M.E. (Power Electronics and Drives)

2018 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NAAC with 'A' Grade)
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REGULATIONS 2018
(CHOICE BASED CREDIT SYSTEM)

(Common to all M.E./M.Tech. Degree Programmes)

NOTE: *The regulations given hereunder are subject to amendments as may be decided by the Academic Council of the Institute from time to time. Any or all such amendments will be effective from such date and to such batches of students including those already in the middle of the programme as may be decided by the Academic Council.*

1. ELIGIBILITY FOR ADMISSION

(i) Candidates seeking admission to the First Semester of M. E. / M. Tech. degree programmes will be required to satisfy the eligibility criteria for admission thereto prescribed by the Directorate of Technical Education, Chennai and Anna University, Chennai.

(ii) Part - time candidates should satisfy conditions regarding experience, sponsorship, place of work and other requirements that may be prescribed by the Directorate of Technical Education, Chennai and Anna University, Chennai from time to time, in addition to satisfying requirements as in Clause 1 (i).

2. DURATION OF THE PROGRAMME

(i) **Minimum Duration:** Master of Engineering (M.E.) / Master of Technology (M.Tech.) extends over a period of two years. The two academic years (Part-time three academic years) will be divided into four semesters (Part-time six Semesters) with two semesters per year.

(ii) **Maximum Duration**: A candidate shall complete all the passing requirements of M. E. / M. Tech. programmes within a maximum period of 4 years / 8 semesters in case of full-time programme and 6 years / 12 semesters in case of part-time programme, these periods being reckoned from the commencement of the First semester to which the candidate was first admitted, regardless to the break-of-study availed.

3. BRANCHES OF STUDY

Following M.E. / M.Tech. Programmes are offered by the Institute

M.E. Programmes

1. Applied Electronics
2. CAD/CAM
3. Communication Systems
4. Computer Science and Engineering
5. Embedded Systems
6. Engineering Design
7. Industrial Automation and Robotics
8. Industrial Safety Engineering
9. Instrumentation Engineering
10. Power Electronics and Drives
11. Software Engineering
12. Structural Engineering

13. VLSI Design

M. Tech. Programme

14. Biotechnology

4. STRUCTURE OF PROGRAMMES

(i) **Curriculum:** Every Post Graduate Programme will have a curriculum with syllabi consisting of theory and practical courses that include **Professional Core** (core courses relevant to the chosen specialization), **Professional Electives** (elective courses) and **Employability Enhancement Courses** (Practical courses, Project Work, Internship, Miniproject and Industrial / Practical Training).

(ii) **Project Work:** Every student, individually, shall undertake Dissertation Phase - I during the third semester (fifth semester for part-time programme) and Dissertation Phase - II during the fourth semester (Sixth semester for part-time programme) under the supervision of a qualified faculty (faculty members with Ph.D. or P.G. with a minimum of 3 years of teaching experience). The Dissertation Phase - II shall be a continuation work of the Dissertation Phase - I. The project work can be undertaken in an industrial / research organization or Institute in consultation with the faculty guide and the Head of the Department. In case of project work at industrial / research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization.

(iii) **Elective Courses: Seven Elective** courses are offered to the students admitted in various disciplines as prescribed in the curriculum to widen their knowledge in their specialization area.

(iv) **Online Courses:** A Student may be permitted to credit online courses with the approval of a Departmental Consultative Committee constituted by the Head of the Department, subject to a maximum of three credits. Such students may be exempted from attending the classes, if such course(s) are offered in the semester. Summary of such on-line courses, taken by the students, along with the offering agency shall be presented to the Academic Council for information and further suggestions. However, the student needs to obtain certification from the agency offering the course to become eligible for writing or seeking exemption from the End Semester Examination. In case of credits earned through online mode from the Institute / University, the credits may also be transferred directly after due approval from the Departmental Consultative Committee and the Office of the Controller of Examinations.

(v) **Industrial Training:** Every full-time student shall take-up training in the industry / research laboratories, under the supervision of a faculty guide during summer / winter vacation till pre-final semester of the programme subject to the evaluation prescribed in the Clause 15. Credits of such courses will be indicated for the course in the Grade Sheet if the student passes, but it will not be considered for computing CGPA.

(vi) **Mini Project**: A Mini Project shall be undertaken by the students individually in consultation with the respective faculty and Head of the Department, as specified in the curriculum. A student is expected to make a presentation about the mini-project during the final evaluation as given in the Clause 15.

(vii) **Value Added / Certificate Courses:** Students can opt for any one of the Value added Courses in II and III semester, approved by the Academic Council. A separate Certificate will be issued on successful completion of the Course by the Controller of Examinations.

(viii) **Credit Assignment:** Each course is normally assigned a certain number of credits with 1 credit per lecture hour per week, 1 credit for 2 hours of practical per week, 1 credit for 1 hours of tutorial per week, The exact numbers of credits assigned to the different courses of various programmes are decided by the respective Boards of Studies.

(ix) **Minimum Credits:** For the award of the degree, the student shall earn a minimum number of total credits as prescribed by the respective Board of Studies as given below:

S.No.	**M.E./M. Tech. Programmes**	**Total Credits**
1.	M.E. Applied Electronics	69
2.	M.E. CAD / CAM	70
3.	M.E. Communication Systems	70
4.	M.E. Computer Science and Engineering	70
5.	M.E. Embedded Systems	70
6.	M.E. Engineering Design	70
7.	M.E. Power Electronics and Drives	69
8.	M.E. Software Engineering	70
9.	M.E. Structural Engineering	69
10.	M.E. VLSI Design	70
11.	M.E. Industrial Safety Engineering	70
12.	M.E. Industrial Automation and Robotics	69
13.	M.E. Instrumentation Engineering	69
14.	M.Tech. Biotechnology	69

5. COURSE ENROLLMENT AND REGISTRATION

5.1 Each student, on admission shall be assigned to a Faculty Advisor (vide Clause 7) who shall advise / counsel the student about the details of the academic programme and the choice of courses considering the student's academic background and career objectives.

5.2 Every student shall enroll for the courses of the succeeding semester, in the current semester. However, the student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of the semester concerned.

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

5.3.1 Each student on admission to the programme shall register for all the **courses prescribed in the curriculum** in the **first Semester of study**.

5.3.2 The enrolment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrolment by registering for the courses within the first five working days after the commencement of the Semester II.

5.3.3 If a student wishes, the student may drop or add courses (vide Clause 5.5) within **five** working days after the commencement of the semester concerned and complete the registration process duly authorized by the PG coordinator of the programme. In the case, if a student fails in a course, he / she may be permitted to register the course in the subsequent semester or when it is offered.

5.3.4 A student who has passed all the courses prescribed in the curriculum for the award of the degree shall not be permitted to re-enroll to improve the student's marks in a course or the aggregate marks / CGPA.

5.4 Minimum Credits to Register for Project work

The Project work for M.E. / M.Tech. consists of Dissertation Phase - I and Dissertation Phase - II. The Dissertation Phase - I is to be undertaken during III semester (V semester for part-time programme) and Dissertation Phase - II, which is a continuation of Phase – I is to be undertaken during IV semester (VI semester for part-time programme). Minimum 24 credits are required to be earned to enroll the Dissertation Phase - I .

If a student fails to earn the requisite minimum credits, the student cannot enroll for the Dissertation Phase - I. In such a case, the student can enroll for the project work in a subsequent semester, after earning the minimum credits specified.

5.5 Flexibility to Add or Drop courses

5.5.1 A student has to earn the total number of credits specified in the curriculum of the respective Programme of study in order to be eligible to obtain the degree. However, if a student wishes, the student is permitted to earn more than the total number of credits prescribed in the curriculum of the student's programme by opting for additional courses.

5.5.2 From the II to final semesters, the student has the option of registering for additional courses or dropping existing courses. Total number of credits of such courses cannot exceed 6. In such cases, the attendance requirement as stated Clause 6 is mandatory.

5.6 Reappearance Registration

5.6.1 If a student fails in a theory course, the student shall do reappearance registration for that course in the subsequent semester or when it is offered next.

5.6.2 On registration, a student may attend the classes for the reappearance registration courses, if the student wishes. However, the attendance requirement (vide Clause 6) is not compulsory for such courses.

5.6.3 The student who fails in any practical / Miniproject or any other EEC courses shall register for the same in the subsequent semester or when offered next, and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6) and earn Continuous Assessment marks.

5.6.4 The student who fails in Dissertation Phase I / II shall register for the same in the subsequent semester or when offered next, and **repeat** the course. In this case, the student shall attend the classes, satisfy the attendance requirements (vide Clause 6), earn Continuous Assessment marks and appear for the End Semester Examinations. Reappearance Registration is not available for such courses.

5.6.5 If a student is prevented from writing the end semester examination of a course due to lack of attendance, the student has to register for that course again, when offered next, attend the classes and fulfil the attendance requirements as per Clause 6.

6. REQUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION OF A COURSE

A student who has fulfilled the following conditions (vide clause 6.1 and 6.2) shall be deemed to have satisfied the attendance requirements for appearing for End Semester Examination of a particular course.

Each semester shall normally consist of 75 working days or 540 periods of each 50 minutes duration, for full-time mode of study or 250 periods for part-time mode of study.

6.1 Ideally every student is expected to attend all the periods and earn 100% attendance. However, a student shall secure not less than 80% attendance (Physical presence) course wise taking into account the number of periods required for that course as specified in the curriculum.

6.2 If a student secures attendance between 70% and 79% in any course in the current semester due to medical reasons (prolonged hospitalization / accident / specific illness) or participation in Institution/ University/ State/ National/ International level extra and co-curricular activities, with prior permission from the Head of the Department, shall be permitted to appear for the current semester examinations subject to the condition that the student shall submit the medical certificate / participation certificate attested by the Head of the Department. Such certificates shall be forwarded to the Controller of Examinations for verification and for the permission to attend the examinations.

6.3 A student shall normally be permitted to appear for End Semester Examination of a course if the student has satisfied the attendance requirements (vide Clause 6.1 –

6.2) and has registered for examination in those courses of that semester by paying the prescribed fee.

6.4 A Student who does not satisfy clause 6.1 and 6.2 and who secure less than 70% attendance in a course will not be permitted to write the End-Semester Examination of that course. The student has to register and repeat this course in the subsequent semester or when it is offered next (vide clause 5.6.4).

6.5 A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of grades / marks.

7. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a Faculty member of the Department who shall function as Faculty Advisor for those students. The Faculty Advisor shall advise and guide the students in registering of courses, reappearance of courses, monitor their attendance and progress and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress / performance of the students concerned.

8. COMMITTEES

8.1 Class Committee Meeting

(i) For all the courses taught, prescribed in the curriculum, Class Committee meeting shall be convened twice in a semester, comprising members of the faculty handling all the courses and two student representatives from the class.

(ii) One of the members of the faculty (not handling any courses to that class), nominated by the Head of the Department, shall coordinate the activities of this Committee. During these meetings, the student members shall meaningfully interact and express their opinions and suggestions of all the students to improve the effectiveness of the teaching-learning process. It is the responsibility of the student representatives to convey the proceedings of these meetings to all other students.

9. ASSESSMENT AND PASSING REQUIREMENTS

9.1 Assessment

The assessment will comprise Continuous Assessment and End Semester Examination, carrying marks as specified in the scheme (Clause 15). All assessments will be done on absolute marks basis. However, for the purpose of reporting the performance of a student, Letter Grades and Grade Points will be awarded as per Clause 9.4.

9.2 End Semester Examinations

End Semester Examinations will normally be conducted as per the time table circulated by the Office of the Controller of Examination. A student will be permitted to appear for the End Semester Examination of a semester only if he/she

completes the study of that semester satisfying the requirements given in Clause 5 and 6, and registers simultaneously for the examinations of the highest semester eligible and the courses, pertaining to that semester, that need reappearance.

9.3 Employability Enhancement Courses

Every candidate shall submit reports on Industrial training / Mini-project, Dissertation - Phase I and Dissertation - Phase II on dates announced by the Institute / Department through the faculty guide to the Head of the Department. If a candidate fails to submit the reports of any of these courses not later than the specified date, he/she is deemed to have failed in it. The reports /papers shall be orally presented by the student before a team of expert consisting of an internal examiner, usually the supervisor, and an external examiner, appointed by the Head of the Institution.

A candidate is permitted to register for the Dissertation -Phase II, only after passing the Dissertation - Phase I. A candidate who fails in Industrial training / Mini-project, Dissertation - Phase I or Dissertation - Phase II shall register for redoing the same at the beginning of a subsequent semester.

9.4 Letter Grade and Grade Point: The Letter Grade and the Grade Point are awarded based on percentage of total marks secured by a candidate in an individual course as detailed below:

Range of Percentage of Total Marks	Grade Point	Letter grade
91 to 100	**10**	O (Outstanding)
81 to 90	**9**	A + (Excellent)
71 to 80	**8**	A (Very Good)
61 to 70	**7**	B + (Good)
50 to 60	**6**	B (Above average)
0 to 49	**0**	RA (Reappearance)
Incomplete	**0**	I
Withdrawal	**0**	W
Absent	**0**	AB

'RA' - Reappearance registration is required for that particular course

'I' - Continuous evaluation is required for that particular course in the subsequent examinations.

After completion of the evaluation process, Semester Grade Point Average (SGPA) and

Cumulative Grade Point Average is calculated using the formula:

$$SGPA/CGPA = \frac{\sum_1^n C_i * g_i}{\sum_1^n C_i}$$

where

C_i : Credit allotted to the course.

g_i : Grade Point secured corresponding to the course.

n : number of courses successfully cleared during the particular semester in the case of SGPA and all the semesters, under consideration, in the case CGPA.

9.5 A student can apply for revaluation of his / her semester examination answer paper in a theory course, within 3 working days from the declaration of results, along with prescribed application to the Controller of Examinations through the Head of Department. Revaluation is not permitted for laboratory courses, industrial training and project works.

9.6 Passing a Course

A candidate who secures Grade Point 6 or more in any course of study will be declared to have passed that course, provided, if secures a minimum of 50% of the total mark in the End Semester Examination of that course. The Continuous Assessment (CA) marks obtained by the candidate in the first appearance shall be retained and considered valid for one subsequent attempt, except Clause 5.6.3 & 5.6.4. However, from the third attempt onwards the candidate shall be declared to have passed the course if he/she secures a minimum of 6 Grade Points in the course prescribed during the End Semester Examination alone.

9.7 Besides satisfying the above Clauses, a student shall present a technical paper, based on the courses of study, in a National or an International conference before the completion of semester IV.

10. REJOINING THE PROGRAMME

A candidate who has not completed the study of any semester as per Clause 6 or who is allowed to rejoin the programme after the period of discontinuance or who on his/her own request is permitted to repeat the study of any semester (break of study), may join the semester which he /she is eligible or permitted to join, only at the time of its normal commencement for a regular batch of candidates and after obtaining the approval from the Director of Technical Education and Anna University, Chennai. In such case, earlier Continuous Assessment in the repeated courses will be disregarded. No candidate will however be allowed to enroll in more than one semester at any point of time.

11. QUALIFYING FOR THE AWARD OF THE DEGREE

A candidate will be declared to have qualified for the award of the M.E. / M.Tech. Degree provided:

(i) he/she has successfully completed the course requirements and has passed all the prescribed courses of study of the respective programme listed in Clause 3 within the duration specified in Clause 2.

(ii) No disciplinary action is pending against the candidate.

12. CLASSIFICATION OF DEGREE

12.1 First Class with Distinction:

A student who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

M.E. / M.Tech., (Full Time)

- Should have passed the examination in all the courses of all the four semesters in the student's First Appearance within three years, which includes authorised break of study of one year. Withdrawal from examination (vide Clause 13) will not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50.
- Should NOT have been prevented from writing end Semester examination due to lack of attendance in any of the courses.

M.E. / M.Tech. (Part Time)

- Should have passed the examination in all the courses of all the six semesters in the student's First Appearance within four years, which includes authorised break of study of one year. Withdrawal from examination (vide Clause 13) will not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50.
- Should NOT have been prevented from writing end Semester examination due to lack of attendance in any of the courses.

12.2 First Class:

A student who satisfies the following conditions shall be declared to have passed the examination in First class:

M.E. / M.Tech. (Full Time)

- Should have passed the examination in all the courses of all four semesters within three years ,which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of not less than 6.50

M.E. / M.Tech. (Part Time)

- Should have passed the examination in all the courses of all six semesters within four years, which includes one year of authorized break of study (if availed) or prevention from writing the End Semester Examination due to lack of attendance (if applicable).
- Should have secured a CGPA of not less than 6.50

12.3 Second Class: All other students who qualify for the award of Degree shall be declared to have passed in Second Class.

13. WITHDRAWAL FROM EXAMINATION

13.1 A student may, for valid reasons, be granted permission by the Head of the Department to withdraw from appearing in the examination in any course(s) of only once during the entire duration of the degree programme.

13.2 Withdrawal application shall be valid only, if the student is eligible to write the examination as per Clause 6 and, if such request for withdrawal is made prior to the submission of marks of the Continuous Assessment of the course(s) with the recommendations from the Head of the Department.

13.3 Withdrawal shall not be construed as an opportunity for appearance in the examination for the eligibility of a candidate for First Class with Distinction or First Class.

14. AUTHORIZED BREAK OF STUDY FROM A PROGRAMME

14.1 A student is permitted to go on break of study for a maximum period of one year either as two breaks of one semester each or a single break of one year.

14.2 A student who would like to avail the break of study, on account of short term employment / Medical treatment / personal reasons) shall apply to the Head of the Institution through concerned Head of the Department, (application available with the Controller of Examinations), in any case, not later than the last date for registering for the semester.

14.3 The students permitted to rejoin the programme after break of study / prevention due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of rejoining. A committee constituted by the Head of the Institution shall prescribe additional / equivalent courses, if any, from the regulation in-force, so as to bridge the requirement between curriculum in-force and the old curriculum.

14.4 The total period for completion of the programme reckoned from the commencement of the first semester to which the student is admitted shall not exceed the maximum period specified in the Clause 2, irrespective of the period of break of study in order that he / she may be eligible, for the award of the degree (vide Clause 11 and 12).

14.5 In case of any valid reasons for the extension of break-of-study, such extended break-of-study may be granted by the Head of the Institution for a period not more than one year in addition to the earlier authorized break of study. Such extended break-of-study shall be counted for the purpose of classification of degree (vide clause 12).

14.6 If a student does not report back to the Institute, even after the extended Break of Study, the name of the student shall be deleted permanently from the college enrolment. Such candidates are not entitled to seek readmission under any circumstances.

15. SCHEME OF ASSESSMENT

I	**THEORY COURSES**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (20)	
	Periodical Test II (20)	
	Term Paper Report (5) & Presentation (5)	
	End Semester Examination	**50**
	Total Marks	**100**

II	**THEORY COURSES WITH LAB COMPONENT**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Periodical Test I (15)	
	Periodical Test II (15)	
	Final Lab Examination (10)	
	Viva-voce (10)	
	End Semester Examination	**50**
	(QP pattern as per (I))	
	Total Marks	**100**

III	**PRACTICAL COURSES**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Conduct of Experiment	
	i. Preparation (10)	
	ii. Experiment and Analysis of Results (20)	
	iii. Record (5)	
	Self-Learning Experiment (15)	
	Test - Cycle I (15)	
	Test - Cycle II (15)	
	Final Viva-voce (20)	
	Total Marks	**100**

IV	**DISSERTATION PHASE I**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Presentation I	
	Identification of topic and Justification (10)	
	Literature Survey (10)	
	Presentation II	
	Work plan & Approach (10)	
	Progress, Results and Discussion (20)	
	End Semester Examination	
	Presentation and Demonstration (20)	**50**
	Report (10)	
	Viva Voce (20)	
	Total Marks	**100**

V	**DISSERTATION PHASE II**	**Marks**
	Continuous Assessment	**50**
	Distribution of marks for Continuous Assessment:	
	Presentation I	
	Work plan & Approach (10)	
	Presentation II	
	Progress, Results and Discussion (20)	
	Journal Publication (20)	
	End Semester Examination	
	Presentation and Demonstration (20)	**50**
	Report (10)	
	Viva Voce (20)	
	Total Marks	**100**

VI	**MINI PROJECT**	**Marks**
	Continuous Assessment	**100**
	Distribution of marks for Continuous Assessment:	
	Review I (25)	
	Review II (25)	
	Report Presentation & Viva voce (50)	
	Total Marks	**100**

VII	**INDUSTRIAL TRAINING / INTERNSHIP (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Presentation and Viva-voce I	**25**
	Presentation and Viva-voce II	**25**
	Review at the Industry	**20**
	Case study / Report	**30**
	Total Marks	**100**

VIII	**VALUE ADDED COURSES / CERTIFICATE COURSES (CONTINUOUS ASSESSMENT ONLY)**	**Marks**
	Test	50
	Final Evaluation / Test	50
	Grades (Excellent / Good / Satisfactory)	

Optional Test: *A student becomes eligible to appear for the one optional test conducted after the Periodical Test II, only under the following circumstances, if absent for Test I or Test II or both, on account of (i) medical reasons (hospitalization / accident / specific illness) (ii) participation in the College / University / State / National / International level Sports events with prior permission from the Head of the Institution and (iii) on satisfying the conditions (i) or (ii), the student should have registered for the Optional Test, through the concerned faculty member who handles the course or through the respective Head of the Department, submitted to the Controller of Examinations. Such Optional Tests are not conducted for the courses under the categories III, IV, V, VI, VII and VIII listed above.*

16. DISCIPLINE

A student is expected to follow the rules and regulations laid down by the Institute and the affiliating University, as published from time to time. Any violations, if any, shall be treated as per the procedures stated thereof.

If a student indulges in malpractice in any of the End Semester / Continuous Assessments, he / she shall be liable for punitive action as prescribed by the Institution / University from time to time.

The Question Paper Pattern (Theory Examination) for PG course is given below:

Type	Questions	Marks
Part A	2 Mark Questions (10 x 2 Marks)	20
Part B	12 Mark Questions either or pattern (5 x 12 Marks)	60
Part C	Comprehensive Type- 20 Mark Question (1 x 20 Marks)	20
	Total	100

M.E. - POWER ELECTRONICS AND DRIVES

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I. The Graduate will be able to apply graduate fundamentals to solve complex engineering problems in the field of Power Electronics and Drives.

II. The Graduate will be able to use latest tools in the field of Power Electronics through simulative research and real time implementation.

III. The Graduate will be able to involve in professional interaction through participation in technical events, for lifelong learning.

PROGRAMME OUTCOMES (POs)

a. The Graduate will be able to apply the knowledge gained from undergraduate engineering to identify, formulate, and solve problems in power electronics and drives.

b. The Graduate will be able to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.

c. The Graduate will be able to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.

d. The Graduate will be able to identify appropriate modern tools for designing power electronic circuits.

e. The Graduate will be able to communicate well with fellow individuals and contribute effectively when working in multidisciplinary team through effective technical reports and presentations.

f. The Graduate will be able to acquire continuous learning skills, plan and conduct a systematic study on significant research with effective utilization of resources.

MAPPING OF PEOs AND POs

POs / PEOs	a	b	c	d	e	f
I	X	X				
II			X	X		
III					X	X

M.E: POWER ELECTRONICS AND DRIVES

Minimum credits to be earned: 69

FIRST SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18PE11	DESIGN AND ANALYSIS OF POWER CONVERTERS	I,II	a, c, d	3	0	0	3
18PE12	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	I	a, b	3	0	0	3
18PE13	ADVANCED POWER ELECTRONIC CONVERTERS	I,II	b,c,d	3	0	0	3
18PE14	POWER QUALITY PROBLEMS AND SOLUTIONS	I,II	a,b,c	3	0	0	3
	ELECTIVE I			3	0	0	3
	ELECTIVE II			3	0	0	3
18PE17	POWER ELECTRONICS SIMULATION LABORATORY	II,III	a,b,c,d	0	0	2	1
			Total	**18**	**0**	**2**	**19**
SECOND SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18PE21	SOLID STATE DRIVES	I,II,III	a,b,c,d,f	3	0	0	3
18PE22	MODELING AND CONTROL OF POWER ELECTRONIC SYSTEMS	I,II	a,b,c	3	0	0	3
18PE23	SYSTEM THEORY	I	a,b	3	0	0	3
18PE24	POWER CONVERTERS FOR RENEWABLE ENERGY SYSTEMS	I,II	a,b,c	3	0	0	3
	ELECTIVE III			3	0	0	3
	ELECTIVE IV			3	0	0	3
18PE27	ELECTRIC DRIVES LABORATORY	I,II	a,b,c,d	0	0	2	1
18PE28	MINIPROJECT	I,II,III	a,b,c,d,e	0	0	2	1
	AUDIT COURSE I			2	0	0	-
			Total	**20**	**0**	**4**	**20**
THIRD SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18PE31	ELECTRIC VEHICLES AND ENERGY STORAGE SYSTEMS	III	c,d	3	0	0	3
	ELECTIVE V			3	0	0	3
	ELECTIVE VI			3	0	0	3
	ELECTIVE VII			3	0	0	3
18PE35	DISSERTATION PHASE I	I,II,III	a,b,c,d,e	0	0	12	6
	AUDIT COURSE II			2	0	0	-
			Total	**14**	**0**	**12**	**18**
FOURTH SEMESTER							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18PE41	DISSERTATION PHASE II	I,II,III	a,b,c,d,e	**0**	**0**	**24**	**12**

LIST OF CORE ELECTIVES							
CODE NO.	**COURSE**	**OBJECTIVES & OUTCOMES**		**L**	**T**	**P**	**C**
		PEOS	**POS**				
18PE51	RESEARCH METHODOLOGY AND IPR	III	e, f	3	0	0	3
18PE52	FINITE ELEMENT ANALYSIS OF ELECTRICAL MACHINES	I,II	a,b,d	3	0	0	3
18PE53	SPECIAL MACHINES AND THEIR CONTROLLERS	II	c,d	3	0	0	3
18PE54	FACTS CONTROLLERS	I,II	b,c,d	3	0	0	3
18PE55	POWER ELECTRONICS APPLICATIONS TO POWER SYSTEMS	I,II	b,c,d	3	0	0	3
18PE56	HARMONICS FILTER DESIGN	I,II	b,c,d	3	0	0	3
18PE57	DESIGN OF CONTROLLERS IN POWER ELECTRONICS APPLICATIONS	I	a,b	3	0	0	3
18PE58	SMPS AND RESONANT CONVERTERS	I,II	a,b,d	3	0	0	3
18PE59	MODERN INDUSTRIAL DRIVES	I,II	a,b,c,d	3	0	0	3
18PE60	DSP BASED SYSTEM DESIGN	I,II	a,b,c,d	3	0	0	3
18PE61	SMART GRID TECHNOLOGIES	I,II	b,c,d	3	0	0	3
18PE62	ELECTRICAL ENERGY CONSERVATION AND MANAGEMENT	I,II	a,c	3	0	0	3
18PE63	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	I,II	b,c,d	3	0	0	3
18PE64	DISTRIBUTED GENERATION SYSTEMS	I,II	a,b,c	3	0	0	3
18PE65	SCADA SYSTEM AND APPLICATIONS	I,II,III	a,b,c,d, e	3	0	0	3
18PE66	HVDC SYSTEMS	I,II	a,b,c,d	3	0	0	3
18PE67	POWER ELECTRONICS APPLICATIONS TO LIGHTING SYSTEMS	I,II	a,b,c,d	3	0	0	3
18PE68	AUTOMOTIVE ELECTRONICS	I,III	a,e,f	3	0	0	3
18PE69	EMBEDDED CONTROL OF ELECTRIC DRIVES	II,III	a,c,d	3	0	0	3
18PE70	OPTIMIZATION TECHNIQUES	II	a,b,c	3	0	0	3

LIST OF OPEN ELECTIVES							
CODE NO.	**COURSE**	**OBJECTIVES & OUTCOMES**		**L**	**T**	**P**	**C**
		PEOS	**POS**				
18GE01	BUSINESS ANALYTICS	III	e,f	3	0	0	3
18GE02	INDUSTRIAL SAFETY	II	c,	3	0	0	3
18GE03	OPERATIONS RESEARCH	II,III	c,d,e,f	3	0	0	3
18GE04	COST MANAGEMENT OF ENGINEERING PROJECTS	I,II,III	a,b,c,d.e,f	3	0	0	3
18GE05	COMPOSITE MATERIALS	II	c,e	3	0	0	3
18GE06	WASTE TO ENERGY	I,II	a,c,d	3	0	0	3

LIST OF AUDIT COURSE I							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18XE11	RESEARCH PAPER WRITING	II,III	d,e,f	2	0	0	-
18XE12	TRADITIONAL TECHNICAL KNOWLEDGE	I,II	a,b,c,d	2	0	0	-
18XE13	VALUE EDUCATION	II,III	c,e,f	2	0	0	-

LIST OF AUDIT COURSE II							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
18XE21	STRESS MANAGEMENT	II,III	c,e,f	2	0	0	-
18XE22	DISASTER MANAGEMENT	III	e,f	2	0	0	-
18XE23	PEDAGOGY STUDIES	I,III	a,b,e,f	2	0	0	-

18PE11 DESIGN AND ANALYSIS OF POWER CONVERTERS 3 0 0 3

Course Objectives

- Interpret the switching and steady state characteristics of power switches, which will enable them to analyze the operation of controlled rectifiers.
- Apply the basic concepts of dc-dc converters and ac-ac converters to design the circuits in various applications.
- Design and analyze the operating modes and modulating techniques of voltage source, current source, Z source, resonant and multilevel inverters.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Determine the operational characteristics of controlled rectifiers.
2. Select and design dc-dc converter topologies for a broad range of power conversion applications.
3. Design ac-ac converters for variable frequency applications.
4. Analyze the performance parameters of inverters using different PWM techniques.
5. Integrate the operation of Z source and Resonant Inverters.

UNIT I **9 Hours**

AC-DC CONVERTER

Construction, operation, types, switching and steady state characteristics of Power Diodes, SCRs, IGBTs and MOSFETs- Design of snubber circuits - Commutation -Opto coupler and driver circuits- Design of heat sinks.-Single phase and Three phase half controlled and fully controlled converters -Dual converters - Effect of source impedance and overlap.

UNIT II **9 Hours**

DC-DC CONVERTERS

Principles of step-down and step-up converters - Analysis and design of Buck-Boost, CUK, LUO and SEPIC converters - Control methods of DC to DC converters- duty ratio control. Principles of volt-seconds balance in inductor for analysis of DC-DC converter topologies. Current ripple and voltage ripple calculations.

UNIT III **10 Hours**

AC - AC CONVERTERS

Single phase and three phase AC voltage controllers - PWM schemes - Single phase and three phase Cyclo converters - Single phase and three phase Matrix Converters - types Analysis of performance parameters: Output Voltage, input current, input and output power factors PWM schemes for matrix converter - Applications.

UNIT IV **8 Hours**

INVERTERS

Performance analysis of voltage source inverter- PWM Techniques-Analysis of single pulse, multiple pulse modulations and sinusoidal pulse modulation - various harmonic elimination techniques. Voltage source inverters, Current source inverters, series inverters and parallel Inverters - Multilevel Inverters- Types- FFT analysis.

UNIT V **9 Hours**

Z-S OURCE AND RESONANT INVERTERS

Principle of operation of Z- source inverter- Shoot thro zero state-Equivalent circuit-PWM methods for Z-Source inverters. Series and parllel resonant inverters - voltage control of resonant inverters - Class E resonant inverter - resonant DC- link inverters.

FOR FURTHER READING

SVPWM schemes for AC voltage controllers and Matrix converter-PWM inverters, Comparison of PWM, AVI and CSI, Multilevel matrix converters.

Total: 45 Hours

Reference(s)

1. M.H. Rashid, Power Electronics: Circuits, Devices and Application, Pearson, India; 2017.
2. Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics: Converters, Applications and Design, New Jersey, John Wiley and Sons, 2007.
3. Hua Bai, Chris Mi, Transients of Modern Power Electronics, John Wiley & Sons, 2011.
4. M.H. Rashid, Hand Book of Power Electronics: Circuits, Devices and Application, Pearson ,India , 2013.
5. Bimal K. Bose, "Modern Power Electronics and Motor Drive- Advances and Trends", 2nd Edition, Pearson Education, 2006.
6. Marty Brown, Power sources and supplies Newnes, Elsevier, Second edition, 2010.

18PE12 MODELING AND ANALYSIS OF ELECTRICAL MACHINES 3 0 0 3

Course Objectives

- Interpret steady state and dynamic state operation of electrical machines which will enhance them to analyze the characteristics.
- Develop the mathematical models for electrical machines which will enable them to model different rating of electrical machines.
- Recognize the theory of transformation of three phase variables to two phase Variables and apply for the various electrical machines.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.

Course Outcomes (COs)

1. Analyze the steady state and dynamic characteristics of DC machines and compute the equation for airgap mmf.
2. Produce stationary circuit variables in arbitrary reference frame.
3. Apply the reference frame theory to three phase symmetrical induction machine and compute the voltage and torque equation.
4. Apply the reference frame theory and generalized theory to three phase synchronous machine.
5. Explain the Synchronous machine dynamic equivalent circuit parameters and enhance the modeling of two phase asymmetrical induction machine and single phase induction machine.

UNIT I **9 Hours**

DC MACHINES

Elementary DC machine and analysis of steady state operation - Calculation of air gap mmf of a DC machine -Voltage and torque equations - dynamic characteristics of permanent magnet and shunt d.c. motors.

UNIT II **9 Hours**

REFERENCE FRAME THEORY

Historical background - Phase transformation and commutator transformation - Stationary circuit variables transformed to the arbitrary Reference frame treating R, L, C elements separately - variables observed from several frames of reference.

UNIT III **9 Hours**

INDUCTION MACHINE MODELING

Static and rotating Reference(s): frames, transformation relationships - Application of Reference frame theory to three phase symmetrical induction machine - Direct and quadrature axis model in arbitrarily rotating Reference frame - Voltage and torque equations.

UNIT IV **9 Hours**

SYNCHRONOUS MACHINE MODELING

Application of reference frame theory to three phase synchronous machine-dynamic model analysis-Park's equation - Voltage and torque equations - - Generalized theory of rotating electrical machine and Kron's primitive machine.

UNIT V **9 Hours**

ELECTRICAL MACHINE EQUIVALENT CIRCUIT PARAMETERS

Synchronous machine dynamic equivalent circuit parameters - Standard and derived machine time constants - Frequency response test, Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.

FOR FURTHER READING

Electromechanical Energy Conversion, Winding Inductance and voltage equation, Linearization of machine equations, Small displacement stability: Eigen values, Eigen values of typical induction machine and synchronous machine, Transfer function formulation.

Total: 45 Hours

Reference(s)

1. Harles Kingsley Jr., A.E. Fitzgerald and Stephen D.Umans, 'Electric Machinery', New York, McGraw- Hil Higher Education, 2010.
2. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, 'Analysis of Electric Machinery and Drive Systems', New Jersey, Wiley Student Edition, 2013.
3. R. Krishnan, 'Electric Motor & Drives: Modeling, Analysis and Control', New Delhi, Prentice Hall of India, 2001.
4. J. R. Hendershot, James R. Hendershot, Timothy John Eastham Miller, 'Design of Brushless Permanent-magnet Machines', Motor Design Books, 2010.
5. K.T Chau, ,'Electric Vehicle Machines and Drives: Design, Analysis and Application',John Wiley & Sons, 2015.

18PE13 ADVANCED POWER ELECTRONIC CONVERTERS 3 0 0 3

Course Objectives

- Interpret the different dc-dc voltage regulator and resonant converter to enable them to model and analyze the physical phenomena.
- Summarize the fundamental principles of multi-pulse and multi-level converters for power electronics applications.
- Identify and model the suitable FACTS controller for reactive power compensation.

Programme Outcomes (POs)

b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Apply the suitable dc-dc voltage regulator for the specific application.
2. Classify and analyze the types of resonant converters.
3. Select appropriate phase shifting transformer for a multi-pulse converter.
4. Analyze the various multi-level converter configurations with the necessary PWM schemes.
5. Compare various FACTS devices for reactive power compensation.

UNIT I **11 Hours**

SWITCHING VOLTAGE REGULATORS

Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck - Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations: Fly back converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, Cuk converter, Sepic Converter; Design criteria for SMPS; Multi-output switch mode regulator.

UNIT II **8 Hours**

RESONANT CONVERTERS

Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero - voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies.

UNIT III **7 Hours**

MULTIPULSE CONVERTERS

Concept of multi-pulse, Multi-pulse Diode and SCR Rectifiers, Configurations for m-pulse converters, (m=12,18,24 ....) series-type and separate-type diode rectifiers, Six-pulse and 12-pulse SCR rectifier, Different phase shifting transformer configurations for multi-pulse converters, Applications

UNIT IV **9 Hours**

MULTI-LEVEL CONVERTERS

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Neutral point Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations, applications, Carrier based PWM schemes for multi-level converters: Phase shifted multi-carrier modulation, Level shifted multi-carrier modulation, over modulation of cascaded H-bridges, Control of dc bus voltages of the H-bridges.

UNIT V **10 Hours**

FACTS DEVICES

Importance of reactive power compensation, Flow of power in AC system and conventional control mechanisms, possible benefits from FACTS, Thyristor-Controlled Reactor (TCR), Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), Thyristor Switched capacitor and Reactor, Thyristor - Switched capacitor- Thyristor Controlled Reactor (TSCTCR), STATCOM configuration and operating principle, Static characteristics and Comparison of SVC and STATCOM, Principle of series compensation, Introduction to Static Synchronous Series Compensator, Advantages and limitation of SSSC, Introduction to UPFC and operating principle.

FOR FURTHER READING

Practical issues in power electronic converters: Selection criteria for diodes, MOSFETs and IGBTs; gate drive circuits, Thermal management, EMI and layout issues.

Total: 45 Hours

Reference(s)

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics-Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2011.
2. Euzeli cipriano, Edison roberto cabral da silva, "Advanced Power Electronic converters", IEEE Press Wiley, 2015.
3. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 28 nov 2017.
4. Bin Wu, "High Power Converters and AC Drives", John Willey & sons, Inc., 2006.
5. Derek A. Paice "Power Electronic Converter Harmonics- Multipulse Methods for Clean Power", IEEE Press, 1996.
6. Muhammad H. Rashid, "Power Electronics Handbook", Elsevier, 4th ed., 2 November 2017.

18PE14 POWER QUALITY PROBLEMS AND SOLUTIONS 3 0 0 3

Course Objectives

- Obtain the characteristic of different types of power quality issues.
- Determine the causes and effects of power quality problems in electrical systems.
- Interpret the various power quality problems, their mitigation and measuring techniques.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.

Course Outcomes (COs)

1. Explain the various power quality issues and indicate their effect in power quality standards.
2. Classify the power quality terminology and identify the different voltage regulating device to mitigate the voltage sag.
3. Analyze the single phase and three phase balanced and unbalanced system for linear and non linear loads.
4. Explain the sources and Effects of harmonic distortion and indicate the mitigation control technique.
5. Exemplify the wiring and grounding and outline the energy storage device for different applications.

UNIT I **9 Hours**

INTRODUCTION

IEC and IEEE definitions -Power quality issues: Short duration voltage variations, Long duration voltage variations, Transients, Waveform distortion, Voltage imbalance, Voltage fluctuation, And Power frequency variations - power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage - Power quality standards

UNIT II **9 Hours**

LONG INTERRUPTIONS AND VOLTAGE SAGS

Definition - Terminology: Failure, Outage, Interruption - Principles of regulating the voltage - Voltage regulating devices, Applications: Utility side, End-User side -Voltage Sag-Introduction - Definition - Characterization: Magnitude, Duration - Causes of Voltage Sag - Load influence on voltage sags-mitigation methods.

UNIT III **9 Hours**

ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM

Single phase linear and non-linear loads - single phase sinusoidal, non-sinusoidal source - supplying linear and nonlinear load - single phase Balance system - single phase unbalanced system - three phase unbalanced and distorted source supplying non-linear loads - concept of power factor - three phase three wire - three phase four wire system.

UNIT IV **9 Hours**

HARMONICS

Definitions and standards- sources- impacts- Voltage Vs Current distortion - Harmonics Vs Transients - Sources and effects of harmonic distortion - Principles of controlling harmonics - limitations - Mitigation and control techniques.

UNIT V **9 Hours**

POWER QUALITY SOLUTIONS

Wiring & Grounding, Uninterruptable power supply, Ferry-resonant transformers, Energy Storage J

FOR FURTHER READING

Power Quality issues and mitigation techniques - Sources and effects of Inter order harmonics -Fourier series analysis - Design of filter for inter order harmonics.

Total: 45 Hours

Reference(s)

1. Angelo Baggini, "Handbook of Power Quality", John Wiley & Sons, 2008.
2. J B. Dixit, Amit Yadav, "Electrical Power Quality", Laxmi Publications, Ltd., 1 Jun 2016.
3. Dugan, Mark F. Mc Granaghan and H. Wayne Beaty, "Electrical Power Systems QualityÃƒ??Ãƒ?Ã‚¢??, New York, McGraw-Hill, 2012.
4. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", John Wiley & Sons, 2015.
5. Dr.Hedaya Alasooly, Monitoring of Power System Quality, Lulu.com, 2012.

18PE17 POWER ELECTRONICS SIMULATION LABORATORY 0 0 2 1

Course Objectives

- Design and verification of various power converter topologies for power quality improvement.
- Analysis of driver circuit for LED Lighting.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Analyze the power quality issues using power quality analyzer.
2. Design the buck AC boost converter and driver circuits for LED lighting.
3. Analyze the controlled converter with LC filter and Matrix converter.
4. Analyze the star and delta connected AC voltage controller using SCR and TRIAC .
5. Analyze three phase inverter with generation of PWM Pulses using Digital Processor.

1 **3 Hours**

EXPERIMENT 1

Design and verify Multilevel inverter topology for Power quality improvement.

2 **3 Hours**

EXPERIMENT 2

Study the single phase Matrix converter for variable frequency applications.

3 **3 Hours**

EXPERIMENT 3

Design and Experimental verification of driver circuits for LED Lighting.

4 **3 Hours**

EXPERIMENT 4

Experimental study of three phase semi and full controlled converter with LC filter in DC Circuit.

5 **3 Hours**

EXPERIMENT 5

Design and verification of DC-DC Buck/Boost converter.

6 **3 Hours**

EXPERIMENT 6

Experimental study of single phase AC voltage Regulator using SCR and TRIAC.

7 **3 Hours**

EXPERIMENT 7

Experimental study of three phase inverter with different PWM schemes.

8 **3 Hours**

EXPERIMENT 8

Experimental verification of AC-AC Voltage controller for star and delta connected loads.

9 **3 Hours**

EXPERIMENT 9

Study the Power quality issues using Power Analyzer.

10 **3 Hours**

EXPERIMENT 10

Generation of PWM Pulses using Digital Processor.

Total: 30 Hours

18PE21 SOLID STATE DRIVES 3 0 0 3

Course Objectives

- Interpret the converter and chopper control of dc drives.
- Illustrate the concept of closed loop control of AC and DC drives.
- Function about digital control of drives.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.
f. Ability to acquire continuous learning skills, plan and conduct a systematic study on significant research with effective utilization of resources.

Course Outcomes (COs)

1. Analyze the AC-DC and DC-DC converters fed dc motor drives for considering various input and output conditions.
2. Understand the different methods of solid state speed control of induction motor drives and analyze different performance parameters of induction motor drives.
3. Analyze different vector control schemes for induction motor.
4. Attribute the self-control mechanism for synchronous motor drive and analyze the different control techniques.
5. Design of closed loop control system for drives and understand the digital control system for drives.

UNIT I **9 Hours**

CONVERTER AND CHOPPER CONTROL OF DC DRIVES

Analysis of series and separately excited dc motor with single phase and three phase converters - modes of operation, power factor improvement - analysis of series and separately excited dc motor fed from choppers - chopper based implementation of braking scheme.

UNIT II **10 Hours**

CONTROL OF INDUCTION MOTOR AND WOUND ROTOR INDUCTION MOTOR DRIVE

Steady state analysis - speed control techniques of induction motor - variable frequency operation of three phase induction motors - constant flux operation - dynamic and regenerative braking of CSI and VSI fed drives - Torque slip characteristics of wound rotor induction motor - rotor resistance control - static Kramer drive - sub synchronous and super synchronous operation.

UNIT III **8 Hours**

CONTROL AND ESTIMATION OF INDUCTION MOTOR DRIVE

Field oriented control of induction machines - DC drive analogy - Direct and Indirect methods - Flux vector estimation - Direct Torque control strategy of induction machines - Torque expression with stator and rotor flux.

UNIT IV **9 Hours**

SYNCHRONOUS MOTOR DRIVES

Synchronous motor types, open loop VSI fed drive and its characteristics - self-control model -torque angle and margin angle control - power factor control - brushless excitation systems - closed loop control of load commutated inverter fed synchronous motor drive.

UNIT V **9 Hours**

DIGITAL CONTROL OF DRIVE

P, PI and PID controller characteristics - simulation of converter and chopper fed dc drive - Phase locked loop and microcomputer control of dc drives - selection of drives and drive considerations for textile mills, lifts and cranes and hoist drives

FOR FURTHER READING

Transfer function of dc motor, closed loop control of induction motor drives, steady state and torque expression of synchronous motors, current and speed loops - application areas and functions of microprocessors in drive technology

Total: 45 Hours

Reference(s)

1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2010.
2. Vedam Subramanyam, Electric Drives: Concepts & Appl, Tata McGraw- Hill Education, 2017.
3. G.K. Dubey, Power Semiconductor Controlled Drives, New Jersy, Prentice Hall International, 1989.
4. J.M.D. Murphy and Turnbull, Thyristor Control of AC Motors, Pergamon Press, Oxford, 1990.
5. P.C. Sen, Thyristor DC Drives, Krieger Publishing Company, 1991.
6. Gopal K. Dubey, Fundamentals of Electrical Drives, New Delhi, Narosa Publishing House, 2010.

18PE22 MODELING AND CONTROL OF POWER ELECTRONIC SYSTEMS 3 0 0 3

Course Objectives

- Recognize the equilibrium, dynamics and control of Power Electronic Circuits.
- Analyse the various types of power electronic converters.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.

Course Outcomes (COs)

1. Analyze the equivalent circuit of converter circuit and its losses and efficiency.
2. Examine the different modeling approach of power converters and analyze the dynamics of the converter.
3. Analyze the stability of power converters with the help of transfer function.
4. Analyze the stability improvement by implementing the closed loop control systems.
5. Explain the small signal modeling of power converters.

UNIT I **9 Hours**

CONVERTERS IN EQUILIBRIUM

Principles of steady state converter analysis - Steady-state equivalent circuit modeling, Losses, and Efficiency - Switch realization - The discontinuous conduction mode.

UNIT II **9 Hours**

CONVERTER DYNAMICS AND CONTROL

AC equivalent circuit modeling - The basic AC modelling approach, State-Space averaging, circuit averaging and averaged switch modeling, the canonical circuit model, Modeling the pulse-width modulator.

UNIT III **9 Hours**

CONVERTER TRANSFER FUNCTIONS

Review of Bode Plots - Pole zero response, frequency inversion, quadratic pole response: resonance, the low-Q approximation, approximate roots of an arbitrary-degree polynomial. Analysis of converter transfer function, Graphical construction of impedance and transfer functions - series impedance, series resonant, parallel impedance, parallel resonant, voltage divider transfer functions. Graphical construction of converter transfer functions.

UNIT IV **9 Hours**

CONTROLLER DESIGN

Effect of negative feedback on the network transfer functions - construction of important quantities 1/(1+T) and T/(1+T) and the closed-loop transfer functions - stability regulator design - measurement of loop gains.

UNIT V **9 Hours**

AC AND DC EQUIVALENT CIRCUIT MODELING OF THE DISCONTINUOUS CONDUCTION MODE

DCM averaged switch model - Small-Signal AC modeling of the DCM switch network - High-Frequency dynamics of converters in DCM.

FOR FURTHER READING

Power and Harmonics in non sinusoidal systems, Harmonic currents in three phase systems, Ac line current harmonic standards, Line commutated rectifiers.

Total: 45 Hours

Reference(s)

1. Ericson, "Fundamentals of Power Electronics", Springer Science & Business Media, 2013.
2. Seddik BACHA, "Power Electronic Converters Modeling and Control", Springer Science & Business Media, 2013.
3. S.K..Bhattacharya , "Fundamental of power electronics", UBS Publishers, Second edition 2009.
4. Ned Mohan , "Power electronics", WILEY edition, 2009.G.K.. Dubey, "Fundamental of electric drives", Second edition, Alpha Science.
5. Seddik Bacha, "Power Electronic Converters Modeling and Control", Springer Science & Business Media, 2013.

18PE23 SYSTEM THEORY 3 0 0 3

Course Objectives

- Interpret the modeling of systems in state variable form and solving linear and non-linear state equations.
- Apply the concept of controllability and observability and stability analysis of systems.
- Develop the modal concepts and design of state and output feedback controllers and estimators.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.

Course Outcomes (COs)

1. Analyze the State equation for Dynamic Systems.
2. Examine the Nonlinear and Linear Time Varying State equations and evaluate matrix exponential using Eigen values and Eigenvectors.
3. Analyze Controllability and Observability for Continuous Time Invariant systems and design State Feedback Controllers and Observers.
4. Apply suitable method for Linearization of nonlinear systems and perform describing function analysis of nonlinear systems.
5. Analyze Stability for Linear Continuous time invariant systems by Lyapunov method, Krasovskii and Variable Gradiant Method.

UNIT I **9 Hours**

STATE VARIABLE REPRESENTATION

Introduction -Concept of State-State equation for Dynamic Systems - Time invariance and linearity - Non uniqueness of state model-State Diagrams- Physical System and State Assignment.

UNIT II **9 Hours**

SOLUTION OF STATE EQUATIONS

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential-System modes- Role of Eigen values and Eigenvectors.

UNIT III **9 Hours**

CONTROLLABILITY AND OBSERVABILITY

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT IV **9 Hours**

STABILTY

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable- Gradiant Method.

UNIT V **9 Hours**

MODAL CONTROL

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

FOR FURTHER READING

Fuzzy Logic controller, Concepts of Artificial intelligence, Soft computing techniques

Total: 45 Hours

Reference(s)

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.
2. K. Ogatta, "Modern Control Engineering", PHI, 2010.
3. John S. Bay, “Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.
4. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.
5. John J. DAzzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003.
6. Z. Bubnicki, " Modern Control Theory ", Springer, 2005.

18PE24 POWER CONVERTERS FOR RENEWABLE ENERGY SYSTEMS 3 0 0 3

Course Objectives

- Summarize the necessity of renewable energy resources and government policies.
- Explain the principle, types and configurations of solar PV conversion system and wind energy conversion system.
- Design the distributed power system using hybrid power generators.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.

Course Outcomes (COs)

1. Illustrate the role of renewable energy resources with its rules and regulations.
2. Analyze the controllers for power converters in solar PV conversion system.
3. Examine the basic principle and different configurations of wind energy conversion system.
4. Analyze the converters for grid connected solar PV and wind energy conversion system.
5. Apply the concepts of solar PV and wind energy conversion system to develop the distributed power systems.

UNIT I **9 Hours**

INTRODUCTION

Trends in energy consumption - World energy scenario - Energy source and their availability - Conventional and renewable source - Need to develop new energy technologies- Wind and solar potential in India and World- MNRE Rules and Regulations-TEDA.

UNIT II **9 Hours**

SOLAR PHOTOVOLTAIC ENERGY CONVERSION SYSTEM

Solar radiation and measurements - Solar PV Panels and its classifications - characteristics- PV arrays - Influence of insolation, temperature-Importance of bypass and blocking diodes- Parasitic capacitance and shadowing effect-Maximum power point tracking Algorithms - Power conditioning schemes -DC-DC converters - Inverters - Design of Solar PV systems.

UNIT III **9 Hours**

WIND ENERGY CONVERSION SYSTEMS

Basic principle of Wind Energy Conversion System - Nature of Wind - Wind farm and its accessories - Components of Wind Energy Conversion System - Generators for WECS Classifications of WECS - Self excited induction generator - synchronous generator - Modern wind generators-Power conditioning schemes.

UNIT IV **9 Hours**

GRID CONNECTED WECS AND SPVECS

Grid connected systems - Grid related problems - Grid Codes -Grid Integrated solar PV systems - Grid integrated WECS -Matrix converters -Line commutated inverters - Multilevel inverters- Power converters for Grid connected WECS - Concept of mini/micro grids and smart grids.

UNIT V **9 Hours**

DISTRIBUTED POWER SYSTEMS

Need for Distributed Systems - Types of Distributed systems - Hybrid Systems - Selection of power conversion ratio - Optimization of System components - Storage systems - types-Reliability evaluation.

FOR FURTHER READING

Intelligent controllers for distributed systems, Harmonic mitigation techniques, Design of active and passive filters.

Total: 45 Hours

Reference(s)

1. Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 2, illustrated, revised 2010.
2. Ahmed F. Zobaa, Ramesh C. Bansal, "Handbook of Renewable Energy Technology", World Scientific,2011.
3. Rakosh Das Begamudre, "Energy Conversion Systems", New Age International, 2007.
4. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems", PHI Learning Private Ltd, 2015.
5. Roger A. Messenger, Jerry Ventre, "Photovoltaic System Engineering", CRC Press, 2010.
6. Toshihisa Funabashi, "Integration of Distributed Energy Resources in Power Systems: Implementation, Operation and Control", Academic Press, 2016.

18PE27 ELECTRIC DRIVES LABORATORY 0 0 2 1

Course Objectives

- Analyze the various dc-dc converter and multilevel inverter fed DC and AC drives.
- Illustrate the working of LED driver circuit, and electric vehicle systems.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Analyze the converter fed DC motor and working of braking methods.
2. Examine the characteristics of PMSM, SRM and synchronous motor drive.
3. Analyze the characteristics of variable frequency drive and multi-level inverter based induction motor drive.
4. Design a driver circuit for LED lights.
5. Illustrate the electrical vehicle/hybrid electric vehicle systems.

1 **3 Hours**

EXPERIMENT 1

DC-DC converter fed DC motor drive.

2 **3 Hours**

EXPERIMENT 2

Permanent Magnet Synchronous Motor drive.

3 **3 Hours**

EXPERIMENT 3

Switched Reluctance motor drive.

4 **3 Hours**

EXPERIMENT 4

Variable frequency drive.

5 **3 Hours**

EXPERIMENT 5

Self-controlled operation of synchronous motor drive.

6 **3 Hours**

EXPERIMENT 6

Multi-Level Inverter based induction motor drive

7 **3 Hours**

EXPERIMENT 7

Study of industrial drive automation.

8 **3 Hours**

EXPERIMENT 8

Design and experimental verification of driver circuits for LED lights.

9 **3 Hours**

EXPERIMENT 9

Braking methods for DC and AC motors.

10 **3 Hours**

EXPERIMENT 10

Study of electrical vehicle / hybrid electric vehicle systems.

Total: 30 Hours

18PE31 ELECTRIC VEHICLES AND ENERGY STORAGE SYSTEMS 3 0 0 3

Course Objectives

- Develop the advanced energy storage systems used for electric vehicles.
- Implement the configuration and control of various electric drives used in electric vehicles.
- Recognize the various control strategies used for communication and cooling systems in electric vehicles.

Programme Outcomes (POs)

c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Analyze the types of energy storage devices and the concept involved for energy storage.
2. Explain the types of electric vehicles and show the mathematical model to describe vehicle performance.
3. Analyze various Configuration and control of electrical drives.
4. Analyze the various converters based electric drives
5. Infer the function of IC engine components and their control.

UNIT I **9 Hours**

ENERGY STORAGE

Introduction to Energy Storage Requirements- Battery Fundamentals - Parameters and Modelling, Types - Battery based energy storage and its analysis: Types, Parameters and Modelling - Fuel Cell based energy storage and its analysis - Super Capacitor based energy storage and its analysis - Fly wheel based energy storage and its analysis - Hybridization of different energy storage devices and applications

UNIT II **9 Hours**

INTRODUCTION TO ELECTRIC VEHICLES

History of electric vehicles - Social and environmental importance of electric vehicles - Basics of vehicle propulsion and mechanics - traction, electric vehicle architecture - Power train components - Mathematical models to describe vehicle performance.

UNIT III **9 Hours**

ELECTRIC PROPULSION

Introduction to electric components used in electric vehicles - Configuration and control of DC Motor drives - Configuration and control of Induction Motor drives - Configuration and control of Permanent Magnet Motor drives- control of Switched Reluctance Motor drives - Drive system efficiency.

UNIT IV **9 Hours**

POWER CONVERTERS FOR ELECTRIC DRIVES

Introduction to power electronics Switches, DC/DC Converters, Cell balancing converters, Buck Converter, Boost Converter, Buck-Boost Converter, Fourth Order DC/DC Converters, Power train boost Converters, Cell Balancing Converters.

UNIT V **9 Hours**

IC ENGINES COMPONENTS, CONTROL

Internal combustion engines- Economy and Emission control, Power train Components, Cooling System, Vehicle Control strategy, Vehicle communication.

FOR FURTHER READING

Impact of modern drive-trains on energy supplies, Basics of vehicle performance, Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies.

Total: 45 Hours

Reference(s)

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, SebastianE.Gay, Ali Emadi, "Modern Electric and Fuel Cell Vehicles, Theory and Design", CRCPress, 2009.
3. James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley, 2012
4. Ali Emadi."Advanced Electric Drive Vehicles", CRC Press, 2014.
5. Jack Erjavec, "Hybrid, Electric, and Fuel-Cell Vehicles", Cengage Learning, 2012.

18PE51 RESEARCH METHODOLOGY AND IPR 3 0 0 3

Course Objectives

- To understand some basic concepts of engineering research and its methodologies.
- To identify various sources of information for literature review and data collection.
- To families the various procedures to formulate appropriate research problem and design of experiments.

Programme Outcomes (POs)

e. Ability to communicate well with fellow individuals and contribute effectively when working in multidisciplinary team through effective technical reports and presentations.
f. Ability to acquire continuous learning skills, plan and conduct a systematic study on significant research with effective utilization of resources.

Course Outcomes (COs)

1. Understand research problem formulation.
2. Analyze research related information and follow research ethics.
3. Understand that todays world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT I **9 Hours**

INTRODUCTION

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II **9 Hours**

PLAGIARISM AND ETHICS

Effective literature studies approaches, analysis Plagiarism, Research ethics.

UNIT III **9 Hours**

RESEARCH PUBLICATION AND PROPOSAL

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

UNIT IV **9 Hours**

INTELLUCTUAL PROPERTY RIGHTS

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

UNIT V **9 Hours**

PATENT RIGHTS AND LICENSING

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

FOR FURTHER READING

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

Total: 45 Hours

Reference(s)

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students",Juta & Company Limited,1996.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", Juta & Company Limited, 1996.
3. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", SAGE Publications Ltd, 2nd Edition, 2005.
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

18PE52 FINITE ELEMENT ANALYSIS OF ELECTRICAL MACHINES 3 0 0 3

Course Objectives

- Recognize the basic principles of finite element analysis and different methods used for analyzing the electrical machines by applying the procedural knowledge gained from the subject.
- Analyze the synchronous machines, induction machines and switched reluctance motors using finite element analysis.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Illustrate the basic principles and the equations used in finite element analysis.
2. Apply the various finite element methods for solving the problems in electrical machines.
3. Analyze the performance of synchronous machine and compute the steady state and transient reactance.
4. Analyze the performance of induction machine in time and frequency domain data and compute the global system equations.
5. Explain the operating principle of switched reluctance motor and analyse the field parameters.

UNIT I **9 Hours**

INTRODUCTION

Vector Analysis-Differential Operators-Different Coordinate Systems-Electromagnetic fields-Poynting's Vector-Maxwell Stress Tensor-Maxwell's Equations-Laplace, Poisson, Helmholtz Equations

UNIT II **10 Hours**

FINITE ELEMENT METHODS

Introduction- Galerkin's Method- Non linear problems-Permanent Magnets- Eddy current Analysis-Computation of losses, resistance and inductance-Calculation of force and torque

UNIT III **10 Hours**

ANALYSIS OF SYNCHRONOUS MACHINES

Basic configuration of a synchronous machine-Modeling Considerations-Excitation Calculation-Computation of steady state reactances-Direct axis transient and subtransient reactance-Frequency Response curves-Time constants-Poynting Vector method

UNIT IV **10 Hours**

ANALYSIS OF INDUCTION MACHINES

Obtaining steady state parameters-Obtaining Reactance from the frequency response- Frequency domain data with time domain solution-Time domain modeling: Galerkin Formulation, Time discretization, Linearization, Global system of equations

UNIT V **6 Hours**

ANALYSIS OF SWITCHED RELUCTANCE MOTORS

Introduction - Operating principle-Field Problem Statement-Computation on solved structure

FOR FURTHER READING

Air-gap elements for electrical machines-Axiperiodic Solutions-Cylindrical magnetic devices

Total: 45 Hours

Reference(s)

1. S.J.Salon, Finite Element Analysis of Electrical Machines, Springer Science + Business Media New Delhi, 2011.
2. Nicola Bianchi, "Electrical Machine Analysis using Finite Elements", CRC Taylor & Francis, LLC, 2005.
3. Jian-Ming Jin, "The Finite Element Method in Electromagnetics", John Wiley & Sons,Inc. 2014.
4. Joao Pedro A.Bastos, Nelson Sadowski, "Electromagnetic Modeling by Finite Element Methods", Marcel Dekker Inc, 2003.

18PE53 SPECIAL MACHINES AND THEIR CONTROLLERS 3 0 0 3

Course Objectives

- Interpret various motors used different industrial applications and analyze their characteristics and applications.
- Execute various methods of controlling special motors and their features.

Programme Outcomes (POs)

c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Analyze the characteristics of a synchronous reluctance motor.
2. Analyze the control technique and operating principle of switched reluctance motor.
3. Analyze the characteristics of permanent magnet synchronous motors
4. Integrate the functions for permanent magnet brushless dc motors.
5. Implement modern control techniques in stepper motor.

UNIT I **9 Hours**

SYNCHRONOUS RELUCTANCE MOTORS

Constructional features: axial and radial air gap Motors - Operating principle - Reluctance torque- Phasor diagram - Motor characteristics.

UNIT II **8 Hours**

SWITCHED RELUCTANCE MOTORS

Constructional features - Principle of operation - Torque equation - Power controllers -Characteristics and control - Microprocessor based controller

UNIT III **11 Hours**

PERMANENT MAGNET SYNCHRONOUS MOTORS

Principle of operation-EMF,Power input and Torque expressions-phasor diagram-power controllers-Torque-speed characteristics self control-vector control-current control schemes

UNIT IV **9 Hours**

PERMANENT MAGNET BRUSHLESS DC MOTORS

Commutation in DC motors - Difference between mechanical and electronic commutators - Hall sensors - Optical sensors - Multiphase Brushless motor - Square wave permanent magnet brushless motor drives - Torque and EMF equation - Torque-speed characteristics - Controllers - Microprocessor based controller- Traction motors.

UNIT V **8 Hours**

STEPPING MOTORS

Constructional features - Principle of operation - Modes of excitation - torque production in Variable Reluctance (VR) stepping motor - Dynamic characteristics - Drive systems and circuit for open loop control- Closed loop control of stepping motor.

FOR FURTHER READING

Real time applications and case studies of stepper motor, brushless dc motor, permanent magnet synchronous motor, switched reluctance motor and synchronous reluctance motor.

Total: 45 Hours

Reference(s)

1. T.J.E. Miller and J R Hendershot Jr., Design of Brushless Permanent Magnet Motors, USA, Oxford University Press, 30 march 2010.
2. T.J.E. Miller, Reluctance Motor and their Controls, USA, Oxford University Press,2001
3. T. Kenjo, Stepping Motors and their Microprocessor Control, England, Clarendon Oxford Press, 1995.
4. T. Kenjo, Power Electronics for the Microprocessor, England, Clarendon Oxford Press, 1994.
5. B.K. Bose, Modern Power Electronics & AC drives, New Delhi, Prentice Hall of India, 2001.
6. B.K. Bose, Modern Power Electronics & AC drives, New Delhi, Prentice Hall of India, 2001.

18PE54 FACTS CONTROLLERS 3 0 0 3

Course Objectives

- Recognize the need for FACTS
- Acquire shunt and series compensation techniques
- Attain about controlled voltage and face angle regulator
- Acquire the concept of unified power flow controller

Programme Outcomes (POs)

b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Realize the operation of the compensator and its applications in power system.
2. Infer the various emerging Facts controllers.
3. Analyze the performance of various series compensation Methods.
4. Design of Static voltage phase Angle Regulator using thyristor.
5. Interpret the role of FACTS Controllers.

UNIT I **8 Hours**

INTRODUCTION TO FACTS

Electrical Transmission Network - Necessity - Power Flow in AC System - relative importance of controllable parameter - opportunities for FACTS - possible benefits for FACTS.

UNIT II **10 Hours**

STATIC VAR COMPENSATION

Need for compensation - introduction to shunt & series compensation - objectives of shunt & series compensation - configuration & operating characteristics - Thyristor Controlled Reactor (TCR) - Thyristor Switched Capacitor (TSC) -Comparison of TCR & TSC.

UNIT III **9 Hours**

SERIES COMPENSATION

Variable Impedance Type Series Compensation: Thyristor Switched Series Capacitor (TSSC)- Thyristor Controlled Series Capacitor (TCSC) - Basic operating control schemes for TSSC & TCSC.

UNIT IV **8 Hours**

STATIC VOLTAGE PHASE ANGLE REGULATOR

Objectives of voltage & phase angle regulators - approaches to Thyristor - Controlled Voltage & Phase Angle Regulator.

UNIT V **10 Hours**

EMERGING FACTS CONTROLLER

STATCOM - Introduction to Unified Power Flow Controller (UPFC) & Interline Power Flow Controller (IPFC) - basic operating principles UPFC - introduction to sub synchronous resonance.

FOR FURTHER READING

DVR- Available Transfer Capacity

Total: 45 Hours

Reference(s)

1. Xiao-Ping Zhang, Christian Rehtanz and, Bikash Pal, "Flexible AC Transmission Systems: Modelling and Control", published on 2012.
2. K.R. Padiyar, "Facts Controllers In Power Transmission and Distribution", new age international publishers ltd.-new delhi, 2007.
3. R. Mohan Mathur and Rajiv K.Varma, " Thyristor Based FACTS Controller for Electrical Transmission Systems", Wiley Interscience Publications, 2002.
4. V Sridhar, Holalu Seenappa Sheshadri, M C Padma, "Emerging Research in Electronics, Computer Science and Technology", Springer Science & Business Media, 2013.
5. T. J. E. Miller, "Reactive Power Control in Electric System", John Wiley & Sons, 2012.

18PE55 POWER ELECTRONICS APPLICATIONS TO POWER SYSTEMS 3 0 0 3

Course Objectives

- Impart knowledge on different types of converter configurations.
- Study the different characterizes applications of converters in HVDC systems.
- Design and analyse the different types of reactive power compensation schemes for converters.

Programme Outcomes (POs)

b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Illustrate t he characteristics of different types of HVDC converter Configurations.
2. Determine the different control functions required for HVDC link.
3. Interpret load balancing in AC and DC system.
4. Analyze the reactive power compensation methods.
5. Analyze Compensation engineering problems and identify suitable shunt or Series Compensation devices for given applications.

UNIT I **9 Hours**

HVDC SYSTEM

HVDC configurations, components of HVDC system: Converter, transformer, smoothing reactor, harmonic filter. Reactive power support, operation of 6-pulse controlled rectifier in inverting mode of operation. Operation of 12- pulse converter. Control of HVDC system, Rectifier and inverter characteristics, mode stabilization, current control, voltage dependent current order limit, combined rectifier-inverter characteristics, valve blocking and by - passing, limitations HVDC system using line commutated converters, modern HVDC system - HVDC light.

UNIT II **9 Hours**

ANALYSIS OF CONVERTERS AND THEIR CONTROL

Pulse number-analysis of Graetz circuit-characteristics of twelve pulse converter - Dc link control - converter Principal of DC Link Control - Converters Control Characteristics - Firing angle control - Current and extinction angle control - Effect of source inductance on the system; Starting and stopping of DC link; Power Control.

UNIT III **9 Hours**

LOAD BALANCING

Limitations of load balancing using passive elements, Use of VSI as a Var generator, Indirect current controlled synchronous link converter Var Compensator (SLCVC). Bi-directional power flow in VSI, Use of VSI as active filter cum Var generator, Current controlled SLCVC, Strategy-1: Sensing the compensator current, Strategy-2: Sensing the source current, Use of two VSIs, one as Var generator and another as active filter.

UNIT IV **9 Hours**

REACTIVE POWER COMPENSATION

Instantaneous reactive power theory, expression for active and reactive powers in terms of d-q components. Reactive power compensator using instantaneous reactive power theory, stationary to rotating frame transformation. Reference wave generation (hardware method), harmonic oscillator, Phase locked loop (PLL) Introduction on one cycle control, discussion on one cycle controlled Var generator and active filter.

UNIT V **9 Hours**

SHUNT AND SERIES COMPENSATION

Introduction, methods of Var generation, analysis of uncompensated AC line, Passive reactive power compensation, Compensation by a series capacitor connected at the mid point of the line, Effect on Power Transfer capacity, Compensation by STATCOM and SSSC, Fixed capacitor-Thyristor controlled reactor (FC-TCR), Thyristor-switched capacitor- Thyristor controlled reactor (TSC-TCR), static var compensators.

FOR FURTHER READING

Static excitation of synchronous generators - Solid state tap changers for transformer - UPS Systems - Induction furnace control.

Total: 45 Hours

Reference(s)

1. K.R. Padiyar, “HVDC Power Transmission System - Technology and System Interaction", New Delhi, New Age International, 2002.
2. Jos Arrillaga, Y. H. Liu, Neville R. Watson, “Flexible Power Transmission: The HVDC Option's", John Wiley &Sons, 2007.
3. Ewald Fuchs, Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines", Academic Press, 2011.
4. Ned Mohan, Power Electronics Converters Applications and Design, New York, John Wiley and Sons, 2002.
5. R. Mohan Mathur, Rajiv K. Varma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", John Wiley & Sons, 2002.
6. Mohd. Hasan Ali, Bin Wu, Roger A. Dougal," An Overview of SMES Applications in Power and Energy Systems", IEEE Transactions on Sustainable Energy, vol. 1, no. 1, April 2010.

18PE56 HARMONICS FILTER DESIGN 3 0 0 3

Course Objectives

- Interpret the introductory concepts of harmonics, which will enable them to analyze the power quality supplied to electrical equipment.
- Apply the methodologies involved in solving problems related to harmonics.
- Develop enough confidence to mitigate and control harmonics in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Interpret the Source and effects of harmonics on any electrical machine.
2. Analyze and measure the harmonic distortions on load side and source side.
3. Design various passive filters to mitigate the effect of harmonics.
4. Characterize and design various active filters to suppress the harmonics.
5. Apply the concept of mitigation of harmonics and analyze the equipment losses.

UNIT I **9 Hours**

SOURCE AND EFFECTS OF HARMONICS

Introduction to harmonics-linear and non linear loads-power quality indices-Source of harmonics: transformers, rotating machine, power converters- -harmonics standards. Effects of Harmonics: Thermal effects on electrical machines -Transformer-Rotating machines- Effects on communication system-Pulsating Torque in AC Drive-harmonics related losses.

UNIT II **9 Hours**

HARMONIC MEASUREMENT AND ANALYSIS

Methods of harmonics measurement- Harmonic source representation- Harmonic Propagation facts- flux of harmonic currents- Interrelation between AC system and Load - Analysis methods- examples of harmonics analysis.

UNIT III **9 Hours**

DESIGN OF PASSIVE FILTER

Harmonics Elimination Techniques: Selective harmonic elimination- Modulation based harmonics elimination technique- optimal PWM technique - Types of Passive filters-Design and Analysis of single tuned and Band Pass Filter- Tuned harmonic filter.

UNIT IV **9 Hours**

DESIGN OF ACTIVE FILTER

Types of active power filter- Suppression of harmonics using active power filters - topologies and their control methods- Single Phase Shunt Current Injection type filter and its control-Three phase three-wire and four-wire shunt active filtering and their control using p-q theory and d-q modeling - Introduction to Hybrid Filter- Case studies.

UNIT V **9 Hours**

MITIGATION AND LOSSES

Harmonic Cancellation through use of Multi pulse Converters-Series Reactors as Harmonic Attenuator Elements- Phase Balancing- Harmonic Losses in Equipment-Resistive Elements- Transformers- K Factor Rotating Machines.

FOR FURTHER READING

Delta-wye and delta-delta connections of transformers, Relation between AC system and load parameters

Total: 45 Hours

Reference(s)

1. Francisco C. De La Rosa Taylor& Francis group "Harmonics and Power systems",CRC Press.
2. Deare A Paice "Power Electronics Converter Harmonics", IEEE Press.
3. J. Arrillaga, N.R. Watson, "Power System Harmonics "Second Edition John Wiley & Sons, Ltd ISBN:0-470-85129-5.
4. Hirofumi Akagi etal, "Instantaneous Power Theory and Application to Power Condition in" IEEE Press, Willey-Interscience A John Willey & Son Publication.
5. S.A. Pactitis, "Active Filters: Theory and Design", CRC Press, 2007.
6. Enriques Acha, Manuel Madrigal, "Power System Harmonics: Computer Modeling & Analysis",John Wiley and Sons Ltd

18PE57 DESIGN OF CONTROLLERS IN POWER ELECTRONICS APPLICATIONS 3 0 0 3

Course Objectives

- Outline the mathematical representation of controller components and solution techniques.
- Impart in-depth knowledge on different methods of modern controllers.
- Get insight of contingency analysis problem and the solution methods.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.

Course Outcomes (COs)

1. Apply different tuning methods for design of Classical Controllers.
2. Analyze sliding mode controller & variable structure control for linear systems.
3. Apply various PWM technique for design of Hysteresis current control and Predictive current controller.
4. Attribute design methods in control theory using H-Infinity Control & Robust Control.
5. Integrate transient stability and the associated solution techniques.

UNIT I **9 Hours**

CLASSICAL CONTROLLER DESIGN

Introduction of controller design - Proportional (P)-Integral (I)-Derivative (D)-PI-PD -PID controllers-Characteristics-Design of controller- Tuning- Ziegler-Nichol's method, Cohen coon method and damped oscillation method.

UNIT II **9 Hours**

SLIDING MODE CONTROL

Dynamics in the sliding mode - linear system, non-linear system, chattering phenomenon - sliding mode control design - reachability condition, robustness properties -application Sliding surfaces- Continuous approximations of Switching control laws- Modeling / Performance trade-Variable structure controller-Adaptive variable structure controller bang-bang control theory-trajectory planning-Case Studies.

UNIT III **9 Hours**

CURRENT CONTROLLER DESIGN

Hysteresis current control (HCC) - Design of HCC with PWM schemes-Case Studies Predictive current controller (PCC) - Model predictive control (MPC)-PWM predictive control (PPC).

UNIT IV **9 Hours**

H-INFINITY CONTROL

Introduction of H-infinity methods in control theory-Elements of robust control theory - Design objectives - Shaping the loop gain -Signal spaces - Computation of H8 norm- All pass systems- Linear-quadratic-Gaussian control (LQG) -Case Studies Robust control theory- Robust controller design- Robust decision methods- Analytic tools for robust decision making-Case Studies.

UNIT V **9 Hours**

CONTROLLER DESIGN

Controller synthesis and tuning, Linear Matrix inequalities, LMI solvers, control system analysis and design with LMIs using MATLAB/Simulink, Uncertain system analysis -Statistical and worst-case analysis of stability and performance Analysis Survey and review of different controllers used in power system and power electronics practices.

FOR FURTHER READING

Neural network and Fuzzy Logic controller

Total: 45 Hours

Reference(s)

1. Jean Pierre Barbot., "Sliding Mode Control in Engineering" Marcel Bekker, 2002.
2. Green M. and Limebeer /D.J.N., "Linear Robust Control", Englewood cliffs, NJ: Prentice Hall, 1995.
3. P.C.Chandrasekharan.,"Robust Control of Linear Dynamical Systems", Academic Press Limited, San Diego.1996.
4. Zinober, Alan S.I., ed."Variable Structure and Lyapunov Control" , London: Springer-Verlag.doi:10.1007/BFb0033675. ISBN 978-3-540-19869-7, 1994.
5. Bryson, A.E and Ho, Y., "Applied Optimal Control: Optimization, Estimation and Control (Revised Printing)", John Wiley and Sons, New York, 1975.
6. Somanath Majhi., "Advanced Control Theory A relay Feedback Approach", Cengage Learning, 2009.

18PE58 SMPS AND RESONANT CONVERTERS 3 0 0 3

Course Objectives

- Choose the converter topologies and PWM switching schemes.
- Function of basic concepts in current regulated inverters and their control methods.
- Analyze the performance of soft switching techniques and its characteristics.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Interpret the operating modes and characteristics of buck and boost regulators.
2. Identify the pulse width modulation techniques and switching schemes for inverters.
3. Summarize the different current control schemes for voltage source inverters.
4. Illustrate the properties and control circuits of current fed topologies.
5. 5. Compare the characteristics of hard switching and soft switching techniques.

UNIT I **9 Hours**

CONVERTER TOPOLOGIES

Introduction to linear regulators - basic operation - limitations of linear regulator - Buck regulator, Boost regulator - Basic Operation - Waveforms - modes of operation - switching stresses - switching and conduction losses - optimum switching frequency - continuous and discontinuous mode operation in boost regulator- design relations in polarity inverting boost regulator.

UNIT II **9 Hours**

CARRIER MODULATION

Switch-Mode dc-ac Inverters - Basic Concepts - Single Phase Inverters - Push Pull - Half Bridge and Full Bridge Square Inverters - Blanking Time - Single Pulse Modulation of Single Phase Square Wave Inverters - Multi pulse modulation - PWM Principles - Sinusoidal Pulse Width Modulation in Single Phase Inverters - Bipolar and Unipolar Switching in SPWM.

UNIT III **9 Hours**

CURRENT CONTROL SCHEMES

Current Regulated Inverter - Current Regulated PWM Voltage Source Inverters - Methods of Current Control - Hysteresis Control - Variable Band Hysteresis Control - Fixed Switching Frequency Current Control Methods - Areas of application of Current Regulated VSI.

UNIT IV **8 Hours**

CURRENT FED TOPOLOGIES

Current mode control - advantages, current fed topology - voltage mode control circuitry- line voltage regulation - current mode deficiencies and limitations - properties of voltage fed and current fed topologies.

UNIT V **10 Hours**

RESONANT CONVERTERS

Advantages and limitations of hard switching methods - fully resonant switching systems - series and parallel resonance - voltage and current fed series resonant blast- resonant circuit quality factor - soft switching techniques - zero voltage switching and zero current switching topologies - waveforms and characteristics.

FOR FURTHER READING

Cuk converter topology- basic operation - relation between output and input voltages - SEPIC converter topology - operation and output waveforms.

Total: 45 Hours

Reference(s)

1. Apraham I Pressman, Switching Power Supply Design, McGraw Hill Publishing Company, 2015.
2. Keith H Billings, Handbook of Switched Mode Power Supplies, McGraw Hill Publishing Conpany, 2010.
3. Ned Mohan, Power Electronics, John Wiley and Sons, 2011.

18PE59 MODERN INDUSTRIAL DRIVES 3 0 0 3

Course Objectives

- Importance of PLC and DCS concepts based control of drives.
- Illustrate the working of FPGA based controls.
- Interpret ARM and DSP based control of electrical Machines.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Understand the basic concepts of PLC and SCADA software and motor controls based on their programming.
2. Analyze the principles of Distributed Control and Computer Numerical System and their usage in machine control.
3. Examine the types of FPGA and control of motor drives using VHDL programming.
4. Describe the working of ARM processor and their control strategy for various motor drives.
5. Explain the application of DSP machine for the control of motor drives.

UNIT I **9 Hours**

PLC BASED INDUSTRIAL CONTROL

PLC architecture, Ladder logic Programming, Programming based on Timer And Counter, PLC Interface, Introduction to SCADA Software, PLC based Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller and Variable speed AC motor drive.

UNIT II **9 Hours**

DISTRIBUTED CONTROL AND COMPUTER NUMERICAL SYSTEM

Basics DCS introduction, DCS components/block diagram, DCS specification, latest trend and developments, Computer Numerically Controlled (CNC) Machines, Basic CNC Principle, servo control, types of servo control for motion axes, CNC based Lathe and drilling machine control.

UNIT III **9 Hours**

FPGA BASED CONTROLS

FPGA-architectures-Types of FPGA ,Xilinx XC3000 series ,Configurable logic Blocks (CLB), Input/ Output Block (IOB) , overview of Spartan 3E and Virtex III pro FPGA boards-Introduction to VHDL programming-simple programs-Control of DC motor-Induction motor speed control- Synchronous motor drive.

UNIT IV **9 Hours**

ARM PROCESSOR BASED MACHINE CONTROL

Introduction of ARM Processors -ARM7 Architecture -Instruction Set - Programming-RTOS support-Control of DC motor-Induction motor speed control-Synchronous motor drive.

UNIT V **9 Hours**

DSP PROCESSOR BASED MACHINE CONTROL

Introduction to the DSP core -The components of the DSP core, Mapping external devices to the core, Peripherals and Peripheral Interface, Assembly Programming using DSP, Instruction Set, Software Tools. DSP Based control of Stepper Motors, Permanent Magnet Brushless DC machines and Permanent Magnet Synchronous machines.

FOR FURTHER READING

DSP Based control of Switched reluctance motor drives, Matrix converters, Vector control of Induction Motors.

Total: 45 Hours

Reference(s)

1. William Bolton, "Programmable Logic Controllers", Elsevier, 2015.
2. Hamid Toliyat and Steven Campbell, "DSP-Based Electromechanical Motion Control", CRC Press, 2011.
3. Wayne Wolf, "FPGA based system design", Prentice hall, 2009.
4. J.R.Gibson, "ARM Assembly language An Introduction", CENGAGE Learning, 2011.
5. Kenneth W. Evans, John Polywka, Stanley Gabrel, "Programming of Computer Numerically Controlled Machines", Second Edition, Industrial Press, 2012.

18PE60 DSP BASED SYSTEM DESIGN 3 0 0 3

Course Objectives

- Interpret the introductory concepts of Digital Signal Processing, which will enable them to model and analyze phenomena involving continuous changes of signals.
- Apply the methodologies involved in solving problems related to Electrical, Electronics and Communication areas.
- Develop enough confidence to identify and model programs in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Design various filters using FFT algorithm.
2. Illustrate the architecture, programming methods and their special features as DSP Controllers.
3. Infer the peripherals of DSP Controllers.
4. Apply the DSP controllers for different applications.
5. Analysis the different concept to DSP.

UNIT I **9 Hours**

DSP INTRODUCTION

Classification of Signals and Systems - Computation of DFT using FFT algorithms, DIT and DIF - Design of Digital Filters, FIR and IIR Filters.

UNIT II **8 Hours**

DSPIC30F4011/4012 CONTROLLERS

Architecture- Memory Organization- I/O Ports- Timer1 Module- Timer2/3 Module- Timer4/5 Module

UNIT III **11 Hours**

PERIPHERALS OF SIGNAL PROCESSORS

General purpose Input/Output (GPIO) Functionality-Interrupts-A/D converter - Event Managers (EVA,EVB) - PWM signal generation control.

UNIT IV **9 Hours**

APPLICATIONS

Voltage regulation of DC-DC converters- Stepper motor and DC motor control - Clarkes and parks transformation -Space vector PWM - Implementation of digital P PI and PID controllers.

UNIT V **8 Hours**

CASE STUDY

Filter Design through the use of the Delta Operator- Review of the Interpolated Finite Impulse Response Technique- Digital Signal Processing Library Development Enables Effective Processor Deployments.

FOR FURTHER READING

Digital Signal Processor.

Total: 45 Hours

Reference(s)

1. John B.Peatman , "Design with PIC Microcontrollers", Pearson Education, Asia 2007
2. Hamid A.Toliyat, Steven Campbell, "DSP based electromechanical motion control", CRC Press 2011.

18PE61 SMART GRID TECHNOLOGIES 3 0 0 3

Course Objectives

- Apply the concepts of power electronics in smart grid.
- Function of smart metering and implementation of demand side integration.
- Analyze automated distribution systems and energy storage devices for smart grid.

Programme Outcomes (POs)

b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Analyze the concept of technologies required to implement the Smart Grid.
2. Implement the concept of smart grid metering and demand side integration.
3. Illustrate smart substations with its applications.
4. Analyze different transmission system operation controller and Energy storage devices.
5. Apply the concepts of power electronics in smart grid.

UNIT I **10 Hours**

INTRODUCTION

Overview of Electrical Grid - Definition of Smart Grid -Functional Characteristics - Inventory of Smart Grid Technologies - Operating Principles and Models of Smart Grid Components, Implementation of

Smart Grid- Early Smart Grid initiatives - Overview of the technologies required for the Smart Grid-Applications.

UNIT II **8 Hours**

SMART METERING AND DEMAND-SIDE INTEGRATION

Introduction - Smart metering - Smart meters- An overview of the hardware used-Communications infrastructure and protocols for smart metering, Demand-side integration- Services provided by DSI , Implementations of DSI, Hardware support to DSI implementations, Flexibility delivered by procurers from the demand side, System support from DSI.

UNIT III **9 Hours**

SMART SUBSTATIONS

Substation Automation equipment, Current transformers. Voltage transformers, Intelligent electronic devices, Bay controller, Remote terminal units, Faults in the distribution system, Components for fault isolation and restoration, Fault location, isolation and restoration, Voltage regulation. Feeder Automation, Geographic Information System(GIS),Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, Pumped Hydro, SMES, Compressed Air Energy Storage, fuel cells, super capacitors and its case studies.

UNIT IV **10 Hours**

TRANSMISSION SYSTEM OPERATION AND ENERGY STORAGE

Introduction-Data sources - IEDs, SCADA and Phasor measurement units; Energy management systems- Wide area applications -On-line transient stability controller, Pole-slipping preventive controller; Visualization techniques- Visual 2-D and 3-D presentations ;Energy storage technologies-Batteries, Flow battery, Fuel cell and hydrogen electrolyser, Flywheels, Superconducting magnetic energy storage systems and Super capacitors.

UNIT V **8 Hours**

POWER ELECTRONICS IN THE SMART GRID

Introduction -Renewable energy generation -Photovoltaic systems, Wind, hydro and tidal energy systems, Fault current limiting Shunt compensation, D-STATCOM, Active filtering, Shunt compensator with energy storage, FACTS- Reactive power compensation, Series compensation, Thyristor-controlled phase shifting transformer, Unified power flow controller.

FOR FURTHER READING

Smart appliance Technology - Pricing for Smart Appliances on demand. Security issues in DG, Distribution Automation, AMI, Electric Vehicle Management Systems - Approach to assessment of smart grid cyber security risks - Methodologies.

Total: 45 Hours

Reference(s)

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Jo& Sons, New Jersey, 2012.john Wiley.
2. Ryszard Strzelecki, Grzegorz Benysek,"Power Electronics in Smart Electrical Energy Networks", Springer, New Zealand, 2009
3. Xiao, "Security and Privacy in Smart Grids", CRC Press, New York, 2013.
4. Tony Flick, Justin Morehouse, "Securing the Smart Grid: Next Generation Power Grid security", Academic Press, Boston, 2011.
5. Yang Xiao, "Communication and Networking in Smart Grids, Taylor and Francis, New Delhi,2012
6. James Momoh,"SMART GRID: Fundamentals of Design and Analysis", John Wiley and Sons, New York, 2012

18PE62 ELECTRICAL ENERGY CONSERVATION AND MANAGEMENT 3 0 0 3

Course Objectives

- Interpret various energy intensive process in different industries and to find out the energy Conservation opportunities.
- Execute various methods of energy management and energy auditing on the site are also Incorporated.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.

c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.

Course Outcomes (COs)

1. Implement modern techniques in energy conservation.
2. Explain the need for energy storage in various forms of energy.
3. Summarize the utilization of energy in various electrical systems.
4. Classify energy audits and outline the principles of energy management.
5. Infer the need for energy monitoring and energy policy for industries.

UNIT I **7 Hours**

INTRODUCTION

Introduction to ENCON, Approach and modern techniques, benefits, trends. Energy Conservation Technology (Electrical Energy). Energy Conservation in Energy Intensive Industries. Techno-Economic evaluation of conservation technologies.

UNIT II **7 Hours**

ENERGY STORAGE

Need and importance of Energy storage in Conventional and Non conventional Energy Systems. Technical Aspects (Measurements, Quantify) various forms of Energy Storage: Thermal, Mechanical, and Electrical Techno Commercial Analysis (Economical aspects), Energy Storage: Devices and Systems.

UNIT III **11 Hours**

ELECTRICAL ENERGY DISTRIBUTION AND UTILIZATION

Electrical Systems, Transformers loss reductions, parallel operations, Transmission and Distribution losses, Power factor improvements. Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches.

UNIT IV **10 Hours**

ENERGY AUDIT

Energy Audit: Need, Types, Methodology and Approach. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Energy Management: Definition, Objective, General Principles, Energy Management Skills, Energy Management Strategy. Demand Side management (DSM), Load Management.

UNIT V **10 Hours**

ENERGY MONITORING, TARGETING REVIEW, EVALUATION AND ENERGY POLICY

Definition - Monitoring and targeting, elements of monitoring and targeting, data and information analysis, techniques energy consumption, production, cumulative sum of difference (CUSUM), Review and evaluation Need for Energy Policy for Industries, Formulation of Policy by any industrial Unit, Implementation in Industries, National & State level Policies.

FOR FURTHER READING

ECONOMIC ANALYSIS AND FINANCIAL MANAGEMENT-

Objectives, Investment needs, appraisal and criteria, sources of funds. Anatomy of investment Initial investment, Return on Investment, Economic life, Basic income equations. Tax Considerations: Depreciation, types and methods of depreciation, Income tax Considerations.

Total: 45 Hours

Reference(s)

1. W.K.Foell, "Management of Energy Environment Systems ", John Wiley & Sons, 1979.
2. W.R.Murphy, G.Mckay (Butterworths) "Energy Management", 2003.
3. D.R.Patrick, S.R.Patrick, S.W.Fardo,"Energy Conservation guide book", Prentice hall, 1993.
4. Sivaganaraju, "Electric Energy Generation, Utilisation and Conservation" S Pearson, New Delhi, 2010.
5. Paul O Callaghan, "Energy management", Mcgraw Hill, New Delhi

18PE63 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY 3 0 0 3

Course Objectives

- Acquire fundamental knowledge on electromagnetic interference and electromagnetic compatibility
- Analyze the important EMI and EMC control techniques
- Interpret the Noise suppression and EMI filter methods

Programme Outcomes (POs)

b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Analyze the EMI / EMC standards.
2. Differentiate the EMI measurement methods.
3. Analyze EMI in Power electronics equipment.
4. Outline noise suppression methods.
5. Design the EMI filter under different conditions.

UNIT I **9 Hours**

INTRODUCTION

Introduction to EMI/EMC, EMC Standardization Efforts, Description of electromagnetic disturbances, Disturbances by Frequency Content, Disturbances by Character, Disturbances by Transmission mode, Compatibility between and within systems, Scope of EMC.

UNIT II

EMI MEASUREMENT AND STANDARDS

EMI Measuring Instruments, Test Equipments, Basic Terms and Conducted EMI References, Measuring the Interference Voltage, Measuring the Interference Current, Spectrum Analyzers, EMI Measurements for Consumer Appliances, Measuring Impulses-like EMI

UNIT III **9 Hours**

EMI IN POWER ELECTRONIC EQUIPMENTS

EMI from Power Semiconductors, EMI from Power Converters Circuits, EMI Calculation for Equipments, Measuring HF Characteristics of EMI Filter Elements.

UNIT IV **9 Hours**

NOISE SUPPRESSION TECNIQUES

Noise Suppression in Relay Systems, Application of ACS witching Relays, Application of RC -Snubbers to Power Semiconductors, Shielded Transformers, Capacitor Filters, EMI Generation and Reduction at Its Source, Influence of Layout and Control of Parasitics.

UNIT V **8 Hours**

EMI FILTER CIRCUIT

Selection and Measurement, Definition of EMI Filter Parameters, EMI Filter Circuits, Test Methods, EMI Filter Design, EMI Filter Design for Insertion Loss, Calculation of Worst -Case Insertion Loss, Design Method for Mismatched Impedance Condition, Design Method for EMI Filters with Common- Mode Choke Coils, Damped EMI Filters and Lossy Filter Elements

FOR FURTHER READING

Testing for Susceptibility to Power Line Disturbances, Surge Voltages in, EMC Tests per IEC Specifications, Electromagnetic Coupling Reduction Methods, Wiring Layout Methods to Reduce EMI Coupling PCB Design Considerations. Energy Content of Transient Disturbances, Impulse Characteristics and Noise Filter Design, Surge Protection Devices.

Total: 45 Hours

Reference(s)

1. L. Tihanyi, "Electromagnetic compatibility in Power Electronics" , IEEE press, 1995
2. M. H. Rashid, "Power electronics Handbook", PHI,2011
3. Bruce Archambeault, Colin Brench, Omar M. Ramahi, "EMI/EMC computational modeling handbook", Kluwer press, second edition, 1998
4. D. Morgan, "A Handbook for EMC Testing and Measurement", IET Electrical Measurement Series, Band 8, 1994
5. Tim Williams, "EMC for product designers", Newnes press, fifth edition, 2016
6. www.nptel.ac.in

18PE64 DISTRIBUTED GENERATION SYSTEMS 3 0 0 3

Course Objectives

- Illustrate the concept of distributed generations and its grid integration.
- Interpret the working of off-grid and grid-connected renewable energy generation schemes.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.

Course Outcomes (COs)

1. Apply the concept of distributed generation and standards for grid interconnection.
2. Analyze the planning and grid integration issues related to Distributed Generation.
3. Determine the impact of DGS upon transient and dynamic stability.
4. Attribute the limitations and control techniques of DGs.
5. Integrate the modeling, analysis of Micro grids.

UNIT I **9 Hours**

CONCEPT OF DISTRIBUTED GENERATIONS

Need for Distributed generation, topologies, and Renewable sources in distributed generation, regulatory standards/ framework, Standards for interconnecting. Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations.

UNIT II **9 Hours**

PLANNING AND GRID INTEGRATION OF DGS

Planning of DGs-Sitting and sizing of DGs optimal placement of DG sources in distribution systems. Grid integration of DGs -Different types of interfaces, Inverter based DGs and rotating machine based interfaces-Aggregation of multiple DG units.

UNIT III **9 Hours**

TECHNICAL IMPACTS OF DGS

Transmission systems - 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 IV **9 Hours**

LIMITATIONS AND CONTROL OF DGS

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

UNIT V **9 Hours**

MICROGRIDS

Introduction to micro-grids. Types of micro-grids: autonomous and non-autonomous grids Sizing of micro-grids. Modeling & analysis of Micro-grids with multiple DGs. Micro-grids with power electronic interfacing units.

FOR FURTHER READING

Transients in micro-grids, Protection of micro-grids, Case studies, Introduction to smart micro grids.

Total: 45 Hours

Reference(s)

1. H. Lee Willis, Walter G. Scott, "Distributed Power Generation - Planning and Evaluation", Marcel Decker Press, 2000.
2. M.Godoy Simoes, Felix A. Farret, "Renewable Energy Systems - Design and Analysis with Induction Generators", CRC press, second edition, 2011.
3. Stuart Borlase,"Smart Grid: Infrastructure Technology Solutions" CRC Press, 2012

18PE65 SCADA SYSTEM AND APPLICATIONS 3 0 0 3

Course Objectives

- Understand the SCADA system components and SCADA communication.
- Interpret on various SCADA architecture and modeling, analysis of SCADA applications.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.
e. Ability to communicate well with fellow individuals and contribute effectively when working in multidisciplinary team through effective technical reports and presentations.

Course Outcomes (COs)

1. Apply the concept of Supervisory Control Systems (SCADA) in utility automation industries.
2. Illustrate the remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server of SCADA systems.
3. Outline the SCADA architecture and single unified standard architecture.
4. Analyze various industrial SCADA communication technologies.
5. Apply SCADA in transmission and distribution sector, industries etc.

UNIT I **9 Hours**

INTRODUCTION TO SCADA

Introduction to SCADA Data acquisition systems, Evolution of SCADA, Communication Technologies - Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries.

UNIT II **9 Hours**

SCADA SYSTEM COMPONENTS

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

UNIT III **9 Hours**

SCADA ARCHITECTURE

Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC61850.

UNIT IV **9 Hours**

SCADA COMMUNICATION

Various industrial communication technologies -wired and wireless methods and fiber optics, open standard communication protocols.

UNIT V **9 Hours**

SCADA APPLICATIONS

Utility applications- Transmission and Distribution sector-operations, monitoring, analysis and improvement. Industries - oil, gas, and water. Case studies.

FOR FURTHER READING

Scada Monitoring and Control- Online monitoring the event and alarm system, trends and reports, Blocking list, Event disturbance recording. Control function: Station control, bay control, breaker control and disconnector control.

Total: 45 Hours

Reference(s)

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2009.
2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.
3. William T. Shaw, "Cyber security for SCADA systems", PennWell Books, 2006.
4. David Bailey, Edwin Wright, "Practical SCADA for industry",Newnes, 2003.
5. Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power",PennWell, 2000.

18PE66 HVDC SYSTEMS 3 0 0 3

Course Objectives

- Interpret the Faults and protections, Harmonics and Filters.
- Importance of HVDC transmission and analysis of HVDC converters.
- Analyze the Reactive power control and Power factor improvements of the system.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Outline the structure of HVDC system and compare it with AC system.
2. Analyze the performance of different types of converters used for HVDC transmission system.
3. Analyze the performance of HVDC converters using different control techniques.
4. Classify the faults and protection schemes in HVDC transmission system.
5. Design of filters for HVDC system.

UNIT I **9 Hours**

INTRODUCTION

Introduction of DC Power transmission technology - Comparison of AC and DC transmission - Application of DC transmission - Structure of HVDC transmission system - Reactive power demand- Economic considerations - Modern trends in DC transmission.

UNIT II **10 Hours**

ANALYSIS OF HVDC CONVERTERS

Pulse number converters - Choice of converter configuration - Properties of Thyristor converter circuits - Three phase converters - Simplified analysis of Graetz circuit with and without overlaps - Characteristics of a twelve pulse converter -Transformer connections.

UNIT III **9 Hours**

CONTROL OF CONVERTERS

Principal of DC Link Control - Basic means of control - Gate Control - Power reversal - Constant current versus constant voltage- Converters Control Characteristics - Firing angle control - Current and extinction angle control- Frequency control - Effect of source inductance on the system- Starting and stopping of DC link- Power Control.

UNIT IV **8 Hours**

FAULTS IN CONVERTERS AND ITS PROTECTION

Converter disturbance - By pass action in bridge- Short circuit on a rectifier - Commutation failure- Basics of protection - DC reactors - Voltage and current oscillations - Clearing line faults and re-energizing - Circuit breakers - Overvoltage protection.

UNIT V **9 Hours**

HARMONICS AND FILTERS

Introduction - Generation of harmonics - Effects of harmonics and its mitigation-Design of AC filters and DC filters - Corona loss in HVDC lines - Radio interference due to corona- Grounding -advantages and problems.

FOR FURTHER READING

Modern trends in thyristor valves-Deciding factors for best circuit of HVDC converters- shunt capacitors-synchronous condensers-surge arresters- Design of earth electrodes

Total: 45 Hours

Reference(s)

1. Padiyar K.R., "HVDC Power Transmission System /direct current", New Academic Science, 2011.
2. DraganJovcic, Khaled Ahmed "High Voltage Direct Current Transmission" ,John Wiley & Sons,2015.
3. Colin Adamson and Hingorani N G, "High Voltage Direct Current Power Transmission", Garraway Limited, London, 1960.
4. Arrillaga J, Liu Y.H, Watson NR, "Flexible Power Transmission: The HVDC Options" John-Wiley & Sons INC publication, 2010.
5. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", New Age International (P) Ltd, New Delhi,2011.
6. Vijay K Sood "HVDC and FACT Controllers: Application of Static Converter in Power Systems" Kluwer Academic Publication, 2006.

18PE67 POWER ELECTRONICS APPLICATIONS TO LIGHTING SYSTEMS 3 0 0 3

Course Objectives

- Determine the different Applications of power Electronics in Lighting Systems.
- Interpret the applications of domestic appliances.
- Illustrate the concepts of metering for energy management make the student to understand the lighting systems.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Design and determine the luminous flux from luminous intensity of lighting.
2. Apply lighting design using indoor design and exterior lighting methods.
3. Integrate the architectural lighting design for interior and exterior applications.
4. Determine the characteristics of LED for illumination applications.
5. Estimate Energy consumption of both domestic and Industrial applications.

UNIT I **9 Hours**

INTRODUCTION

Illuminance calculation-Derivation of luminous flux from luminous intensity, flux transfer and inter-reflection luminance calculations, Discomfort glare. Optical design reflector system, refractor system.

UNIT II **9 Hours**

LIGHTING DESIGN AND CALCULATION

Principal of lighting design-Indoor lighting design by lumen method, by point method, Designing problem and solution and designing documentation. Exterior lighting system- Road lighting System and highway lighting system

UNIT III **9 Hours**

ARCHITECTURAL LIGHTING

Fundamental architectural lighting design practices-Day light factor &Sky factor-day lighting systems-Fenestration design aspects- calculation of interior illuminance due to daylight. Design and analysis of lighting for exterior and interior applications- economically siso flighting systems, Green Lighting for Modern Buildings and designing daylight-responsive control systems.

UNIT IV **9 Hours**

SOLID STATE LIGHTING AND CONTROL

Introduction-.Review of Light sources-.Basics of solid state lamps -white light generation techniques-characterization of LEDs for illumination application.-Power LEDs-High brightness LEDs-Electrical and optical properties-LED driver considerations-color issues of white LEDs-Dimming of LED sources-Designing usable lamp from white LEDs,-Luminaire design steps-. SSL test standards.

UNIT V **9 Hours**

LIGHTING POWER CONDITIONING, MONITORING AND CONTROL

Lighting control strategies, techniques & equipment, sensors and timers, switches versus dimming control algorithm, harmonics, EI from lighting equipment - its measurement &suppression techniques. Impact of lighting control, protocols for lighting control. Status monitoring, fault Monitoring, electrical load monitoring, lamp life monitoring system, applications.

FOR FURTHER READING

Energy Management and building control systems -Impact of Lighting Controls on HVAC- Power Quality issuesÃ¢?? Integration of lighting controls with Building Management Systems.

Total: 45 Hours

Reference(s)

1. Craig Di Louie, "Lighting Control", The Fairmont Press, Inc., 2008
2. IES Lighting Handbook, 10th Edition IESNA, 2011.
3. CraigDi Louie, "Advanced Lighting Controls: Energy Saving Productivity", Technology & Applications, Fairmont Press, Inc., 2006.
4. Davies, "Hand book of Condition Monitoring :Techniques and Methodology ", Springer Science& Business Media, 2012
5. www.aboutlightingcontrols.org

18PE68 AUTOMOTIVE ELECTRONICS 3 0 0 3

Course Objectives

- Interpret the internal structure and the switching and operating characteristics of the basic power devices.
- Summarize the advanced power devices and its working principle.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
e. Ability to communicate well with fellow individuals and contribute effectively when working in multidisciplinary team through effective technical reports and presentations.
f. Ability to acquire continuous learning skills, plan and conduct a systematic study on significant research with effective utilization of resources.

Course Outcomes (COs)

1. Infer various devices used for Ignition system.
2. Characterize the design of Lighting devices and its parameters.
3. Analyze the protection circuits and control circuits.
4. Analyze the reliability of engine control system.
5. Integrate the functions of battery system for hybrid vehicles.

UNIT I **9 Hours**

IGNITION SYSTEMS

Ignition Systems: Types, Construction &working of battery coil an Magneto ignition systems. Relative merits, Centrifugal and vacuum advance mechanisms, types and construction of spark plugs, electronic ignition systems.

UNIT II **9 Hours**

INJECTION

Electronic fuel Control: Basics of combustion-Engine fuelling and exhaust emissions-Electronic control of carburetion-Petrol fuel injection- Diesel fuel injection. Lighting system -Insulated &earth return systems. Positive& negative earth systems. Details of headlight &sidelight. Headlight dazzling &preventive methods.

UNIT III **9 Hours**

ELECTRIC PROPULSION

Introduction to electric components used in electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of Permanent Magnet Motor drives, and control of Switched Reluctance Motor drives, Drive system efficiency.

UNIT IV **9 Hours**

SENSORS AND ACTUATORS

Working principle and characteristics of Airflow rate, Engine crank shaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors study of fuel injector, exhaust Gas recirculation actuators, stepper motor actuator, vacuum operated actuator.

UNIT V **9 Hours**

THERMAL MANAGEMENT FOR BATTERIES AND ITS CONTROL

Introduction- Thermal control in vehicular battery systems: battery performance degradation at low and high temperatures -Passive, active, liquid, air thermal control system configurations for HEV and EV applications.

FOR FURTHER READING

Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, on board diagnostic system, security and warning system.

Total: 45 Hours

Reference(s)

1. Tom Denton."Automobile electrical and electronic system", Edward Arnold publishers, 4thEdition, 2012.
2. William B. Ribbens, "Understanding Automotive Electronics", Newness7thEdition2012.
3. AlSantini," Automotive Electricity &Electronics " Cengage Learning, 2012
4. Muhammad Rashid, "Power Electronics Hand book ,Elsevier, 2011
5. WilliamB. Ribbens, Understanding automotive electronics, an engineering perspective, Elsevier2014
6. Nag.P.K, "Engineering Thermodynamics",5th Edition, Tata McGraw Hill Education, New Delhi,2013

18PE69 EMBEDDED CONTROL OF ELECTRIC DRIVES 3 0 0 3

Course Objectives

- Understand the internal architecture and interfacing of different peripheral devices with microcontrollers.
- Integrate 8051 and PIC micro controller based control of electric drives.
- Design real time embedded controller based on microcontrollers.

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
d. Ability to identify appropriate modern tools for designing power electronic circuits.

Course Outcomes (COs)

1. Interpret the architecture of 8051 microcontroller and classify the addressing modes.
2. Explain the peripheral interfacing used in 8051 microprocessor.
3. Interpret the architecture & instruction set of DSPIC microcontroller.
4. Analyze the interfacing of different peripheral devices with DSPIC Microcontrollers.
5. Execute the applications using 8051 and PIC16f87XA microcontroller programming.

UNIT I **8 Hours**

8051 ARCHITECTURE

Basic organization - 8051 CPU structure - Memory Organization - Addressing modes - Instruction set- Programming - Timing diagram - Memory expansion.

UNIT II **9 Hours**

PERIPHERALS AND VERSIONS OF 8051

Parallel Ports -Timers and Counters - Interrupts -Serial Communication - Simple Programs ADC, DAC and Analog Comparator - PWM and Watch dog timer options in PIC 16F877A.

UNIT III **8 Hours**

ARCHITECTURE OF DSPIC

DSPIC30F4011-Architecture -Timer- I/O ports-PWM module-ADC-Case study.

UNIT IV **10 Hours**

PERIPHERALS INTERFACING OF DSPIC

I/O Ports -Timers / Counters - Capture / Compare / PWM modules - Master Synchronous Serial Port (MSSP) module - USART - A / D Converter module -Comparator module.

UNIT V **10 Hours**

APPLICATIONS USING 8051 AND PIC16F87XA

Real Time Clock - DC motor speed control - Generation of gating signals for Converters and Inverters - Frequency measurement - Temperature control - Speed control of induction motors -Implementation of PID controller.

FOR FURTHER READING

P, PI, PID control Control of AC Drives - VFD and TRIAC Firing Angle control Control of DC Drives.

Total: 45 Hours

Reference(s)

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay," The 8051 Microcontroller and Embedded Systems- Using Assembly and C, Prentice Hall of India, New Delhi, 2008.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18, Prentice Hall of India, New Delhi, 2007.
3. Dogan Ibrahim, Designing Embedded Systems with 32-Bit PIC Microcontrollers and MikroC Newnes, 2013.
4. Muhammad Rashid,"Power Electronics Hand book" ,Elsevier, 2011
5. Kenneth Ayls, "The 8051 Microcontroller",Cengage Learning 3rd Edition,2007. David Calcutt, Fred Cowan, Hassan Parchizadeh, 8051 Microcontrollers - An Application Based Introduction, Elsevier, 2006.
6. Subrata Ghoshal, Embedded Systems & Robots: Projects Using The 8051 Microcontroller, Cengage Learning, 2nd Edition, 2009.

18PE70 OPTIMIZATION TECHNIQUES 3 0 0 3

Course Objectives

- Interpret about the various optimization techniques
- Summarize the geometric, integer and dynamic programming
- Summarize concepts of geometric, integer and dynamic programming

Programme Outcomes (POs)

a. Ability to apply the knowledge gained from undergraduate engineering to identify, formulate and solve problems in power electronics and drives.
b. Ability to apply knowledge in mathematics, science and engineering fundamentals to develop and analyze mathematical models for power electronic circuits and controllers.
c. Ability to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.

Course Outcomes (COs)

1. Determine the optimization techniques based on its applications
2. Demonstrate the process for different types of Linear programming
3. Demonstrate different types of Non Linear programming methods
4. Explain the Constraints involved in Geometric Programming and Integer Programming
5. Exemplify the concepts of dynamic Programming

UNIT I **8 Hours**

INTRODUCTION TO OPTIMIZATION

Engineering Applications - Classification of optimization problems - Classical optimization techniques - Single and multivariable optimization - multivariable optimization with and without constraints - Lagrange model - Kuhn - tucker conditions

UNIT II **9 Hours**

LINEAR PROGRAMMING

Applications - Standard form of LPP - definitions and Theorem - Solution of a system of Linear simultaneous equations - Pivoted reduction - Simplex algorithm - Identifying an optimal point Revised simplex methods - Gauss Jordan Elimination process - Duality in linear programming Decomposition principle -Transportation problem - Northwest corner rule - Least cost method

UNIT III **10 Hours**

NON LINEAR PROGRAMMING

Nonlinear programming - one dimensional minimization methods - unrestricted search Exhaustive search - Interpolation and Quadratic interpolation method - Cubic method unconstrained optimization techniques -Direct search methods - simplex method - Descent methods - Gradient of a function - Steepest Descent method - Constrained optimization techniques - Transformation techniques - sequential unconstrained minimization techniques Interior and exterior penalty function method.

UNIT IV **9 Hours**

GEOMETRIC PROGRAMMING AND INTEGER PROGRAMMING

Geometric programming - Polynomial - Unconstrained minimization problem - Constrained minimization problem - Primal and Dual programmes - Geometric programming with mixed in equality constraints - Complementary geometric programming. Integer linear programming Mixed integer programming - Integer non linear programming - Sequential linear discrete programming

UNIT V **9 Hours**

DYNAMIC PROGRAMMING

Dynamic programming: Multistage decision processes - Concept of sub-optimization - Principle of optimality -Conversion of a final value problem into an initial value problem -Linear programming as a case of dynamic programming - Continuous dynamic programming Applications

FOR FURTHER READING

Stochastic Programming, Separable programming and Practical aspects of optimization

Total: 45 Hours

Reference(s)

1. Rao, S.S., "Optimization Theory and Applications", Wiley Eastern Ltd., Second Edition, 2009.
2. Donald A. Pierre., "Optimization Theory with Applications", Courier Corporation, 2012.
3. Stephen G Nash and ArielaSofer,"Linear and Nonlinear Programming", McGraw Hill College Div., 2009.
4. David G. Luenberger, Yinyu Ye., "Linear and Nonlinear Programming" ,Springer Science & Business Media, 200.8
5. Rao, S.S., "Engineering Optimization Theory and Practice - Third Edition", New Age International, 2009.
6. Hamdy A. Taha.,"Integer Programming: Theory, Applications, and Computations", Academic Press, 2014.

OPEN ELECTIVES

18GE01 BUSINESS ANALYTICS 3 0 0 3

Course Objectives

- Understand the role of business analytics within an organization
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
- To become familiar with processes needed to develop, report, and analyze business data
- Use decision-making tools/Operations research techniques and Manage business process using analytical and management tools

Course Outcomes (COs)

1. Implement the knowledge of data analytics
2. Apply the ability of think critically in making decisions based on data and deep analytics.
3. Analyze the ability to use technical skills in predicative and prescriptive modeling to support business decision-making
4. Determine the ability to translate data into clear, actionable insights
5. Analyze the decision problems in business analytics

UNIT I **9 Hours**

BUSINESS ANALYTICS AND STATISTICAL TOOLS

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics-Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

UNIT II **9 Hours**

TRENDINESS AND REGRESSION ANALYSIS

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology

UNIT III **9 Hours**

ORGANIZATION STRUCTURES OF BUSINESS ANALYTICS

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization

UNIT IV **9 Hours**

FORECATING TECHNIQUES

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time

Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models

UNIT V **9 Hours**

DECISION ANALYSIS

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making

FOR FURTHER READING

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism

Total: 45 Hours

Reference(s)

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press
2. Business Analytics by James Evans, persons Education

18GE02 INDUSTRIAL SAFETY 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To infer the safety requirement for chemical industry.
- To classify the various safety measures adopted in construction industries.

Course Outcomes (COs)

1. Demonstrate the safety management system of an industry.
2. Implement the provisions if acts and rules in industries.
3. Explain and review the safety performance followed in various industries.
4. Compare the safety appraisal of various industries.
5. Formulate safety reports on construction industries.

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Investigation and

Reporting - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Motor Vehicle Rules,

Explosive Act 1983, Boiler Act.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in metal working machinery and wood working machines, principles, standards and codes - Principles of machine guarding - zero mechanical state (ZMS),types of guards, Personal protective equipment- Safety in handling industrial gases, storage and handling of gas cylinders- Safety in cold forming and hot working of metals- Power press, forging, safety in furnaces, Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, non-destructive testing, vibration, corrosion Plant maintenance and emergency planning, management of maintenance HAZOP study, ALOHA, SOFTWARE.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Causes of fatal accidents, Construction regulations, contractual clauses, permit to work, Quality assurance
in construction- Education and training Hazards of construction and prevention- excavation, scaffolding,
dismantling, road works, construction of high rise buildings - Working at heights, Occupational Safety and Health Administration (OSHA) requirement for working at heights- Working on fragile roofs, work permit systems- Construction machinery, inspection and testing of cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, keys to safe demolition, health hazards from demolition, fire and explosion hazard- Safety in confined spaces.

FOR FURTHER READING

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

Total: 45 Hours

Reference(s)

1. R.B.Blake, Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988.
3. V.Subramanian, The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras.
4. Environmental Pollution Control Act, 1986.
5. BOCW Act,1996, Madras Book agency, Chennai-1.
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

18GE03 OPERATIONS RESEARCH 3 0 0 3

UNIT I **9 Hours**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II **9 Hours**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III **9 Hours**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV **9 Hours**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming

UNIT V **9 Hours**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Total: 45 Hours

Reference(s)

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

18GE04 COST MANAGEMENT OF ENGINEERING PROJECTS

3 0 0 3

UNIT I **9 Hours**

COST CONCEPTS IN DECISION-MAKING

Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control;

Provision of data for Decision-Making.

UNIT II **9 Hours**

PROJECT

Meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance.

Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT III **9 Hours**

COST BEHAVIOR AND PROFIT PLANNING MARGINAL COSTING

Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning,

UNIT IV **9 Hours**

TOTAL QUALITY MANAGEMENT AND THEORY OF CONSTRAINTS

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V **9 Hours**

QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Total: 45 Hours

Reference(s)

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

18GE05 COMPOSITE MATERIALS 3 0 0 3

9 Hours

UNIT I

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 II **9 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 Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT III **9 Hours**

MANUFACTURING OF METAL MATRIX COMPOSITES

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 IV **9 Hours**

MANUFACTURING OF POLYMER MATRIX COMPOSITES

Preparation of Moulding compounds and prepares - hand layup method - Autoclave method - Filament winding method – Compression moulding - Reaction injection moulding. Properties and applications

UNIT V **9 Hours**

STRENGTH

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

Total: 45 Hours

Reference(s)

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

18GE06 WASTE TO ENERGY 3 0 0 3

UNIT I **9 Hours**

INTRODUCTION TO ENERGY FROM WASTE

Classification of waste as fuel Agro based, Forest residue, Industrial waste - MSW Conversion devices Incinerators, gasifiers, digestors

UNIT II **9 Hours**

BIOMASS PYROLYSIS

Pyrolysis - Types, slow fast - Manufacture of charcoal - Methods – Yields and application - Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III **9 Hours**

BIOMASS GASIFICATION

Gasifiers Fixed bed system Downdraft and updraft gasifiers Fluidized bed gasifiers Design, construction and operation Gasifier burner arrangement for thermal heating Gasifier engine arrangement and electrical power Equilibrium and kinetic consideration in gasifier operation.

UNIT IV **9 Hours**

BIOMASS COMBUSTION

Biomass stoves Improved chullahs, 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 V **9 Hours**

BIOGAS

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Total: 45 Hours

Reference(s)

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

AUDIT COURSES

18XE11 RESEARCH PAPER WRITING 2 0 0 -

UNIT I **5 Hours**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II **5 Hours**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III **5 Hours**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV **5 Hours**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT V **5 Hours**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

UNIT VI **5 Hours**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Total: 30 Hours

Reference(s)

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

18XE12 TRADITIONAL TECHNICAL KNOWLEDGE 2 0 0 -

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world.
- Learning of Sanskrit to improve brain functioning.
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects.
- Enhancing the memory power.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Course Outcomes (COs)

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

UNIT I **10 Hours**

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

UNIT II **10 Hours**

Order, Introduction of roots, Technical information about Sanskrit Literature.

UNIT III **10 Hours**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics.

Total: 30 Hours

Reference(s)

1. "Abhyaspustakama" - Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.
3. "India's Glorious Scientific Tradition", Suresh Soni, Ocean books (P) Ltd., New Delhi.

18XE13 VALUE EDUCATION 2 0 0 -

Course Objectives

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Programme Outcomes (POs)

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

Course Outcomes (COs)

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT I **8 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

UNIT II **7 Hours**

Importance of cultivation of values- Sense of duty Devotion- Self-reliance- Confidence-Concentration-Truthfulness- Cleanliness-Honesty- Humanity- Power of faith- National Unity- Patriotism- Love for nature-Discipline

UNIT III **8 Hours**

Personality and Behavior Development - Soul and Scientific attitude- Positive Thinking- Integrity and discipline-Punctuality- Love and Kindness- Avoid fault Thinking- Free from anger- Dignity of labour-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 IV **7 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.

Total: 30 Hours

Reference(s)

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

18XE21 STRESS MANAGEMENT BY YOGA 2 0 0 -

Course Objectives

- To achieve overall health of body and mind
- To overcome stress by practicing yoga

Programme Outcomes (POs)

a. Acquire in-depth knowledge in Materials of construction and design of structures with an ability to evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.

b. Analyse and design complex Structural Engineering problems critically, and apply independent judgement.

Course Outcomes (COs)

1. Develop healthy mind in a healthy body thus improving social health also.
2. Improve Efficiency of the body by practicing breathing exercises and yoga.

UNIT I **10 Hours**

Definitions of Eight parts of yoga. (Ashtanga)

UNIT II **10 Hours**

Yam and Niyam Do`s and Dont's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III **10 Hours**

Asan and Pranayam i) Various yoga poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam

Total: 30 Hours

Reference(s)

1. Yogic Asanas for Group Training-Part-I Janardan Swami Yogabhyasi Mandal, Nagpur. Model Curriculum of Engineering & Technology PG Courses [Volume-I][47].
2. Rajayoga or conquering the Internal Nature by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

18XE22 DISASTER MANAGEMENT 2 0 0 -

Course Objectives

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
- 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

Course Outcomes (COs)

1. Understanding the key concepts in disaster risk reduction and humanitarian response
2. Understand the strengths and weaknesses of disaster management approaches, planning and programming

UNIT I **5 Hours**

INTRODUCTION

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II **5 Hours**

REPERCUSSIONS OF DISASTERS AND HAZARDS

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 III **5 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 IV **5 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.

UNIT V **5 Hours**

RISK ASSESSMENT

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

UNIT VI **5 Hours**

DISASTER MITIGATION

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Total: 30 Hours

Reference(s)

1. R. Nishith, Singh AK, "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.
4. Model Curriculum of Engineering & Technology PG Courses [Volume-I][42]

18XE23 PEDAGOGY STUDIES 2 0 0 -

Course Objectives

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers
- Identify critical evidence gaps to guide the development.

Course Outcomes (COs)

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? verall personality

UNIT I **8 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 II **7 Hours**

THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education

UNIT III **8 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 materials 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 IV **7 Hours**

PROFESSIONAL DEVELOPMENT

Alignment with classroom practices and follow up, Support Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Total: 30 Hours

Reference(s)

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site 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 RJ (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