosing a topic - Thesis Statement – Outline – Organizing notes – Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing- Typing the final draft

UNIT 5: (~6 Lecture Hours) How to & where to get published

Reputed Journals – National/International – ISSN No, No. of volumes, Scopes Index/UGC Journals – Free publications - Paid Journal publications– /Advantages/Benefits

Reference Books:

1. MLA Hand book for writers of Research Papers, East West Press Pvt.
2. C. R Kothari, Gaurav, Garg, Research Methodology Methods and Techniques, New Age International Publishers. 4th Edition.
3. Lauri Rozakis, Schaum's Quick Guide to Writing Great Research Papers, Tata McGraw Hills Pvt. Ltd, New Delhi.
4. N. Gurumani, Scientific Thesis Writing and Paper Presentation, MJP Publishers

Online Resources:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc18_mg13/preview

Course Outcomes:

After learning the contents of this course, the students will be able to

CO1 Understand the nuances of research writing.

CO2 Write a research paper with required writing skills and be confident to share their writing with others.

CO3 Publish a paper using the requisite standard in a journal.

CO4 Review the research papers and articles in a scientific manner.

CO5 Work on citations and ably place them in her research paper.

CO6 Avoid plagiarism with an ability to develop one's own writing skills in presenting the research work.

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I Year M.Tech. PEED, I-Semester **L T P C**
Course Code: **2 0 0 0**

DISASTER MANAGEMENT (Audit Course-1)

(Common to PEED, DECE, CSE, CNIS, WMC)

Prerequisites: Awareness about Various Planetary & Extra Planetary Hazards, their Impacts & Mitigation measures

Course Objectives:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.
5. Students will get the overview on the roles of government and non- government agencies in disaster management.
6. Describe the basic concepts of the emergency management cycle (mitigation, preparedness, response and recovery) and their application on various types of disasters.

UNIT -I: (~8Lecture Hours)

Introduction and Repercussions of Disasters and Hazards: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT II: (~5Lecture Hours)

Disaster Prone Areas in India Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with special reference to Tsunami; Post- Disaster Diseases and Epidemics.

UNIT III: (~5 Lecture Hours)

Disaster Preparedness and Management Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness. Disaster Management Cycle.

UNIT IV: (~5Lecture Hours)

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, People's Participation Risk Assessment, Strategies for Survival, Case Studies of Global, National and Local disasters, Techniques of Risk reduction for different disasters.

UNIT V: (~5Lecture Hours)

Disaster Risk Reduction & Mitigation: Meaning, Environment Security, Climate Change & Security risks, Climate Security Mechanism, Environmental Cooperation and Peace Building, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation - Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.Role of NDMA in Disaster Mitigation in India.

Text Books:

1. R.Nishith,Singh A.K,. "Disaster Management in India: Perspectives, Issues and Strategies "'New Royal Book Company.
2. Sahni, Pardeep Et.Al. (Eds.), "Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S.L ,Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

Reference Books:

1. Disaster Management Guidelines.GOI-UNDP Disaster Risk Reduction Programme (2009-2012).
2. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003.
3. Satapathy S. (2009) psychosocial care in Disaster management, A Training of Trainers Manual (ToT), NIDM Publication.
4. Guerisse P.2005 Basic Principles of Disaster Medical Management. Act Anaesth. Belg; 56:395-40.
5. Aim and Scope of Disaster Management. Study Guide prepared by Sharman and Hansen. UW-DMC, University of Washington.
6. UNEP.org - ECO - DRR

Online Resources:

1. https://www.mooc-list.com/tags/earthquake
2. https://freevideolectures.com/course/3581/earthquakes-in-your-backyard
3. https://summer.uci.edu/online/
4. http://www.open.edu/openlearn/free-courses/full-catalogue
5. https://www.edx.org
6. https://www.disasterready.org/courses
7. https://www.unep.org/explore-topics/disasters-conflicts/what-we- do/disaster-risk-reduction/ecosystem-based-disaster-risk

Course Out Comes:

At the end of the course students will be able to

1. Acquire the knowledge of different disasters and measures to reduce the risk due to these disasters.
2. Plan institutional framework for disaster management at national as well as global levels.
3. Analyze, evaluate and manage the different public health aspects of disaster events at local and global levels, even when limited information is available.
4. Develop capacity to describe, the environmental, social, cultural, economic, legal and organizational aspects influencing vulnerabilities and capacities to face disasters.
5. Acquire the knowledge on emergency/disaster management cycle for various types of disasters.
6. Develop a basic understanding of prevention, mitigation, preparedness, response and recovery on various types of disasters.

I Year M.Tech. PEED, I-Semester **L T P C**
Course code: **2 0 0 0**

PEDAGOGY STUDIES

(Audit Course-1)
(Common to all M.Tech Courses)

Prerequisites: -

Course Objectives:

1. To understand the programme design and policies of pedagogy studies.
2. To develop knowledge, abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. Analyze various theories of learning and their connection to teaching practice.
4. To familiarize the student with various research designs and research methods.
5. To create an awareness about the practices followed by DFID, other agencies and other researchers.
6. To identify critical evidence gaps to guide the development.

UNIT 1: (~8 Lecture Hours) Introduction and Methodology:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT 2: (~6 Lecture Hours)
Thematic overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT 3: (~6 Lecture Hours)
Evidence on the effectiveness of pedagogical practices - Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and pedagogic strategies.

UNIT 4: (~6 Lecture Hours)
Professional development: alignment with classroom practices and follow up support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT 5: (~6 Lecture Hours)
Research gaps and future directions - Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

Reference Books:

1. Ackers J, Hardman F (2001) Classroom Interaction in Kenyan Primary Schools, Compare, 31 (2): 245 – 261.
2. Agarwal M (2004) Curricular Reform in Schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3) : 361 – 379.
3. AkyeampongK, (2003) Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER) Country Report 1.London: DFID
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count? International Journal Educational Development, 33 (3): 272- 282.
5. Alexander R J (2001) Culture and Pedagogy : International Comparisons in Primary Education. Oxford and Boston : Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resources%20working%20paper%202.pdf.

Online Resources:

https://onlinecourses.nptel.ac.in/noc17_ge03/preview

Course Outcomes:

After learning the contents of this course, the students will be able to

1. The pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Importance of the role of teacher education, school curriculum and guidance materials for effective pedagogy.
5. Identify the critical evidence gaps in teaching – learning and to develop strategic plan to fill the gaps.
6. Develop appropriate resources in alignment with the curriculum and its objectives.

I Year M.Tech. PEED, I-Semester **L T P C**
Course code: **2 0 0 0**

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

(Audit Course-1)
(Common to all M.Tech Courses)

Prerequisites:

Course Objectives:

1. To learn to achieve the highest goal happily.
2. To become a person with stable mind, pleasing personality and determination.
3. To awaken wisdom in students.

UNIT 1: (~ 6 Lecture Hours)
Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22
(Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT 2: (~ 6 Lecture Hours)
Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT 3: (~ 7 Lecture Hours)
Introduction to Bhagavadgeetha for Personality Development - Shrimad BhagawadGeeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses
13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48

UNIT 4: (~ 7 Lecture Hours)
Statements of basic knowledge - Shrimad BhagawadGeeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad BhagawatGeeta.

UNIT 5: (~ 6 Lecture Hours)
Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Reference Books:

1. Srimad Bhagavad Gita by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2. Bhartrihari'sThri Satakam (Niti – Sringar- Vairagya) by P. Gopinath,Rashtriya Sanskrit Sansthanam, New Delhi.

Online Resources:

1. NTPEL: http://nptel.ac.in/downloads/109104115/

Course Outcomes:

After learning the contents of this course, the students will be able to

CO1 Develop their personality and achieve their highest goal of life.

CO2 Lead the nation and mankind to peace and prosperity.

CO3 Develop versatile personality.

CO4 Harmonize peace and mental well-being to handle day-to-day works more productively.

CO5 Understand oneself for holistic development.

CO6 Explore one's own potential to enhance their productive work.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AK **3 0 0 3**

ADVANCED ELECTRIC DRIVES

Prerequisites: Electrical drives, Control systems.

Course Objectives:

1. To Understand Basic electrical drives and their analysis.
2. To Learn Design of controller for drives.
3. To Understand scalar control, vector control of drives and special motors.

Unit-1: (~ 12 CLASSES)

Control Techniques for Direct Current (DC) Motor drives:(Phase controlled and Chopper controlled)

Modelling of DC motors- Steady-state and - Transient response characteristics of DC motors - Motor control system- Design of Current and Speed controller -Power electronic converter for motors- Transfer function of current and speed controllers, current and speed feedback- Simulation of DC motor drive - current controller and flow chart for Simulation- Examples of day to day applications.

Chopper controlled DC motor drives: Model of the chopper –closed loop operation of DC motor drives – speed controlled drive system- current control loop - pulse width modulated current controller- Hysteresis current controller-modelling of current controller, design of current controller-dynamic simulation of the speed controlled DC motor drive. Examples of day to day applications.

Unit-2: (~8 Lecture Hours)

Scalar control of induction motor drives:

Voltage fed inverter control –open loop volts /HZ control – speed control with slip regulation – speed control with torque and flux control – current controlled voltage fed inverter drive-current fed inverter control-Independent current and frequency control –speed and flux control in current fed inverter drive-volts/Hz control of current fed inverter drive – efficiency optimization control by flux program. Examples of day to day applications.

Unit-3: (~8 Lecture Hours)

Vector control of Induction motor drives:

Vector control: Principle of vector control –vector controlled methods- direct method of vector control – indirect method of vector control- Direct torque and flux control (DTC)- Adaptive control – self tuning control – model referencing adaptive control – sliding mode control. Examples of day to day applications.

Unit-4: (~6 Lecture Hours)

Synchronous motor drives:

Current of permanent magnet synchronous motor drive: Constant torque angle control-unity power factor control - constant mutual flux linkages control-indirect flux weakening – maximum permissible torque speed control scheme – implementation strategy. Examples of day to day applications.

Unit-5: (~10 Lecture Hours)

Brushless DC Motor (BLDC) drives and Switched Reluctance motor(SRM) drives:

BLDC drives: Configuration of brushless direct current motors—Driving principle of brushless direct current motors- Modelling of brushless direct current motors- Control of brushless direct current motors -Pulse width modulation techniques- Sensor less control of brushless direct current motors. Examples of day to day applications.

SRM drives: Principle of operation –Torque equation – Power Electronic Converter circuit characteristics and control – Torque / speed characteristics current sensing – Rotor position requirement and estimation. Examples of day to day applications.

Text Books:

1. R.Krishnan, Electric Motor Drives Modeling, Analysis and Control- Pearson Education-low price edition – 1st Edition- 2002.
2. Bimal K. Bose Modern Power Electronics and AC Drives, Pearson education –low price edition- 4th Edition 2004.
3. R.Krishnan, Switched reluctance motor drives-Modelling, Analysis and Control, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.

Reference Books:

1. S.H.Kim , Electric Motor Drives, Elsevier Publications, 2017.
2. GK. Dubey, Fundamentals of Electrical Drives, Narora publications -1995.
3. B.K.Bose, Power Electronics and Variable frequency drives- IEEE Press - Standard publications – 1st Edition-2002.

Online Resource: http://nptel.ac.in/courses/108104011

Course Outcomes:

1. Able to apply the knowledge of electrical drives system for various applications making Electric Drives an enabling technology.
2. Able to understand the basic requirements placed by mechanical systems on electric drives.
3. Able to apply the basic principles of power electronics in drives using switch- mode converters and pulse width modulation to synthesize the voltages in dc and ac motor drives.
4. Able to understand the need of modification of the torque speed characteristics of machines. Describe the operation of induction machines in steady state and dynamic condition.
5. Able to appreciate the speed control of induction motor drives in an energy efficient manner using power electronics with higher level control technique such as vector control.
6. Able to model and control the BLDC and SRM drives.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AL **3 0 0 3**

HVDC AND FACTS DEVICES

Prerequisites: Power Electronics, Power Systems

Course Objectives:

1. To understand the importance of HVDC transmission.
2. To analyze Graetz circuit, Various Converter Control methods, Harmonics, Filters and Reactive power control
3. To understand the basic FACTS concepts, static shunt and series compensation and combined compensation techniques.

UNIT – I (~8 Lecture Hours)

Introduction: Comparison of AC and DC transmission systems, application of DC transmission, types of DC links, typical layout of a HVDC converter station. HVDC converters, pulse number, analysis of Graetz circuit with and without overlap, converter bridge characteristics, equivalent circuits or rectifier and inverter configurations of twelve pulse converters.

UNIT – II (~8 Lecture Hours)

Converter & HVDC System Control: Principles of DC Link Control – Converters Control Characteristics – system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link.

UNIT-III (~9 Lecture Hours)

Harmonics, Filters and Reactive Power Control: Introduction, generation of harmonics, AC and DC filters, Reactive Power Requirements in steady state, sources of reactive power, static VAR systems.

Power Flow Analysis in AC/DC Systems: Modeling of DC/AC converters, Controller Equations-Solutions of AC/DC load flow – Simultaneous method- Sequential method.

UNIT-IV (~10 Lecture Hours)

Introduction to FACTS: Flow of power in AC parallel paths and meshed systems, basic types of FACTS controllers, brief description and definitions of FACTS controllers.

Static Shunt Compensators: Objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators, SVC and STATCOM, comparison between SVC and STATCOM.

UNIT – V (~10Lecture Hours)

Static Series Compensators: Objectives of series compensation, variable impedance type- thyristor switched series capacitors (TCSC), and switching converter type series compensators, static series synchronous compensator (SSSC)-power angle characteristics-basic operating control schemes.

Combined Compensators: Introduction, unified power flow controller (UPFC), basic operating principle, independent real and reactive power flow controller, control structure.

Text Books:

1. S. Kamakshaiah, V. Kamaraju, HVDC Transmission, The Mc – Graw Hill Companies, 2017.
2. 2.Narain G. Hingorani, Laszlo Gyugyi, Understanding FACTS Concepts and technology of Flexible AC Transmission Systems, IEEE Press, 2019 ISBN-978-81-265-3040-3.

Reference Books:

1. Vijay K. Sood, HVDC and Facts Controllers Applications of Static Converters in Power Systems, Kluwer Academic Publishers, 2004.
2. K.R.Padiyar, HVDC Power Transmission Systems: Technology and system Interactions, New Age International (P) Limited, 1991.
3. R. Mohan Mathur, Rajiv K. Varma, Thyristor – Based Controllers for Electrical Transmission Systems, Wiley India, 2002.
4. Enrique Acha, FACTS Modeling and Simulation in Power Networks, Wiley India, BSP Books Pvt. Ltd, 2004.

Online Resource: https://nptel.ac.in/courses/108104013

Course Outcomes:

After going through this course the student will be able to:

1. Classify HVDC systems, categorize major components employed and applications of HVDC Transmission system.
2. Identify a device and its control scheme for a given application in the HVDC system.viz power control, converter control etc..
3. Analyze HVDC converter, harmonics, filters , reactive power control and graetz circuit in HVDC system
4. Design and analyze DC/AC converters, AC/Dc load flow in HVDC system.
5. Impart knowledge on various compensation techniques in FACTS devices.
6. Identify the FACTS devices and their applications on system control.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AM **3 0 0 3**

SMARTGRID TECHNOLOGIES

(Program Specific Elective 3.1)

Prerequisites: Power Systems, Power Quality

Course Objectives:

1. To understand the salient concepts of Smart Grid and its advantages over Conventional Grid.
2. To Study the architecture and operation of Micro-grids including the common distributed energy sources.
3. To Model and analyze Smart Distribution systems including the Advanced Metering and Wireless Communication Technologies
4. To Learn wide area measurement techniques for monitoring and control of Smart Transmission Systems in Modern Energy Management Centers.
5. To Understand the Power Quality issues associated with Grid-connected renewable energy sources and the mitigation techniques deployed.

Unit-1 (~8LectureHours)

Introduction to Smart Grid:

Evolution of Smart Grid from Conventional Grid, Concept and need of Smart Grid, Smart Grid Architectures, Interoperability, Communication technologies, National Smart Grid Mission (NSGM) by Govt. of India and International policies in Smart Grids.

Unit-2 (~10LectureHours)

Micro-Grids:

Concept of micro-grid and its Architecture, need and salient features of micro-grid, Formation of micro grid with the main distributed generators like solar PV systems, Fuel cells, small Wind Energy Conversion Systems, Micro-turbines and Energy Storage Devices along with their Power Electronic Interfaces to utility grid. Issues of interconnections, operation of micro- grid including protection and control aspects.

Unit-3 (~10LectureHours)

Smart Distribution Systems:

Substation and Distribution System Automation, Fault location isolation and service restoration (FLISR),Outage Management Systems (OMS), Automated Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Home and building automation with smart appliances, Demand response, Tariff Design, Time of the Day pricing (TOD), Time of Use(TOU) Pricing, Real time Pricing using web based services.

Unit-4 (~8LectureHours)

Smart Transmission Systems:

Intelligent Electronic Devices (IED), Supervisory Control and Data Acquisition (SCADA), Geographic Information System (GIS), Phasor Measurement Units(PMU), Wide Area Monitoring Systems (WAMS), Coordination of SCADA & WAM Sin modern energy management centers.

Unit-5 (~8 Lecture Hours)

Power Quality in Smart Grid:

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Text Books:

1. AliKeyhani, Design of smart power grid renewable energy systems, Wiley IEEE, 2011.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, SmartG rid:Technology and Applications,Wiley 2012.

Reference Books:

1. Stuart Borlas'e, Smart Grid: Infrastructure, Technology and solutions CRC Press, 2017.
2. A.G.Phadke, Synchronized Phasor Measurement and their Applications,Springer.
3. James Momoh, Smart Grid Fundametals of Design and Analysis,Wiley,IEEE Press, 2016.
4. ClarkW.Gellings, The SmartGrid: Enabling Energy Efficiency and Demand Response, CRC Press, 2009.

Online Resource: https://freevideolectures.com/course/4338/nptel- introduction-smart-grid

Course Outcomes:

Upon the completion of the subject, the student will be able to

1. Indentify the different technologies for Smart Grid.
2. Analyze the architecture and operation of Micro-grids including the common distributed energy sources
3. Analyze the Smart transmission as well distribution systems
4. Interpret the Power Quality issues associated with grid-connected renewable energy sources and the mitigation techniques deployed.
5. Formulate and analyze the power systems problems from the point of view of reliability.
6. Apply the concepts SCADA and WAMS Technologies towards realizing a better distribution system.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AN **3 0 0 3**

POWER QUALITY

(Program Specific Elective-3.2)

Prerequisites: Power Systems, Power Electronics

Course Objectives:

1. To understand and analyze the short and long interruptions in power Systems.
2. To study the voltage sag magnitude and its characteristics.
3. To gain knowledge on various mitigation methods for interruptions and voltage sags.

Unit 1: (~6 Lecture Hours)

Introduction: Introduction of the Power Quality (PQ) problem - Terms used in PQ: Voltage, Sag,Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption – overview of power quality phenomenon- Remedies to improve power quality - power quality monitoring.

PQ Standards: Purpose of standardization - IEC Electromagnetic compatibility standards- European voltage characteristics standards.

Unit 2: (~10 lecture Hours)

Long Interruptions: Interruptions – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruptions – Overview of Reliability evaluation to power quality- comparison of observations and reliability evaluation.

Short interruptions: origin of short interruptions- monitoring of short interruptions- Multiple events - single phase tripping – voltage and current during fault period- voltage and current at post fault period- stochastic prediction of short interruptions.

Unit 3:(~10 Lecture Hours)

Voltage Sag-Characterization:

Voltage sag – causes of voltage sag-voltage sag magnitude-voltage sag duration-three phase unbalances- phase angle jumps- magnitude and phase angle jumps for three phase unbalanced sags- other characteristics of voltage sags- load influence on voltage sags-sags due to starting of Induction motors.

Loads that cause Power quality problems: Introduction-classification of non-linear loads- power quality problems caused by non-linear loads.

Unit 4: (~10 Lecture Hours)

Voltage Sag-Equipment Behavior: Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics- adjustable

speed AC drives and its operation- Mitigation of AC Drives- adjustable speed DC drives and its operation-mitigation methods of DC drives- other sensitive load.

Harmonics: Individual and total harmonic distortion, RMS value of Harmonic waveform, triplex harmonics. Important harmonic introducing devices, effect of harmonics on power quality.

Unit 5: (~9 Lecture Hours)

Mitigation of Interruptions and Voltage Sags:

Overview of mitigation methods –System equipment interface – active shunt compensation- DSTATCOM's principle and operation- active series compensation-DVR, principle and Operation-Unified power quality compensators, principle of operation.

Future directions and opportunities for Power quality enhancement: Power quality sensitivity- utility based vs customer based correction-power quality performance requirements and validation- role of compensators in future energy delivery.

Text Books:

1. Math H J Bollen, Understanding Power Quality Problems, IEEE Press, standard publisher's distributers, Delhi, 2016.
2. Bhimsingh, Ambrish Chandra, kamal AI-Haddad, Power quality problems and mitigation techniques, Wiley Publications, 2015.
3. A Ghosh, G. Ledwich, Power Quality Enhancement Using Custom Power Devices, KluwerAcademic, 2002.

Reference Books:

1. R.C. Dugan, M.F. Mc Granaghan and H.W. Beaty, Electric Power Systems Quality,NewYork: McGraw-Hill. 1996
2. G.T. Heydt, Electric Power Quality, 2nd Edition. West Lafayette, IN, Stars in aCircle Publications, 1994.
3. R.Sastry, Vedam Mulukutla S. Sarma, Power Quality VAR Compensation in Power Systems, CRC Press, 2017.
4. J.Arrillaga, B.C.Smith, N.R.Watson & A.R. Wood, Power system Harmonic Analysis, Wiley publishers, 1997.

E- Resource: https://nptel.ac.in/courses/108102179

Course Outcomes:

1. Power quality terms used and PQ standards.
2. Distinguish causes for power quality issues.
3. Interpret the characteristics of voltage sag.
4. Understand the equipment behavior with power quality issues.
5. Understand harmonics and its effects in power system.
6. Compute the mitigation techniques for interruption.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AP **3 0 0 3**

AI AND ML TECHNIQUES FOR POWER ELECTRONIC APPLICATIONS

(Program Specific Elective-3.3)

Pre Requisites: Power Electronics

Course objectives

1. Understand basis in designing with Intelligent Systems
2. Concept of learning Support Vector Machines
3. Understand Neural Networks & their learning rules
4. Comprehend Fuzzy Inference Systems.
5. Analyse power electronic systems which are designed using Fuzzy and Neural Networks.

UNIT-1: INTRODUCTION (~10 Hours)

Towards Intelligent Machines, Well-Posed Machine Learning Problems, Examples of ApplicationsMachine Vision, Biometric Recognition & Handwriting recognition, load forecasting and Control& Automation. Time Series Forecasting, Datasets for Unreastically Simple and Realistic Problems,Domain Knowledge for Productive use of Machine Learning, Diversity of Data:Structured/Unstructured. Forms of Learning, Machine Learning and Data Mining, Basic LinearAlgebra in Machine Learning Techniques.

UNIT-2: SUPPORT VECTOR MACHINES (~10 Hours)

Learning with Support Vector Machines, Perceptron Algorithm, Linear Soft Margin Classifier forOverLapping Classes, Nonlinear Classifier, Regression by Support Vector Machines, Variants ofBasic SVM Techniques.

UNIT- 3: NEURAL NETWORKS (~10 Hours)

Towards Cognitive Machine, Neuron Models, Network Architectures, Perceptron's, Linear Neuronand the Widrow-HoffLearning Rule, Error- Correction Delta Rule, Multi-Layer PerceptronNetworks, Radial Basis Functions Networks.

UNIT-4: FUZZY LOGIC SYSTEMS (~08 Hours)

Cognitive Uncertainty and Fuzzy Rule-Base, Fuzzy Quantification of Knowledge, Fuzzy Rule-Baseand Approximate Reasoning, Takagi-Sugeno Fuzzy Mode, Neuro-Fuzzy Inference Systems.

UNIT-5: APPLICATIONS (~7 Hours)

Neural Network Topologies for space vector pulse width modulation of three level inverter, NeuralNetwork based feedback signal estimator performance – Torque & Rotor Flux, Neural Networktopology for stator flux estimator, Neuro-fuzzy based efficiency optimization control, Neuro-FuzzyController based Direct Torque Control

Text Books:

1. M. Gopal, Applied Machine Learning , Mc Graw Hill, 2019.
2. Bimal K Bose, Power Electronics & Motor Drives – Advances & Trends, 2nd Edition, 2020.

Course outcome

1. Describe the importance of designing the System with AI and Machine Learning.
2. Learn Support Vector Machines and its Regression.
3. Distinguish the various Neural Networks Architectures.
4. Categorize Fuzzy rule base and neuro-fuzzy systems.
5. Analyze various power electronic systems using neural & fuzzy systems.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AQ **3 0 0 3**

PWM TECHNIQUES FOR POWER ELECTRONIC CONVERTERS

(Program Specific Elective-4.1)

Prerequisites: Electric Machines, Power Electronics, Engineering Mathematics and Control Systems

Course Objectives:

1. To study Converter topologies for AC/DC and DC/AC
2. To study overview of applications of voltage source converters
3. To learn pulse width modulation techniques for 1-phase and 3-phase bridge converters
4. To analyze basics of space vector based PWM, switching frequency current ripple and torque ripple in inverter fed drives; over modulation

UNIT-1: (~8 LectureHours)

Power electronic converters for dc-ac & ac-dc power conversion: Electronic switches, dc-dc buck and boost converters, H-bridge, multilevel converters – diode clamp, flying capacitor and cascaded-cell converters; voltage source and current source converters; evolution of topologies for dc- ac power conversion from dc-dc converters.

Applications of voltage source converters: Overview of applications of voltage source converter, motor drives, active front-end converters, reactive compensators, active power filters.

UNIT-2: (~8 LectureHours)

Purpose of pulse width modulation: Review of Fourier series, fundamental and harmonic voltages; machine model for harmonic voltages; undesirable effects of harmonic voltages – line current distortion, increased losses, pulsating torque in motor drives; control of fundamental voltage; mitigation of harmonics and their adverse effects

Pulse width modulation (PWM) at low switching frequency: Square wave operation of voltage source inverter, PWM with a few switching angles per quarter cycle, equal voltage contours, selective harmonic elimination, THD optimized PWM, off-line PWM.

UNIT-3: (~8 Lecture Hours)

Triangle-comparison based PWM: Average pole voltages, sinusoidal modulation, third harmonic injection, continuous PWM, bus-clamping or discontinuous PWM.

Space vector based PWM: Space vector concept and transformation, per phase methods from a space vector perspective, space vector based modulation, conventional space vector PWM, bus-clamping PWM, advanced PWM, triangle comparison approach versus space vector approach to PWM.

UNIT-4: (~10 Lecture Hours)

Analysis of line current ripple: Synchronously revolving reference frame; error between reference voltage and applied voltage, integral of voltage error; evaluation of line current ripple; hybrid PWM for reduced line current ripple.

Analysis of torque ripple: Evaluation of harmonic torques and rms torque ripple Inverter loss: Simplifying assumptions in evaluation of inverter loss, dependence of inverter loss on line power factor, influence of PWM techniques on switching loss, design of PWM for low inverter loss.

Effect of inverter dead-time effect: Requirement of dead-time, effect of dead-time on line voltages, dependence on power factor and modulation method, compensation of dead-time effect.

UNIT-5: (~8 Lecture Hours**)**

Overmodulation: Per-phase and space vector approaches to overmodulation, average voltages in a synchronously revolving d-q reference frame, low-frequency harmonic distortion.

PWM for multilevel inverter: Extensions of sine-triangle PWM to multilevel inverters, voltage space vectors, space vector based PWM, analysis of line current ripple and torque ripple.

Text Books:

1. D. Grahame Holmes, Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, IEEE Press Series on Power and Energy Systems, - 2003
2. Isaak Mayergoyz, SiddharthTyagi ,Pulse Width Modulation in Power Electronics,World Scientific, 2021.

Reference Books:

1. Eric Monmasson, Power Electronic Converters: PWM Strategies and Current Control Techniques, Wiley, 2013.
2. Satish Kumar Peddapelli, O'Reilly,Pulse Width Modulation, De Gruyter Olden bourg publisher 2016.
3. G Narayanan, Pulse width Modulation for Power Electronic Converters-NPTEL Course, IISc Bangalore.

Course Outcomes:

Upon the completion of the course, the students will be able to

1. Analyze single phase VSI and 3 phase VSI.
2. Understand need of PWM, Control CSI and VSI using PWM.
3. Understand different PWM techniques.
4. Get basic knowledge PWM for multilevel inverters.
5. Interpret the Continuing developments in modulation.
6. Implement different PWM techniques.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AR **3 0 0 3**

DISTRIBUTED GENERATION

(Program Specific Elective-4.2)

Prerequisites: Power Systems

Course Objectives:

1. To illustrate the concept of distributed generation
2. To analyze the impact of grid integration.
3. To study concept of Micro grid and its configuration
4. To find optimal size, placement and control aspects of DGs

Unit-1: (~8LectureHours)

Need for Distributed generation:

Renewable sources in distributed generation-Planning of DGs- Siting and sizing of DGs- optimal placement of DG sources in distribution systems-current scenario in Distributed Generation.

Unit-2: (~8LectureHours)

Grid integration of DGs:

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

Unit-3: (~10LectureHours) **Technical impacts of DGs:**

Distribution Systems-De-Regulation Impact of DGs upon protective relaying-Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis.

Unit-4: (~8LectureHours)

Economic and control aspects of DGs:

Market facts-Issues and challenges Limitations of DG- Voltage control techniques, Reactive power control, Harmonics Power quality issues-Reliability of DG based systems.

Unit-5: (~10LectureHours) **Introduction to micro-grids:**

Types of Micro-grids-Autonomous and non-autonomous grids - Sizing of micro-grids - Modeling & analysis - Micro-grids with multiple DGs - Micro-grids with power electronic interfacing units - Transients in micro-grids–Protection of micro-grids.

Text Books:

1. H.LeeWillis, WalterG.Scott, Distributed Power Generation – Planning and Evaluation, Marcel Decker Press.
2. Robert Lasseter, Paolo Piagi, Micro-grid: A Conceptual Solution, PESC 2004, June 2004.
3. F. Katiraei, M.R. Iravani, Transients of a Micro-Grid System with Multiple Distributed Energy Resources, International Conference on Power Systems Transients (IPST'05) in Montreal, Canada on June 19-23, 2005.
4. Z. Ye, R. Walling, N. Miller, P. Du, K. Nelson, Facility Microgrids, General Electric Global Research Center, Niskayuna, New York, Subcontract report, May 2005.

Reference Books:

1. M. Godoy Simoes, FelixA. Farret, Renewable Energy Systems– Design and Analysis with Induction Generators, CRC press.
2. Stuart Borlase, SmartGrid: Infrastructure Technology Solutions, CRC Press.

Online Resources:

https://www.digimat.in/nptel/courses/video/108107112/L25.html
https://www.digimat.in/nptel/courses/video/108108034/L01.html
https://www.digimat.in/nptel/courses/video/108108034/L02.html
https://www.digimat.in/nptel/courses/video/108108034/L03.html
https://www.digimat.in/nptel/courses/video/108108034/L09.html
https://www.digimat.in/nptel/courses/video/108108034/L11.html
https://www.digimat.in/nptel/courses/video/108108034/L11.html
https://www.digimat.in/nptel/courses/video/108108034/L17.html

Course Outcomes

Students will be able to:

1. Understand the planning and operational issues related to Distributed Generation.
2. Acquire Knowledge about Distributed Generation Learn micro-Grids
3. Analyze the De-regulation Impact of DGs upon protective relaying and transient and dynamic stability of existing distribution systems.
4. Identify and apply Economic and control aspects of DGs wrt market factors.
5. Realize the significance of micro-grids.
6. Gain an overall picture of autonomous and non- autonomous grids in the back drop of prevailing energy scenario.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:522AS **3 0 0 3**

OPTIMAL AND ADAPTIVE CONTROL

(Program Specific Elective-4.3)

Prerequisites: Control Systems

Course Objectives:

1. To acquire knowledge in the mathematical area of 'calculus of variations' so as to apply the same for solving the optimal control problems.
2. To acquire knowledge of problem formulation, performance measure and mathematical treatment of optimal control problems so as to apply the same to engineering control problems.
3. To acquire knowledge on solving optimal control design problems by taking into consideration the physical constraints on practical control systems.

Unit1: Introduction to Optimal Control Problems (~10 Lecture Hours)

Optimal Control Problem – Open loop & Closed loop form of Optimal Control – Measures for Optimal Control Problems – General form of performance measures – Fundamental concepts & theorems of Calculus of variations – Function & Functionals – Extremal of functionals with dependant functions – Use of Lagrange multipliers – differential equation constraints – isoperimetric constraints.

Unit 2: Calculus of Variations and Hamilton Formulation (~8 Lecture Hours)

The Variational approach to solving Optimal Control Problems – Necessary conditions for Optimal Control using Hamiltonian – Different boundary conditions for solving the optimal Control Problem – Closed loop control for linear regulator problem – Linear Tracking Problem.

Unit 3: Dynamic Programming (~7 Lecture Hours)

Minimum Time Problem – Minimum Control Effort Problem. Dynamic Programming – Principle of Optimality – Application to Multistage Decision Making – Application to Optimal Control Problems.

Unit 4: The Pontryagin's Minimum Principle (~8 Lecture Hours)

Pontryagin's Minimum Principle – State Inequality Constraints Need for Interpolation – Recurrence Relation of Dynamic Programming – Curse of Dimensionality – Discrete Linear Regulator Problem – Hamilton-Jacobi-Bellman Equation – Continuous Linear Regulator Problem.

Unit 5: Introduction to Adaptive Control and Model Reference Adaptive Systems (Mras) (~9 Lecture Hours)

An Overview of Adaptive control Systems – Model Reference Adaptive Systems (MRAS) – the need for MRAS - Mathematical Description of Model Reference Adaptive Systems (MRAS) – Design Hypothesis – Equivalent Representation of MRAS. Introduction to Design Method Based on the use of Liapunov Function – Design & Simulation of an Adaptive of Variable Structure Model – Concept of Linear Model Following Control Systems.

Text Books:

1. Donald E. Kirk, Optimal Control Theory, An introduction, Prentice Hall Inc., 2004.
2. Yoan D. Landau, Adaptive Control – The Model Reference Approach, Marcel Dekker, INC, 1981.
3. M Gopal, Modern Control Systems Theory, 2nd Edition, New Age International Publications Ltd. 2014.

Reference Books:

1. HSU and Meyer, Modern Control, Principles and Applications, McGraw Hill, 1968
2. A.P. Sage, Optimum Systems Control, Prentice Hall, 1977
3. K.K.D.Young, Design of Variable Structure Model Following Control Systems., IEEE Transactions on Automatic Control, Vol. 23, pp 1079-1085, 1978.
4. A.S.I. Zinobar, O.M.E. EI-Ghezawi and S.A. Billings, Multivariable variable structure adaptive model following control systems. . Proc. IEE., Vol. 129, Pt.D., No.1, pp 6- 12, 1982.

Online Resources:

1) https://archive.nptel.ac.in/courses/108/102/108102113/
2) https://nptel.ac.in/courses/108107098

Course Outcomes:

1. Apply the knowledge in the mathematical area of 'calculus of variations' for solving the optimal control problems.
2. Apply the knowledge of problem formulation, performance measure to engineering control problems with the possibility to do further research in this area.
3. Solve optimal control design problems by taking into consideration the physical constraints on practical control systems.
4. Apply the knowledge of controller design problems to obtain optimal solutions by taking into consideration the limitation on control energy.
5. Apply the knowledge acquired to develop and utilize modern software tools for design and analysis of optimal control problems.
6. Extend the knowledge in model reference adaptive control system design to other areas of model-following control.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:52205 **0 0 3 1.5**

ADVANCED ELECTRIC DRIVES LAB

Prerequisites: Electrical Machines, Power Electronics, Control Systems

Course Objectives:
1. To gain hands on experience on various types of Electric drives.
2. To become familiar with different speed control methods including V/f control.
3. To analyze the performance of an MATLAB.

Compulsory Experiments
1. Thyristorised drive for 1Hp DC motor with closed loop control.
2. Thyristorised drive for PMDC Motor with Speed Measurement & Closed loop control.
3. Open Loop and closed loop control of DC motor using IGBT based 4 Quadrant chopper.
4. V/f control of 3Phase induction motor drive.
5. AC single phase motor speed control using TRIAC.
6. Speed control of three Phase Wound Rotor Induction motor using Slip Power Recovery scheme.
7. Characteristics of solar PV systems.
8. VSI fed Induction motor drive using MATLAB software

Optional (Any 2 to be Conducted)
1. PWM Inverter fed 3Phase Induction Motor control using MATLAB software.
2. 3Ø Input IGBT based 4 quadrant Chopper Drive for DC Motor with closed loop control.
3. Inverter control for Solar PV based systems.
4. PLC based AC/DC motor control operation.

Course Outcomes:
1. Analyse the DC Motor drive with closed loop control.
2. Apply the knowledge of 4-Quadrant operation by using choppers.
3. Use Programmable logic controller for control operations of AC/DC motors.
4. Apply the concept of Maximum power point tracking system for solar systems.
5. Analyze the performance of 1Ø converters with Inductive Load.
6. Use the software tools like MATLAB to create and control of typical drive models.

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I Year M.Tech. PEED II-Semester **L T P C**
Course Code:52206 **0 0 3 1.5**

POWER CONVERTERS SIMULATION LAB

Prerequisites: Power Electronics

Course Objectives:

1. To familiarize the students in different simulation software's viz. MATLAB/Simulink, FPGA-Xilinx.
2. To generate the basic input signals using FPGA-Xilinx.
3. To study & simulate various converter topologies.
4. To gain knowledge on PWM techniques viz. SPWM & SVPWM.

List of Experiments

1. Simulation of cuk and fly back converter with open loop operation.
2. Three Level three phase Sinusoidal PWM (SPWM) based H-bridge Inverter.
3. Five Level three phase Sinusoidal PWM based H-bridge Inverter.
4. Generation of Sine and ramp signals using FPGA-Xilinx.
5. Simulation of two level inverter employing SPWM method using FPGA- Xilinx.
6. Three Level three phase Sinusoidal PWM based Diode Clamped Inverter.
7. Five Level three phase Sinusoidal PWM based Diode Clamped Inverter.
8. Three Level three phase Sinusoidal PWM based Flying Capacitor Inverter.
9. Five Level three phase Sinusoidal PWM based Flying Capacitor Inverter.
10. Space vector pulse width Modulation (SVPWM) technique of Single phase inverter using MATLAB.

Course Outcomes:

The students at the end of the course will be able to

1. Design and conduct simulations for different converters viz. Cuk, flyback regulators andinverters.
2. Gain knowledge on various tool boxes in different simulation platforms.
3. Identify, formulate & solve engineering problems with simulation.
4. Simulate various multilevel inverter topologies.
5. Gain knowledge on FPGA-Xilinx software.
6. Simulate and interpret circuits and hardware kits.

I Year M.Tech. PEED, II-Semester **L T P C**
Course code: **2 0 0 0**

SANSKRIT FOR TECHNICAL KNOWLEDGE

(Audit Course-2)
(Common to all M.Tech Courses)

Prerequisites:

Course Objectives:

1. To get a working knowledge in Illustrious SANSKRIT, the scientific language in the world.
2. To improve brain functioning.
3. To enhance the memory power to develop logic in Mathematics, Science and other subjects.
4. To explore the huge treasure of knowledge that is hidden in the ancient literature.

UNIT 1: (~ 6 Lecture Hours)

Alphabets in SANSKRIT

Varnamala – Vowels (Swaraaha) and consonants (Vyanjanaani) – samyukta varnaaha (compound letters) – Varna vishleshanam (Disjoining of letters) – Varna samshleshanam (Joining of letters) - Practise of simple words – Three genders – Pumlingam (Masculine Gender) – Streelingam (Feminine Gender) – Napumsaka lingam (Neutral Gender) – The forms of Nouns – Singular & Plural.

UNIT 2: (~ 6 Lecture Hours)

Pronouns & Demonstrative pronouns (Sarvanaama shabdaaha) Eshaha, Yeshaa & Yetat –Question words – Five Ws & one H (Kim, kadaa, kutra, Kaha, Kimartham & Katham) Different forms of verbs – Tenses – Present – Past & Future Tenses.

UNIT 3: (~ 6 Lecture Hours)

Propositions (Vibhaktis) – Prathama – Dwitiya – Truteeya – Chaturthee – Panchami – Shashtee – Saptami – Sambodhana Prathama The Three Purushas – Prathama (Ramaha Raamou Raamaaha) – Madhyama (twam Yuvaam Yooyam) – Uttama (Aham Aawaam Vayam).

UNIT 4: (~ 6 Lecture Hours)

Order (Subject – Verb – Object) karta – Kriya - karma

Introduction of Roots – Ancient literature on Science & Technology in SANSKRIT language - Scope of SANSKRIT in India – Technical information about SANSKRIT Literature. - Technical concepts of Engineering.

UNIT 5: (~ 6 Lecture Hours)

Technical concepts of Engineering – Electrical, Mechanical, Architecture and Mathematics - Role of SANSKRIT in the field of Science & Technology. Scope of SANSKRIT as a powerful & alternative tool in the field of Computer Science.

Suggested Reading:

1. "ABHYAAS PUSTAKAM", Dr. Vishwas, Samskrutha Bharati Publications, New Delhi.
2. Teach Yourself SANSKRIT, Prathama Deeksha by Vempati Kutumba Shastri, Rashtriya Sanskrit Sansthan, New Delhi Publications.
3. "India's glorious Scientific Tradition", Suresh Soni, Ocean Books Pvt. Ltd., NewDelhi.

Course Outcomes:

After learning the contents of this course, the students will be able to

CO1 Gain knowledge in basic SANSKRIT language.

CO2 Understand the ancient SANSKRIT literature about Science & Technology.

CO3 Develop logical and analytical skills.

CO4 Relate the relevance of Sanskrit to Science and Technology

CO5 Appreciate the conceptual understanding of Sanskrit to develop one's own competencies to understand, analyze and apply to sciences.

CO6 Identifying the similarities and differences to develop linguistic competency in learning a new language.

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I Year M.Tech. PEED, II-Semester **L T P C**
Course code: **2 0 0 0**

VALUE EDUCATION

(Audit Course-2)
(Common to all M.Tech Courses)

Prerequisites:

Course Objectives:

1. Understand value of Education and self-development.
2. Imbibe good values in students
3. Know the importance of character

UNIT 1: (~7 Lecture Hours)
Values and self – development – Social values and Individual attitudes. Work ethics, Indian vision of humanism - Moral and non – moral Valuation - Standards and principles - Value judgements - Importance of cultivation of values.

UNIT 2: (~6 Lecture Hours)
Sense of duty, Devotion, Self – reliance. Confidence, Concentration, Truthfulness, Cleanliness - Honesty, Humanity. Power of faith, National Unity - Patriotism, Love for nature, Discipline

UNIT 3: (~ 6 Lecture Hours)
Personality and Behaviour Development – Soul and Scientific attitude. Positive thinking. Integrity and Discipline - Punctuality, Love and Kindness - Avoid Fault Thinking - Free from anger, Dignity of labour

UNIT 4: (~ 6 Lecture Hours)
Universal brotherhood and religious tolerance - True friendship - Happiness Vs suffering, love for truth - Aware of self - destructive habits - Association and Cooperation - Doing best for saving nature.

UNIT 5: (~ 6 Lecture Hours)
Character and Competence – Holy books Vs Blind faith - Self-management and Good Health - Science of Reincarnation - Equality, Nonviolence, Humility, Role of Women - All religions and same message - Mind your Mind, Self- control - Honesty, Studying effectively.

Reference Books:

1. Chakroborty, SK. 'Values and Ethics for Organizations – Theory and Practise', - Oxford University Press, NewDelhi.

Online Resources:

1. http://nptel.ac.in/courses/109104068/36
2. http://nptel.ac.in/courses/109104068/37

Course Outcomes (COs)

After learning the contents of this course, the students will be able to

1. Gain knowledge on self-development.
2. Learn the importance of Human Values.
3. Develop overall personality.
4. Understand the importance of value education to build tolerance and harmony at different layers.
5. Identify the ways for self-development.
6. Identify the basic values and principles to guide one's own life.

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I Year M.Tech.PEED II-Semester **L T P C**
Subject Code: **2 0 0 0**

CONSTITUTION OF INDIA

(Audit Course-2) (Common to all M.Tech Courses)

Prerequisites: NIL

Course Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT 1: (~ 8 Lecture Hours)

HISTORY OF MAKING OF THE INDIAN CONSTITUTION & PHILOSOPHY OF THE INDIAN CONSTITUTION HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee (Composition & Working) **Philosophy of the Indian Constitution**: Preamble, Salient Features.

UNIT 2: (~ 6 Lecture Hours)

CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT 3: (~ 6 Lecture Hours)

ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions- Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT 4: (~ 6 Lecture Hours)

LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayati Raj : Introduction, PRI : ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Position and role, Block Level :

Organizational Hierarchy (Different departments), Village level : Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT 5: (~ 6 Lecture Hours)

ELECTION COMMISSION

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

ReferenceBooks:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr.S.N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edition, Lexis Nexis, 2014.

Online Resources:

1. https://nptel.ac.in/courses/129106003 [Constitutional Studies by Prof. Sudhir Krishna Swami, IIT Madras]
2. https://onlinecourses.swayam2.ac.in/cec20_hs38/preview [Indian Government and Politics by Dr.Aijaz Ashraf Wani, University of Kashmir, Srinagar]

Course Outcomes:

After learning the contents of this course, the students will be able to

1. Tell about function of Indian constitution with clarity and understanding.
2. Identify the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Mark the knowledge of union government & their powers and function.
4. Define the state and central policies, fundamental duties.
5. Explain the powers and functions of Municipalities, Panchayats and Co-operative Societies.
6. Discuss the Electoral Process, special provisions.

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I Year M.Tech. PEED, II-Semester **L T P C**
Course code: **2 0 0 0**

Stress Management by Yoga
(Audit Course-2)
(Common to all M.Tech Courses)

Prerequisites:

Course Objectives:
1. Creating awareness about different types of Stress and role of Yoga in the management of Stress.
2. Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3. Prevention of stress related health problems by Yoga practice.

UNIT 1: (~ 4 Lecture Hours)
- Meaning and definition of Yoga
- Historical perspective of Yoga
- Principles of Astanga Yoga by Patanjali.

UNIT 2: (~ 4 Lecture Hours)
- Meaning and definition of Stress.
- Types of Stress-Eustress and Distress.
- Anticipatory Anxiety and Intense Anxiety and depression.
- Meaning of Management- Stress Management.

UNIT 3: (~ 8 Lecture Hours)
- Concept of Stress according to Yoga
- Stress assessment methods
- Role of Asana, Pranayama and Meditation in the management of stress.

UNIT 4: (~ 8 Lecture Hours) Asanas:: (5 Asanas in ach posture)
- Warm up
- Standing Asanas
- Sitting Asanas
- Prone Asanas
- Supine asanas
- Surya Namaskar

UNIT 5: (~ 8 Lecture Hours)
Pranayama:
- Anulom and Vilom Pranayama
- Nadishudhi Pranayama
- Kapalabhati Pranayama

- Bhramari Pranayama
- Nadanusandhana Pranayama.

Meditation techniques:

- Om Meditation
- Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Suggested Reading:

1. Andrews, Linda Washer (2005) Stress control for peace of mind, London: Greenwich Editions.
2. Author's Guide -Yoga- The science of Holistic Living, Chennai: The Vivekananda Kendra Prakashan trust.
3. Iyengar BKS (2003) The art of Yoga, New Delhi: Harper Collins Publishers.
4. Lalvani, Vimla ((1998) Yoga for Stress, London: Hamlyn.
5. Maguire,Imelda 92005)Yoga for a healthy body, London: Greenwich editions.
6. Nagendra H.R. and Nagaratna.R 92004) Yoga prespective in stress management, Bangalore: Swami Vivekananda Yoga prakashan.
7. Nagendra H.R. and Nagaratna.R 92004) Yoga practices for Anxiety and Depression, Bangalore: Swami Sukhabhogananda Yoga prakashan.
8. Sukhabhogananda, Swami (2002) Stress management, Bangalore: Prakashan trust.
9. Udupa (1998) Stress management by Yoga , New Delhi: Motilal Bandaridas Publishers pvt. Ltd.
10. Ravi Shankar N.S. (2001) Yoga for Health, New Delhi: Pustak Mahal.

Reference Books:

1. Chakroborty, SK. 'Values and Ethics for Organizations – Theory and Practise', - Oxford University Press, NewDelhi.

Course Outcomes:

After learning the contents of this course, the students will be able to

1. Enhancement of Physical strength and flexibility
2. Learn to relax and focus.
3. Relieves physical and mental tension
4. Improved work performance/ efficiency.
5. Integrate Yoga into one's lifestyle.
6. Learn to practice the basic concepts of yoga to manage stress.

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II Year M.Tech. PEED I-Semester **L T P C**
Course Code:523AT **3 0 0 3**

PLCs AND FPGAs

(Program Specific Elective -5.1)

Prerequisites: Microprocessors and Microcontrollers

Course Objectives:

1. To introduce the concepts of ON-OFF logic in industrial arena.
2. To introduce the concepts of Ladder logic or contact coil logic or programming.
3. To introduce the concepts of FPGAs as a sequel to VLSI.

Unit 1: (~10 Lecture Hours)

Introduction to PLC:

PLC Basics - PLC system - I/O modules and interfacing CPU processor - programming equipment - programming formats - construction of PLC ladder diagrams - devices connected to I/O modules. PLC Programming - input instructions – output instructions - operational procedures - programming examples using contacts and coils - Drill press operation.

Unit 2: (~9 Lecture Hours)

Programming with PLC:

Digital logic gates programming in the Boolean algebra system - conversion examples - Ladder diagrams for process control - Ladder diagrams and sequence listings - ladder diagram construction and flow chart for spray process system.PLC Registers: Characteristics of Registers - module addressing - holding registers - input registers - output registers.

Unit 3: (~8 Lecture Hours)

PLC Applications:

PLC Functions - Timer functions and industrial applications - counter functions - industrial applications, Arithmetic functions - Number comparison functions - number conversion functions. Data Handling functions: SKIP - Master control Relay - Jump - Move – FIFO – FAL – ONS - CLR and Sweep functions and their applications.

Unit 4: (~9 Lecture Hours)

PLC Interfacing with devices:

Bit Pattern and changing a bit shift register, sequence functions and applications Controlling of two axes and three axis Robots with PLC - Matrix functions. Analog PLC operation: Analog modules and systems - Analog signal processing - multi bit data processing - analog output application examples PID principles - position indicator with PID control - PID modules - PID tuning - PID functions.

Unit 5: (~9 Lecture Hours) **Introduction to FPGA:**

Over view of Field Programmable Gate Arrays – CPLD Vs FPGA - Types of FPGA - configurable logic blocks (CLBs) - Input Output Block (IOB) - Xilinx Processors - Overview of Spartan 3E and Virtex Pro-FPGA boards –Zynq Processors.

Text Books:

1. John W. Webb and Ronald A. Reis, Programmable Logic Controllers – Principles and Applications , 5th Edition, PHI, 2006.
2. W.Bolton, Newnes, Program Logic Controllers, 4th edition, 2011.
3. Learning FPGAs Justin Rajewski, O'Reilly Media (ISBN 9781491965498), 2015. 74

Reference Books:

1. Programmable Logic Controllers – Programming Methods and Applications by J R. Hackworth and FD. Hackworth, Jr.– Pearson, 2004.
2. FPGA based System Design, Wayne Wolf, Pearson, 2014.
3. Essentials of VLSI circuits and Systems, Kamram Eshraghian, Douglas A.Pucknell, Sholeh, Eshraghian, PHI (EEE)
4. Designing with Xilinx FPGAs using Vivado: Sanjay Churiwala (Editor), Springer.

Online Resources:

a) https://www.coursera.org/learn/intro-fpga-design-embedded- systems#syllabus
b) https://nptel.ac.in/courses/117108040
c) https://www.coursera.org/lecture/intelligent-machining/programmable- logic-controllers-plc-fGz3r

Course Outcomes:

1. Apply the knowledge of Boolean algebra for constructing the ladder diagrams.
2. Apply the knowledge of contact-coil logic to real time control problems like Drill press operation.
3. Solve Industrial control problems by taking into consideration all the constraints including safety of the operating personnel.
4. Apply the knowledge of timers and counters to obtain better performance of Industrial manufacturing systems.
5. Apply the knowledge acquired in FPGA's for design of simple logic circuits.
6. Extend the concepts FPGAs to understand Xylinx processors for different Control logistics

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II Year M.Tech. PEED I-Semester **L T P C**
Course Code:523AU **3 0 0 3**

GRID INTEGRATION OF RENEWABLE ENERGY SOURCES

(Program Specific Elective 5.2)

Prerequisites: Power Systems-I, Power Systems-II, Power Electronics

Course Objectives:

1. To describe the concepts of different renewable energy sources.
2. To explain the concepts of solar, wind energy, biomass, ocean energy, geothermal and hydro power generation system.
3. To describe the utilization of different storage technologies.
4. To analyze the issues involved in the integration of renewable energy sources to the grid.

UNIT 1: (~7 Lecture hours)

Introduction: Renewable Sources of Energy-Grid-Supplied Electricity- Distributed Generation Renewable Energy Economics-Calculation of Electricity Generation Costs-Demand side Management Options –Supply side Management Options-Modern Electronic Controls of Power Systems.

UNIT 2: (~9 Lecture hours)

Solar and Wind energy Systems: Solar thermal power generation. Solar Photovoltaics- energy conversion principle-classifications-equivalent circuit-characteristics-Cell efficiency- Limitations-PV modules-MPPT algorithms. Power and energy from wind - types of electric generatorsfor wind power generation, Singly fed and doubly fed Induction generator, PMSM generator, Dynamics matching- performance of wind generators - economic considerations.

UNIT 3: (~9 Lecture hours)

Other renewable energy sources: Bioenergy, Bio-fuels - classification

- biomass conversion technologies-applications; OTEC Systems, tidal energy-wave energy-Geothermal energy-mini, micro and pico-hydro power generation.

UNIT 4: (~9 Lecture hours)

Storage Devices: Super capacitor-SMES- Battery storage-flywheel storage- compressed air storage- Fuel cells–types and applications; MHD generators-backup -System design-industrial and domestic applications of storage devices.

UNIT 5: (~9 Lecture hours)

Integration of Alternative Sources of Energy with the grid: Principles of Power Injection-Instantaneous Active and Reactive Power Control Approach Integration of Multiple Renewable Energy Sources-Islanding and Interconnection Control-DG Control and Power Injection. Interconnection Technologies -Standards and Codes for Interconnection- Interconnection Considerations -Interconnection Examples for Alternative Energy Sources.

Text Books:

1. Felix A. Farret, M. Godoy Simoes, Integration of Alternative Sources of Energy, John Wiley & Sons, INC, 2006.
2. D.Mukherjee, S.Chakrabarti: Fundamentals of Renewable Energy Systems, New Age International publishers, 2011.
3. Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, INC, 2004.

Reference Books:

1. Rai G D, Solar Energy Utilization, 5th Edition, Khanna Publishers, 2004.
2. B H Khan, Non-Conventional Energy Resources, 2nd Edition, Tata McGraw-Hill, 2009.
3. Remus Teodorescu, Marco Liserre, Pedro Rodríguez: Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

Online Resource: https://nptel.ac.in/courses/108107143

Course Outcomes:

At the end of this course, the students will be able to

1. Describe the concepts of different renewable energy sources.
2. Explain the concepts of solar energy conversion systems.
3. Explain the concepts of wind energy based electricity generationsystems
4. Describe the utilization of different storage technologies.
5. Describe the concepts of renewable energy sources like biomass, ocean energy and hydro power generation system
6. Analyze the issues involved in the integration of renewable energy sources with the grid.

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II Year M.Tech. PEED I-Semester **L T P C**
Course Code:523AV **3 0 0 3**

ENERGY STORAGE TECHNIQUES

(Program Specific Elective 5.3)

Pre-requisites: None

Course Objectives:

1. To Understand nonelectrical storage technologies available
2. To Understand Electro chemical secondary batteries characteristics
3. To Understand efficiency improvement techniques in storage systems
4. To Appreciate various applications of storage systems

UNIT-I: Non-electrical Storage Systems (~9 Lecture Hours)

Flywheel, Energy Relations, Flywheel System Components, Benefits of Flywheel over Battery, Superconducting Magnet Energy Storage, Compressed Air Energy storage, Overview of Thermal Energy Storage. Capacitor bank storage, Comparison of storage Technologies.

UNIT-II: Electro Chemical Storage (~9 Lecture Hours)

History, General battery concepts- Types of Batteries- Primary, seconday- Battery Vs Cell, Nickel-Cadmium - Nickel-Metal Hydride, Nickel hydrogen, LithiumIon- Lithium-Polymer, Fuel cells.Domains of applications of Energy storage- Starter-Traction-stationary-mobile or nomadic, Review of storage requirements.

UNIT-III: Sealed-Lead Cells and Batteries (~10 Lecture Hours)

Definitions of characteristics, Terminology of States, Battery Design, Battery Charging, Charge Regulators, Battery Management, General Equivalent Electrical Circuit, Performance Characteristics.Discharge Characteristics, Charging-Importance characteristics-charge acceptance-over charging, Types of charging-Constant voltage charging- Constant current charging- Taper charging-special charging- Charging power sources, storage, Testing, safety.

UNIT–IV: Electrical Energy Storage System Efficiency Improvement (~10 Lecture Hours)

Hybrid Electrical Energy storage– Design Considerations- Architecture- Charge management- components Modeling of Power Conversion, Reconfigurable EES Array Architecture, Cycle Efficiency and Capacity Utilization of EES Bank, General Bank Reconfiguration Architecture, Dynamic Reconfiguration Algorithm, Cycle Efficiency and Capacity Utilization Improvement.

UNIT-V: Storage Applications (~9 Lecture Hours)

Electric Vehicle application- Regenerative Brake- PV module assistanceStorage bank reconfiguration- Overall cost analysis, Energy storage in Transient regimes of Power system-Problem formulation- modeling- steady state stability analysis with storage-storage Parameters to ensure transient stability, Battery rating calculations for standalone system.

Text Books:

1. Energy Storage for Power Systems, A. Ter-Gazarian, Peter Peregrinus Ltd., 1994.
2. Design and Management of Energy-Efficient Hybrid Electrical Energy Storage Systems, Younghyun Kim, Naehyuck Chang, Springer, 2014.
3. Rechargeable Batteries Applications Handbook, EDN Series for Design Engineers, Elsevier.

References:

1. Lithium Batteries and Other Electrochemical Storage Systems, Christian Glaize, Sylvie Geniès
2. Wind and Solar Power Systems, Second Edition, Mukund R. Patel, CRC Press, 2006

Course Outcomes:

After completion of the course, students should be able to

1. Learn Mechanical, Magnetic and Electrostatic storage systems.
2. Enumerate merits and demerits of various secondary batteries.
3. Understand the characteristics of Lead acid batteries.
4. Compare and implement various types of Charging techniques.
5. Improve the efficiency of storage systems.
6. Apply knowledge of storage technologies in EV and Power systems.

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II Year M.Tech. PEED, I-Semester **L T P C**
Subject Code: **3 0 0 3**

BUSINESS ANALYTICS

(Open Elective)

Prerequisites: - NIL-

Course Objectives:

1. To understand the role of business analytics within an organization.
2. To gain an understanding in usage of business analytics in formulating and solving problems using analytical and management tools in managerial decision making.
3. To Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization and across various sectors.

UNIT 1: **Introduction to Business Analytics** (~ 08 Lecture Hours)

Introduction to Analytics - Importance of Analytics in Problem Analytics - Business Analytics - Importance - Difference between Business Analytics and Business Intelligence - Evolution of Business Analytics - Types of Business Analytics - Characteristics - Goals - Domains of Business Analytics - Framework of Business Analytics - Analytics Ecosystem - Process - advantages - steps of Decision modeling for Business Analytics.

UNIT 2: Organization Structure and Data for Business Analytics (~ 09 Lecture Hours)

Organization Structure of Business Analytics - Functional organization - Matrix - centralized structure with Business Analytics - Factors determining in choosing appropriate structure - Reasons for organizational failure for Business Analytics Initiatives - Team Management - Reasons for Team failure

Data - Characteristic of Readiness of data Dimensions - Data taxonomy – Data mining - Process - Implications of Data outlines- Steps in data driven decision making - Importance of sampling - Data visualization - Types Data Storytelling - Data Journalism - Data warehousing.

UNIT 3: Descriptive Analytics (~10 Lecture Hours)

Introduction to Descriptive Analytics, Measure of Central tendency-Mean, Median, Mode Measure of Variation-Variance, Standard deviation, Mean Deviation, Interquartile Deviation Measure of Shape-Kurtosis, Skewness, Measure of Association-Covariance, Correlation

Random Variables: Discrete probability Distribution and Continuous Probability Distribution (Mean, Median, Mode)

UNIT 4: Predictive and Prescriptive Analytics (~ 10 Lecture Hours)

Predictive Analytics- Regression- Simple linear regression, Multiple linear regression-Test of significance of regression coefficients Using ANOVA (one way and two way classification), Coefficient of Determination. Forecasting -Time Series Analysis- Trend Analysis, Moving Average Method, ARMA Model with error Analysis.

Prescriptive Analytics: Linear Programing Problem- Graphical Method, Simplex Method

UNIT 5: Decision Analysis (~ 08 Lecture Hours)

Problem Formulation, Decision analysis without probabilities, Decision analysis with probabilities, Decision Analysis with sample information, Computing Branch Probabilities with Bayes Theorem, Utility Theory.

Text Books:

1. Ramesh Sharada, Dursun Delen, Efraim Turban, David King : Business Intelligence, Analytics, and Data Science - A Managerial Perspective : Pearson : 4th Edition.
2. U Dinesh Kumar : Business Analytics - The Science of Data-Driven Decision Making : Wiley, 2nd Edition.

References:

1. Gert H.N. Laursen, Jesper Thorlund : Business Analytics for Managers - Taking Business Intelligence Beyond Reporting : Wiley 2nd Edition.
2. Camm, Cochran, Fry, Ohlmann, anderson, Sweeney, Williams: Essentials of Business Analytics : Cengage Publishers

Online Resources:

1. NPTEL: Business Analytics for Management Decision - http://nptel.ac.in/courses/110105089/

Course Outcomes:

After learning the contents of this course, the student must be able to

CO1 Understand and apply business analytics in real time world.
CO2 Comprehend the structure of an organization for business analytics implementation.
CO3 Identify the befitting descriptive tool required for the business problem.
CO4 Apply suitable predicative method that supports business decision making.
CO5 Identify appropriate prescriptive modeling techniques for decision making.
CO6 Translate data into clear, actionable insights in the decision-making process.

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II Year M.Tech. PEED, I-Semester **L T P C**
Subject Code: **3 0 0 3**

INDUSTRIAL SAFETY

(Open Elective)

Prerequisites: Industrial Management

Course Objectives:

The purpose of this course is to teach the students.

1. Concepts of industrial safety and provide useful knowledge for work place safety.
2. Understand Industrial Safety Programs, Fire explosions and its Preventive methods.
3. Helps in identification, evaluation and control of the hazards.
4. Mitigate harm to people, property and the environment.
5. Quality maintenance process, Duties & Responsibilities of Safety officer's.
6. Overhauling of Mechanical & Electrical machinery components, difference between Periodic & Preventive Maintenance.

Unit 1: (~10 Lecture Hours)

Industrial Safety: Importance and objectives of safety, safety programs – components and realisation. Evolution of modern safety concept, safety policy, safety organisation. Implementation of safety procedures.

Unit 2: (~10 Lecture Hours)

Accidents: causes, types, results and control, mechanical and electrical hazards types, causes and preventive steps, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water, lights, cleanliness fire guarding etc. safety colour code, fire prevention and fire fighting equipments and methods.

Unit 3: (~10 Lecture Hours)

Fundamentals of maintenance engineering: Definition of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, types of maintenance, maintenance cost and its relations with replacement economy, service life of equipment.

Unit 4: (~8 Lecture Hours)

Quality and safety in maintenance: needs for quality maintenance process, maintenance work quality, use of quality control, post maintenance testing, reasons for safety problems in maintenance, guidelines to safety in maintenance work, safety officers' role in maintenance work, Protection of maintenance workers.

Unit 5: (~ 10 Lecture Hours)

Types of maintenance: corrective, breakdown, predictive, replacement, preventive and proactive maintenance.

Periodic and preventive maintenance in details: Periodic maintenance: inspection- concept and need , degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motors, common troubles and remedies of electric motor , repair complexities and its use

Preventive maintenance: definition, needs, steps and advantages.

Text books:

1. Krishnan N.N. Safety management in industries, Jaico publishing house, Bombay, 1997.
2. H.P. Garg, S., Maintenance Engineering, S. Chand and company.

References:

1. Handley,W. Industrial safety Hand book, 2nd Edn, McGraw-Hill Book Company, 1969
2. Higgins & Morrow, Maintenance Engineering Handbook, Da Information Services.
3. Mc Cornick, E.J., Human Factors in Engineering and design, Tata McGraw-Hill, 1982

Online websites/ Materials :

1. https://www.spplimited.co.in/industrial-safety-certificate-course-trainingin- chennai/
2. https://onlinecourses.nptel.ac.in/noc18_mg42/preview

Course Outcomes:

Students after completing this course would be able to:

1. Know the need for safety in industries.
2. Know about factory acts and industrial safety regulations.
3. Analyse causes and types of different hazards on their preventions.
4. Asses quality maintenance processes and maintenance work quality.
5. Assess safety practices and programs.
6. Know about periodic and preventive maintenance activities in industries.

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II Year M.Tech. PEED, I-Semester **L T P C**
Subject Code: **3 0 0 3**

OPERATIONS RESEARCH

(Open Elective)

Course objectives:

The course will enable the students to:

1. Study the linear programming and non-linear programming techniques used for business and engineering applications.
2. Understand the importance of dynamic programming concept in operations research
3. Know about the inventory, Game theory and waiting line model applications in real world.

UNIT 1 (~10 Lectures)

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem-Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M methods, Special cases in LP-Degeneracy, unbounded, infeasibility & alternative optima.

UNIT 2 (~10 Lectures)

Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions-Northwest corner rule, least cost method and Vogel's approximation method. Optimality test by MODI method & stepping stone method.

Assignment problem: Formulation. Hungarian method for optimal solution. Solving unbalanced Assignment problem.

UNIT 3 (~10 Lectures)

a) **Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Coach/Shortest Path and cargo loading problems.

b) **Inventory models**. Inventory costs. Models with deterministic demand-model (a) demand rate uniform and production rate infinite, model (b) demand rate uniform and production rate finite.

UNIT 4 (~10 Lectures)

a) **Games Theory**. Competitive games rectangular game saddle point, minimax (maximin) method of optimal strategies, and value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point-mixed strategy for 2*2 games.

b) **Waiting lines:** Single channel –poison arrivals and exponential service times with infinite population and finite population models. Multi-channel- poisson arrivals and exponential service times with infinite population.

UNIT 5 (~8 Lectures)

Non-linear Programming: Introduction to non-linear programming (NLP), Convex and concave functions, NLP with one variable, Line search algorithms, Multivariable unconstrained problems, constrained problems, Lagrange Multiplier, The Karush-Kuhn- Tucker (KKT) conditions, the method of steepest ascent, convex combination method, penalty function, Quadratic programming.

Text Books

1. J K Sharma., Operations Research, theory and applications, 5th edition, Macmillan India Ltd ,2013
2. S S Rao, Engineering optimisation – Theory and Practice, 4th Edition, John Wiley & Sons Inc., 2009 .

Reference Text Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. F.H. Hillier and G.J. Lieberman, Introduction to Operations Research, Tata-McGraw- Hill, 2010
3. S.D. Sharma, Operations Research, Kedarnnath, Ramnath & Co., Meerut, 2009.
4. V.K. Kapoor, Operations Research, S. Chand Publishers, New Delhi, 2004.

Online websites / Materials:

IOR Tutorials (Interactive Operations Research Tutorial)

Online Courses:

onlinecourses.nptel.ac.in

Course outcomes

At the end of the course students are expected to

1 Apply linear programming models to several Engineering Applications.
2 Solve selected models in Dynamic Programming practical applications.
3 Apply simple mathematical models in Inventory into the real Engineering Applications.
4 Solve Game theory problems related to business applications,
5 To minimize waiting time of the customer and optimization of number of servers.
6 Able to apply the concept of non-linear programming models to various engineering applications.

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II Year M.Tech. PEED, I-Semester **L T P C**
Subject Code: **3 0 0 3**

COST MANAGEMENT OF ENGINEERING PROJECTS

(Open Elective)

Prerequisites: - NIL-

Course Objectives:

1. Give inputs in handling the cost associated with engineering projects.
2. Acquaint the practical aspects of cost management.
3. Orient the quantitative techniques applicable to cost management.

UNIT 1: (~ 8 Lecture Hours)

INTRODUCTION TO PROJECT MANAGEMENT

Project- Need of Project Management- Objectives -Scope- Importance of Project Management -Principles of Project Management- Types of Projects-Roles and Responsibilities of Project Team.

UNIT 2: (~ 09 Lecture Hours)

PROJECT PLANNING AND IMPLEMENTATION

Project Management Life Cycle-Process-Project Selection – Feasibility study: Types of feasibility - Steps in feasibility study- Estimation of Project cost – Cost of Capital

– Project Representation and Preliminary Manipulations – Basic Scheduling Concepts - Resource Levelling – Resource Allocation-Execution.

UNIT 3: (~ 08 Lecture Hours)

COST MANAGEMENT FOR PROJECTS

Introduction and importance of Cost Management for Projects- Objectives of Costing System -Various cost concepts- Cost Classification on the basis of behaviour (as variable, fixed and semi variable)-Traceability (as direct and indirect)- Functions (as production cost, administration cost, selling cost and distribution cost).

UNIT 4: (~ 10 Lecture Hours)

BUDGETARY CONTROL

Introduction to Budget- Concepts, Advantages- Types of Functional budgets: Fixed and Flexible budget, Performance budget, Cash Budget and Production Budget (Simple Problems on Functional based budget). Introduction to Zero based budgeting.

UNIT 5: (~ 10 Lecture Hours)

PROJECT-COST MANAGEMENT

Project Cost Estimation- Project Financing- Project Planning and Scheduling-Project Cost Control-Quantitative Techniques for Project Cost Management-Linear Programming-Network Analysis-PERT/CPM-Project Cost Analysis-Transportation Model-Assignment Model (Simple Problems)- Simulation-Learning Curve Theory-Project Methodologies -Types-Project Integrated Management (PIM).

Text Books:

1. K.Nagarajan, Project Management, New Age International Publishers.
2. L. S. Srinath, PERT and CPM Principles and Applications.
3. Charles T. Horngren and George Foster, Cost Accounting: A Managerial Emphasis, PHI, 1st Edition.

Reference Books:

1. Arun Kanda, Project Management A Life Cycle Approach, Prentice Hall of India, 2011.
2. R.B.Khanna, Project Management, Prentice Hall of India, 2011.
3. R.Panneerselvam and P.Senthilkumar, Project Management, Prentice Hall of India, 2009.
4. Blocher, Chen, Cokins, and Lin, Cost Management: A Strategic Emphasis.
5. John K. Shank and Vijay Govindarajan, Strategic Cost Management.

Online Resources:

1. Managerial Accounting: http://nptel.ac.in/courses/110101004/24

Course Outcomes:

After learning the contents of this course, the student must be able to

CO1 Perceive the cost associated in managing engineering projects
CO2 Develop Project Planning proposal considering time and cost
CO3 Furnish effective cost management practices for better handling of engineeringprojects
CO4 Prepare budgets for engineering projects.
CO5 Propose the Quantitative Techniques for Project Cost Management.
CO6 Orient the cost management decision-making using quantitative methodology in minimizing the cost associated with the projects.

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II Year M.Tech., I-Semester **L T P C**
Subject Code: **3 0 0 3**

COMPOSITE MATERIALS

(Open Elective)

Pre-requisites: Nil

Course Objectives:

1. Learn to demonstrate a critical understanding of composite materials of their nature and application
2. Critically evaluate the types of reinforcements and their advantages in application.
3. Develop an understanding of different types of metal matrix composites and their preparation.
4. Develop an understanding of different types of ceramic matrix composites and their preparation.
5. Develop an understanding of different types of polymer matrix composites and their preparation.
6. Critically evaluate strength of the composite materials through laminar study.

UNIT 1: (~ 9 Lecture Hours)

INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT 2: (~ 9 Lecture Hours)

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behaviour of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT 3: (~ 9 Lecture Hours)

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications.

Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. **Manufacturing of Carbon – Carbon composites:** Knitting, Braiding, Weaving. Properties and applications.

UNIT 4: (~ 8 Lecture Hours)

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT 5: (~ 9 Lecture Hours)

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro-thermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Text books:

1. R.W.Cahn – VCH, Material Science and Technology – Vol 13 – Composites, West Germany.
2. R. Bala subramaniam, Callister's Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian Edition, 2007.

Reference books:

1. ed-Lubin, Hand Book of Composite Materials.
2. K.K.Chawla, Composite Materials.
3. Deborah D.L. Chung, Composite Materials Science and Applications.
4. Danial Gay, Suong V. Hoa, and Stephen W, Composite Materials Design and Applications.

Web resources:

1. http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Composite%20Materials/pdf/ Lecture_Notes/LNm1.pdf
2. https://www.asminternational.org/documents/10192/1849770/05287G_Sample_Chapter.pdf
3. http://home.iitk.ac.in/~mohite/Composite_introduction.pdf
4. https://onlinecourses.nptel.ac.in/noc18_me03/preview
5. https://www.online.colostate.edu/courses/MECH/MECH530.dot

Course Outcomes:

After completion of the course, students will be able to

1. Differentiate composite materials and their applications.
2. Analyse, evaluate and manage the different the types of reinforcements.
3. Develop different types of metal matrix composites and prepare the same for their specific needs as engineers.
4. Develop different types of ceramic matrix composites and prepare the same for their specific needs as engineers.
5. Develop different types of polymer matrix composites and prepare the same for their specific needs as engineers.
6. Critically enhance strength of the composite materials through laminar usage.

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II Year M.Tech. PEED I-Semester **L T P C**
Subject Code: **3 0 0 3**

ENERGY FROM WASTE

(Open Elective)

Prerequisites:

Course Objectives:

1. To classify various waste resources.
2. To identify various methods of waste disposal.
3. To study various energy generation methods from waste.
4. To analyze various processes of recycling of waste and environmental benefits.

UNIT 1: (~8 Lecture Hours)

Classification of waste – Agro based, Domestic, Bio-Medical, Forest residue, Industrial waste, recycling of waste, Segregation of waste, waste treatment, Environmental impacts. Land fill method for disposal of waste, Landfill classification.

Guidelines for Minimization of Wastage in Society (Individual houses, Apartments, Industries etc.)-Reduce, Reuse & Recycle. Minimization of all types of wastage through Orientation programs, Awareness camps, workshops, seminar etc.Group Discussion Activity (~2 Lecture Hours).

UNIT 2:(~9 Lecture Hours)

Biomass: Pyrolysis – Byproducts of Pyrolysis– Manufacture of pyrolytic oils and gases, applications. Biomass Gasification: Gasifiers – Fixedbed system –Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation Concepts of Gasifier Arrangements, Burner and Engine arrangements for electric power generation.

UNIT 3:(~8 Lecture Hours)

Biomass Combustion: Biomass stoves – Improved challahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT 4: (~8 Lecture Hours)

Biogas: Properties of biogas (Calorific value and composition), Biomass resources and their classification - Biomass conversion processes.

Types of biogas Plants, Applications, Alcohol production from biomass- Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

UNIT 5:(~7 Lecture Hours)

E-waste: e-waste in the global context- Environmental concerns and health hazards Recycling e-waste, Global trade in hazardous waste, e-waste legislation, Government regulations on e-waste management.

NOTE:A classroom activity such as Group Discussion involving all students to be conducted on the topics given in the second half of first unit.

Text Books:

1. Desai, Ashok V.," Non-Conventional Energy" Wiley Eastern Ltd.,1990.
2. Challal, D.S.,"Food, Feed and Fuel from Biomass" IBH Publishing Co.Pvt.Ltd.,1991
3. NicholasP.Cheremisinoff."HandbookofSolidWasteManageme ntandWasteMinimization Technologies" An Imprint of Elsevier, NewDelhi, 2003.
4. T.V. Ramachandra, Management of Municipal Solid Waste, The Energy and Resources Institute, TERI, 2009.

Reference Books:

1. C.Y.WereKoBrobbyandE.B.Hagan,"BiomassConversionandT echnology"JohnWiley & Sons, 1996.
2. M.Dutta,B.P.Parida,B.K.Guha and T.R.Surkrishnan " Industrial Solid Waste Management and Land filling practice." Narosa Publishing House, New Delhi, 1999.
3. Khandelwal, K.C. and Mahdi S.S. "Biogas Technology-A Practical Hand Book Vol.I& II," Tata McGraw Hill Publishing Co.Ltd.' 1983.

Online Resouce:

https://nptel.ac.in/courses/103107125

Course Outcomes:

At the end of this course students will be able to

1. Understand the methods of recycling of waste.
2. Compare the methods of waste disposal.
3. Identify different sources of energy from waste.
4. Analyze methods for management of waste.
5. Understand the global trade in hazardous waste.
6. Understand and adapt Waste minimization techniques as a societal responsibility.

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II Year M.Tech. PEED I-Semester **L T P C**
Subject Code: **3 0 0 3**

POWER FROM RENEWABLE ENERGY SOURCES

(Open Elective)

Prerequisites: NIL

Course Objectives:

1. To introduce various types of renewable energy technologies
2. To understand the technologies of energy conversion from the resources and their quantitative analysis

Unit 1: (~10 Lecture Hours)

Fundamentals of Solar Energy-Solar spectrum- Solar Radiation on Earth's surface- Solar radiation geometry-Solar radiation measurements- Solar radiation data- Solar radiation on horizontal and tilted surfaces. Solar Thermal conversion- Flat plate collectors- concentrated collectors- construction and thermal analysis- Solar applications- Solar ponds- Heliostat systems-water heater-air heater-solar still.

Unit 2: (~8 Lecture Hours)

Solar-Electric Power generation-Photovoltaic cells-Equivalent circuit-V-I Characteristics-Photo voltaic modules– constructional details-design considerations- Tracking- Maximum power point tracking - Solar Thermo electric conversion.

Unit 3: (~8 Lecture Hours)

Wind Energy- Fundamentals of wind energy-power available in wind- Betz Limit Aerodynamics of wind turbine- Wind turbines- Horizontal and vertical axis turbines –their configurations- Wind Energy conversion systems.

Unit 4: (~9 Lecture Hours)

Energy from Bio Mass- Various fuels- Sources-Conversion technologies-Wet Processes – Dry Processes- Bio Gas generation – Aerobic and anaerobic digestion - Factors affecting generation of bio gas - Classification of bio gas plants-Different Indian digesters- Digester design considerations - Gasification process - Gasifiers – Applications. Geothermal Energy - sources- Hydrothermal convective - Geo- pressure resources - Petro- thermal systems (HDR) - Magma Resources-Prime Movers.

Unit 5: (~9 Lecture Hours)

Ocean Thermal Energy Conversion Systems- Principle of operation - Open and closed cycles, Energy from Tides - Principle of Tidal Power - Components of tidal Power plants - Operation Methods - Estimation of Energy in Single and double basin systems - Energy and Power from Waves Wave energy conversion devices - Fuel Cells - Design and Principle of operation - Types of Fuel Cells - Types of Electrodes – Applications - Basics of Batteries - Constructional details of Lead acid batteries - Ni-Cd Batteries.

Text Books:

1. "John Twidell & Wier", "Renewable Energy Resources", CRC Press, 2009.
2. "G. D. Rai", "Non Conventional Energy sources", Khanna publishers, 2004.

Reference Books:

1. "D.P.Kothari, Singal, Rakesh and Ranjan", "Renewable Energy sources and Emerging Technologies", PHI, 2009.
2. "F. C. Treble", Generating Electricity from Sun, Pergamon Press, 1st Edition 1991
3. "C. S. Solanki", "Solar Photo voltaics-Fundamentals- Principles and Applications", PHI, 2009
4. "S. P. Sukhatme", "Solar Energy Principles and Application", TMH, 2009.

Online Resource:

https://nptel.ac.in/courses/103103206

Course Outcomes:

After completion of this course, the students will be able to

1. Analyse solar thermal and photovoltaic systems and related technologies for energy conversion.
2. Understand Wind energy conversion and devices available for it.
3. Understand Biomass conversion technologies, Geo thermal resources and energy conversion principles and technologies.
4. Realize Power from oceans (thermal, wave, tidal) and conversion devices.
5. Understand fundamentals of fuel cells and commercial batteries.
6. Suggest suitable methods of power generation for a particular region/ organization based on the availability of resources.

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO 1:	Excel in the chosen career to be taken-up in R&D organizations/ Higher Educational Institutions/ Relevant Industries in the area of "Power Electronics and Electric Drives".
PEO 2:	Work effectively as an individual and a team member, keeping in mind the high Importance currently being given to sustainability and Emerging Green Energy Technologies.
PEO 3:	Contribute to the Community/Society Development through acquired knowledge and skills.
PEO 4:	Continuous upgradation of knowledge and skills.

PO 1:	An ability to independently carry out research / investigation and development work to solve practical problems.
PO 2:	An ability to write and present substantial technical reports/documents.
PO 3:	Students should be able to demonstrate a degree of mastery in the area of Power Electronics & Electric Drives.
PO 4:	The students will able to analyze, design and develop new control strategies in the areas of Power Electronics Drives and Power Systems suitable for Industry requirements.

G.NARAYANAMMA INSTITUTE OF TECHNOLOGY & SCIENCE (For Women)
(AUTONOMOUS)

INSTITUTE VISION

To become a center of quality education in Engineering and Technology for women empowerment.

INSTITUTE MISSION

- To fulfill the academic aspirations of women engineers for enhancing their intellectual capabilities and technical competency.
- To Leverage Leading – Edge Technologies and cultivate exemplary work culture.
- To facilitate success in their desired career in the field of engineering to build a progressive nation.

INSTITUTE QUALITY POLICY

G. Narayanamma Institute of Technology and Science (For Women), Hyderabad is committed in imparting Quality Education and Training for women empowerment in the field of "Engineering and Technology" and to satisfy applicable requirements through continual improvement of the Quality Management System by facilitating and supporting the staff and students to work as a team in upgrading their knowledge and skill in tune with the industrial and technological developments through a set of Quality objectives.