B.S.ABDUR RAHMAN
UNIVERSITY
B.S.ABDUR RAHMAN INSTITUTE OF SCIENCE & TECHNOLOGY
(Estd.u/s 3 of the UGC Act, 1956)

(FORMERLY B.S.ABDUR RAHMAN CRESCENT ENGINEERING COLLEGE)
Seethakathi Estate, G.S.T. Road, Vandalur, Chennai - 600 048.

REGULATIONS (2009), CURRICULUM AND SYLLABUS
FOR
M.TECH. (POWER ELECTRONICS AND DRIVES)
(FOUR SEMESTER-FULL TIME)

(Updated upto June 2012)

REGULATIONS
2009 FOR

M.TECH. POWER ELECTRONICS AND DRIVES

REGULATIONS (2009) FOR
M.TECH / MCA / M. Sc DEGREE PROGRAMMES

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

i) **"Programme"** means Post Graduate Degree Programme (M.Tech./ MCA / M.Sc.)

ii) **"Course"** means a theory or practical subject that is normally studied in a semester, like Applied Mathematics, Structural Dynamics, Computer Aided Design, etc.

iii) **"University"** means B.S.Abdur Rahman University, Chennai, 600048.

iv) **"Institution"** unless otherwise specifically mentioned as an autonomous or off campus institution means B.S.Abdur Rahman University.

v) **"Academic Council"** means the Academic Council of the University.

vi) **'Dean (Academic Courses)'** means Dean (Academic Courses) of B.S.Abdur Rahman University.

vii) **'Dean (Students)'** means Dean(Students) of B.S.Abdur Rahman University.

viii) **"Controller of Examinations"** means the Controller of Examinations of B.S.Abdur Rahman University who is responsible for conduct of examinations and declaration of results.

2.0 PROGRAMMES OFFERED, MODE OF STUDY AND ADMISSION REQUIREMENTS

2.1 P.G. Programmes Offered

The various P.G. Programmes and their modes of study are as follows:

Degree	Mode of study
M.Tech.	Full Time
M.Tech.	Part Time – Day / Evening
M.C.A.	Full Time
M. Sc.	Full Time

2.2 MODES OF STUDY

2.2.1 Full-time

Candidates admitted under "Full-Time" shall be available in the institution during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

2.2.2 A full time student, who has completed all non-project courses desiring to do the Project work in part-time mode for valid reasons, shall apply to the Head of the Institution through the Head of the Department, if the student satisfies the clause 2.3.5 of this Regulations. Permission may be granted based on merits of the case. Such conversion is not permitted in the middle of a semester.

2.2.3 Part time - Day time

In this mode of study, the candidates are required to attend classes for the courses registered along with full time students.

2.2.4 Part time - Evening

In this mode of study, the candidates are required to attend only evening classes.

2.2.5 A part time student is not permitted to convert to the full time mode of study.

2.3. ADMISSION REQUIREMENTS

2.3.1 Candidates for admission to the first semester of the Master's Degree Programme shall be required to have passed an appropriate degree examination of this University as specified in Table 1 or any other examination of any University or authority accepted by the University as equivalent thereto.

2.3.2 Notwithstanding the qualifying examination the candidate might have passed, he/she shall have a minimum level of proficiency in the appropriate programme/courses as prescribed by the institution from time to time.

2.3.3 Eligibility conditions for admission such as class obtained, number of attempts in qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

2.3.4 All part-time candidates should satisfy other conditions regarding experience, sponsorship etc., which may be prescribed by the institution from time to time.

2.3.5 A candidate eligible for admission to M.Tech. Part Time - Day Time programmeshall have his/her permanent place of work within a distance of 65km from the campus of the institution.

2.3.6 A candidate eligible for admission to M.B.A. Part Time - Evening programme shall have a working experience of 2 years at least at supervisory level. He/ she shall have his/her place of work within a distance of 65 km from the campus of the institution.

3.0 DURATION AND STRUCTURE OF THE P.G. PROGRAMME

3.1. The minimum and maximum period for completion of the P.G. Programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech. (Full Time)	4	8
M.Tech.(Part Time)	6	12
M.C.A. (Full Time)	6	12
M.Sc. (Full Time)	4	8

3.2 The P.G. programmes will consist of the following components as prescribed in the respective curriculum

i. Core courses
ii. Elective courses
iii. Project work / thesis / dissertation
iv. Laboratory Courses
v. Case studies
vi. Seminars
vii. Practical training

3.3 The curriculum and syllabi of all the P.G. programmes shall be approved by the Academic Council.

3.4 The number of credits to be earned for the successful completion of the programme shall be specified in the curriculum of the respective specialization of the P.G. programme.

3.5 Each academic semester shall normally comprise of 75 to 80 working days spread over sixteen weeks. End-semester examinations will follow immediately after these working days.

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl.No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
01.	Civil Engineering	M.Tech. (Structural Engineering)	B.E / B.Tech. (Civil Engineering) / (Structural Engineering)
		M.Tech. (Construction Engineering and Project Management)	B.E. / B.Tech. (Civil Engineering) /(Structural Engineering)
02.	Mechanical Engineering	M.Tech. (CAD - CAM)	B.E. / B.Tech. (Mechanical / Auto /Manufacturing / Production / Industrial/Mechatronics / Metallurgy / Aerospace/Aeronautical / Material Science / Marine Engineering)
		M.Tech. (Manufacturing Engineering)	B.E. / B.Tech. (Mechanical / Auto / Manufacturing / Production / Industrial/Mechatronics / Metallurgy / Aerospace/Aeronautical / Material Science / Marine Engineering)
03.	Polymer Technology	M.Tech. (Polymer Technology)	B. E. / B. Tech. degree Mech./ Production / Polymer Science or Engg or Tech/Rubber Tech/ M.Sc(Polymer Sc./Chemistry Appl. Chemistry)
04.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engg)	B.E/B.Tech (EEE/ECE/E&I/ I&C/ Electronics / Instrumentation)
		M.Tech. (Power Electronics & Drives)	B.E/B.Tech (EEE/ECE/E&I/ I&C/ Electronics/ Instrumentation)
05.	Electronics and Communication Engineering	M.Tech. (Communication Systems)	M.Tech (Power System Engg) B.E / B.Tech (EEE/ ECE / E&I / I&C / Electronics / Instrumentation)
		M.Tech. (VLSI and Embedded Systems)	B.E./ B.Tech. in ECE / Electronics / EIE
06.	ECE Department jointly with Physics Department	M.Tech. (Optoelectronics and Laser Technology)	B.E./B.Tech. (ECE / EEE / Electronics / EIE / ICE) M.Sc (Physics / Materials Science / Electronics / Photonics)
07.	Electronics and Instrumentation Engineering	M.Tech. (Electronics and Instrumentation Engineering)	B.E./B.Tech. (EIE/ICE/Electronics/ECE/EEE)
08.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. /B.Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics / MCA)
		M.Tech. (Software Engineering)	B.E. / B.Tech. (CSE / IT) MCA
09	Information Technology	M.Tech. (Information Technology)	B.E /B.Tech. (IT/CSE/ECE/EEE/EIE/ICE/ Electronics) MCA
10	Computer Applications	M.C.A.	Any degree. Must have studied Mathematics / Statistics /Computer oriented subject.
		M.Tech. (Systems Engineering and Operations Research)	Any degree. Must have studied Mathematics / Statistics /Computer oriented subject.
11	Mathematics	M.Sc. (Actuarial Science)	B.Sc. (Mathematics) of B.Sc. (Applied Science)
12	Chemistry	M.Sc.(Chemistry)	B.Sc (Chemistry) of B.Sc. (Applied Science)

3.6 The curriculum of P.G. programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall lie within the limits specified below:

Programme	Minimum prescribed credit range
M.Tech.	70 to 80
M.C.A	130 to 140
M.Sc	74 to 80

3.7 Credits will be assigned to the courses for all P.G. programmes as given below:

* One credit for one lecture period per week
* One credit for one tutorial period per week
* One credit each for seminar/practical session of two or three periods per week
* One credit for four weeks of practical training

3.8 The number of credits registered by a candidate in non-project semester and project semester should be within the range specified below:

P.G. Programme	**Non-project Semester**	**Project semester**
M.Tech. (Full Time)	15 to 23	12 to 20
M.Tech. (Part Time)	6 to 12	12 to 16
M.C.A. (Full Time)	12 to 25	12 to 20
M.Sc. (Full Time)	15 to 25	12 to 20

3.9 The electives from the curriculum are to be chosen with the approval of the Head of the Department.

3.10 A candidate may be permitted by the Head of the Department to choose electives offered from other P.G. Programmes either within a Department or from other Departments up to a maximum of three courses during the period of his/her study, provided the Heads of the Departments offering such courses also agree.

3.11 To help the students to take up special research areas in their project work and to enable the department to introduce courses in latest/emerging areas in the curriculum, "Special Electives" may be offered. A candidate may be permitted to register for a "Special Elective" up to a maximum of three credits during the period of his/her study, provided the syllabus of this course is recommended by the Head of the Department and approved by the Dean (AC) before the commencement of the semester, in which the special elective course is offered. Subsequently, such course shall be ratified by the Board of Studies and Academic Council.

3.12 The medium of instruction, examination, seminar and project/thesis/ dissertation reports will be English.

3.13 Practical training or industrial attachment, if specified in the curriculum shall be of not less than four weeks duration and shall be organized by the Head of the Department.

3.14 PROJECT WORK/THESIS/DISSERTATION

3.14.1 Project work / Thesis / Dissertation shall be carried out under the supervision of a qualified teacher in the concerned Department.

3.14.2 A candidate may however, in certain cases, be permitted to work on the project in an Industrial/Research Organization, on the recommendation of Head of the Department, with the approval of the Head of the Institution. In such cases, the project work shall be jointly supervised by a supervisor of the Department and an Engineer / Scientist from the organization and the student shall be instructed to meet the supervisor periodically and to attend the review committee meetings for evaluating the progress.

3.14.3 Project work / Thesis / Dissertation (Phase - II in the case of M.Tech.) shall be pursued for a minimum of 16 weeks during the final semester, following the preliminary work carried out in Phase-1 during the previous semester.

3.14.4 The Project Report/Thesis / Dissertation report / Drawings prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the Head of the Institution.

3.14.5 The deadline for submission of final Project Report / Thesis / Dissertation is within 30 calendar days from the last working day of the semester in which Project / Thesis / Dissertation is done.

3.14.6 If a candidate fails to submit the Project Report / Thesis / Dissertation on or before the specified deadline he / she is deemed to have not completed the Project Work / Thesis / dissertation and shall re-register the same in a subsequent semester.

3.14.7 A student who has acquired the minimum number of total credits prescribed in the Curriculum for the award of the Masters Degree will not be permitted to enroll for more courses to improve his/her cumulative grade point average (CGPA).

4.0 FACULTY ADVISER

To help the students in planning their courses of study and for getting general advice on academic programme, the concerned department will assign a certain number of students to a faculty member who will be called the Faculty Adviser.

5.0 CLASS COMMITTEE

5.1 Every class of the P.G. Programme will have a Class Committee, constituted by the Head of the Department as follows:

i. Teachers of all courses of the programme

ii. One senior faculty preferably not offering courses for the class, as chairperson.

iii. One or two students of the class, nominated by the Head of the Department.

iv. Faculty Advisers of the class - Ex-Officio Members

v. Professor in-charge of the P.G. Programme - Ex-Officio Member.

5.2 The Class Committee shall be constituted by the respective head of the department of the students.

5.3 The basic responsibilities of the Class Committee are to review periodically the progress of the classes, to discuss problems concerning curriculum and syllabi and the conduct of the classes. The type of assessment for the course will be decided by the teacher in consultation with the Class Committee and will be announced to the students at the beginning of the semester. Each Class Committee will communicate its recommendations to the Head of the Department and the Head of the Institution. The class committee, **without the student members,** will also be responsible for finalization of the semester results.

5.4 The Class Committee is required to meet at least thrice in a semester, once at the beginning of the semester, another time after the end-semester examination to finalise the grades, and once in between.

6.0 COURSE COMMITTEE

Each common theory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers teaching the common course with one of them nominated as Course coordinator. The nomination of the Course coordinator shall be made by the Head of the Department / Head of the Institution depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The Course Committee shall meet as often as possible and ensure uniform evaluation of the tests and arrive at a common scheme of evaluation for the tests. Wherever it is feasible, the Course Committee may also prepare a common question paper for the test(s).

7.0 REGISTRATION AND ENROLMENT

7.1 For the first semester every student has to register and enroll for the courses he/she intends to undergo on a specified day notified to the student. The concerned Faculty Adviser will be present and guide the students in the registration/enrolment process.

7.2 For the subsequent semesters registration for the courses will be done by the student during a specified week before the end-semester examination of the previous semester. The curriculum gives details of the core and elective courses, project and seminar to be taken in different semester with the number of credits. The student should consult his/her Faculty Adviser for the choice of courses. The Registration form is filled in and signed by the student and the Faculty Adviser.

7.3 Late registration will be permitted with a prescribed fine up to two weeks from the last date specified for registration.

7.4 From the second semester onwards all students shall pay the prescribed fees and enroll on a specified day at the beginning of a semester.

A student will become eligible for enrolment only if he/she satisfies clause 9 and in addition he/she is not debarred from enrolment by a disciplinary action of the Institution. At the time of enrolment a student can drop a course registered earlier and also substitute it by another course for valid reasons with the consent of the Faculty Adviser. Late enrolment will be permitted on payment of a prescribed fine up to two weeks from the date of commencement of the semester.

7.5 Withdrawal from a course registered is permitted up to one week from the date of the completion of the first assessment test.

7.6 Change of a course within a period of 15 days from the commencement of the course, with the approval of Dean (AC), on the recommendation of the HOD, is permitted.

7.6.1 Courses withdrawn will have to be taken when they are offered next if they belong to the list of core courses.

7.7 SUMMER TERM COURSES

7.7.1 Summer term courses may be offered by a department on the recommendation by the Departmental Consultative Committee and approved by the Head of the Institution. No student should register for more than three courses during a summer term.

7.7.2 Summer term courses will be announced by the Head of the Institution at the end of the even semester before the commencement of the end semester examinations. A student will have to register within the time stipulated in the announcement. A student has to pay the fees as stipulated in the announcement.

7.7.3 Fast-track summer courses of 30 periods for 3 credit courses and 40 periods for 4 credit courses will be offered for students with I grades. They may also opt to redo such courses during regular semesters with slotted time-tables. Students with U grades will have the option either to write semester end arrears exam or to redo the courses during summer / regular semesters with slotted time-table, if they wish to improve their continuous assessment marks also.

The assessment procedure in a summer term course will also be similar to the procedure for a regular semester course.

7.7.4 Withdrawal from a summer term course is not permitted. No substitute examination will be held for the summer term courses.

8.0 TEMPORARY WITHDRAWAL FROM THE PROGRAMME

A student may be permitted by the Head of the Institution to temporarily withdraw from the programme up to a maximum of two semesters for reasons of ill health or other valid grounds. However the total duration for completion of the programme shall not exceed the prescribed number of semesters (vide clause 3.1).

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / THESIS / DISSERTATION

9.1 A candidate is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum No. of credits to be earned to enrol for project semester
M.Tech. (Full time)	18 (III semester)
M.Tech. (Part-time)	18 (V semester)
M.C.A. (Full time)	45 (VI semester)
M.Sc. (Full-time)	28 (IV semester)

9.2 **M.Tech.:** If the candidate has not earned minimum number of credits specified, he/she has to earn the required credits (at least to the extent of minimum credit specified in clause 9.1) and then register for the project semester.

9.3 **M.C.A.:** If the candidate has not earned the required minimum number of credits specified he/she has to earn the required credits (at least to the extent of minimum credits specified in clause 9.1) and then register for the project work in subsequent semesters.

10.0 DISCIPLINE

10.1 Every candidate is required to observe discipline and decorous behaviour both inside and outside the campus and not to indulge in any activity, which will tend to bring down the prestige of the institution.

10.2 Any act of indiscipline of a candidate reported to the Head of the Institution will be referred to a Discipline and Welfare Committee for taking appropriate action.

10.3 Every candidate should have been certified by the HOD that his / her conduct and discipline have been satisfactory.

11.0 ATTENDANCE

11.1 Attendance rules for all Full Time Programme and Part time - day Time Programmes are given in the following sub-clauses.

11.2 A student **shall earn 100% attendance** in the contact periods of every course, subject to a **a maximum relaxation of 25%** for genuine reasons like on medical grounds , representing the University in approved events etc., to become eligible to appear for the end-semester examination in that course, failing which the student shall be awarded "I" grade in that course. If the course is a core course, the candidate should register for and repeat the course when it is offered next.

12.0 ASSESSMENTS AND EXAMINATIONS

12.1 The following rule shall apply to the full-time and part-time P.G. programmes (M.Tech./ M.C.A. / M.Sc.)

For lecture-based courses, normally a minimum of two assessments will be made during the semester. The assessments may be combination of tests and assignments. The assessment procedure as decided at the Class Committee will be announced to the students right at the beginning of the semester by the teacher and informed to Dean(AC)

12.2 There shall be one **examination** of three hours duration, at the end of the semester, in each lecture based course.

12.3 The evaluation of the Project work will be based on the project report and a Viva-Voce Examination by a team consisting of the supervisor concerned, an Internal Examiner and External Examiner to be appointed by the Controller of Examinations.

12.4 At the end of practical training or industrial attachment, the candidate shall submit a certificate from the organization where he/she has undergone training and also a brief report. The evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a Departmental Committee constituted by the Head of the Department.

13.0 WEIGHTAGES

13.1 The following shall be the weightages for different courses:

i) Lecture based course		
Two sessional assessments	-	50%
End-semester examination	-	50%
ii) Laboratory based courses		
Laboratory work assessment	-	75%
End-semester examination	-	25%
iii) Project work		
Periodic reviews	-	50%
Evaluation of Project Report by External Examiner	-	20%
Viva-Voce Examination	-	30%

13.2 The markings for all tests, tutorial assignments (if any), laboratory work and examinations will be on absolute basis. The final percentage of marks is calculated in each course as per weightages given in clause 13.1.

14.0 SUBSTITUTE EXAMINATION

14.1 A student who has missed for genuine reasons any one of the three assessments including end-semester examination of a course may be permitted to write a substitute examination. However, permissions to take up a substitute examination will be given under exceptional circumstances, such as accident or admissions to a hospital due to illness, etc.,

14.2 A student who misses any assessment in a course shall apply in a prescribed form to the Dean(AC) through the Head of the department within a week from the date of missed assessment. However the substitute tests and examination for a course will be conducted within two weeks after the last day of the end-semester examinations.

15.0 COURSEWISE GRADING OF STUDENTS AND LETTER GRADES:

15.1 Based on the semester performance, each student is awarded a final letter grade at the end of the semester in each course. The letter grades and the corresponding grade points are as follows, but grading has to be relative grading

Letter grade	Grade points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
I	-
W	-

Flexible range grading system will be adopted

"W" denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevention from End Semester examination.

"U" denotes unsuccessful performance in a course.

15.2 A student is considered to have completed a course successfully and earned the credits if he / she secure five grade points or higher. A letter grade U in any course implies unsuccessful performance in that course. A course successfully completed cannot be repeated for any reason.

16.0 METHOD OF AWARDING LETTER GRADE:

16.1 A final meeting of the Class Committee without the student member(s) will be convened within ten days after the last day of the semester end examination. The letter grades to be awarded to the students for different courses will be finalized at the meeting.

16.2 Three copies of the results sheets for each course, containing the final grade and three copies with the absolute marks and the final grade should be submitted by the teacher to the concerned Class Committee Chairman. After finalisation of the grades at the class committee meeting the Chairman will forward two copies of each to the Controller of Examinations and the other copies to the Head of the Department in which course is offered.

17.0 DECLARATION OF RESULTS:

17.1 After finalisation by the Class Committee as per clause 16.1 the Letter Grades awarded to the students in the each course shall be announced on the departmental notice board after duly approved by the Controller of Examinations. In case any student feels aggrieved, he/she can apply for revaluation after paying the prescribed fee for the purpose, within two weeks from the commencement of the semester immediately following the announcement of results. A committee will be constituted by the Controller of Examinations comprising the Chairperson of the concerned Class Committee (Convener), the teacher concerned and another teacher of the department who is knowledgeable in the concerned course. If the Committee finds that the case is genuine, it may jointly revalue the answer script and forward the revised mark to the Controller of Examinations with full justification for the revision if any.

17.2 The **"U"** grade once awarded stays in the grade sheet of the students and is not deleted when he/she completes the course successfully later. The grade acquired by the student later will be indicated in the grade sheet of the appropriate semester.

18.0 COURSE REPETITION AND ARREARS EXAMINATION

18.1 A student should register to re-do a core course wherein "I" or "W" grade is awarded. If the student is awarded "I", or "W" grade in an elective course either the same elective course may be repeated or a new elective course may be taken.

18.2 A student who is awarded "U" grade in a course shall write the end-semester examination as arrear examination , at the end of the next semester, along with the regular examinations of next semester courses. **The marks earned earlier in the continuous assessment tests for the course, will be used for grading along with the marks earned in the end-semester arrear examination for the course.**

19.0 GRADE SHEET

19.1 The grade sheet issued at the end of the semester to each student will contain the following:

(i) the credits for each course registered for that semester.

(ii) the performance in each course by the letter grade obtained.

(iii) the total credits earned in that semester.

(iv) the Grade Point Average (GPA) of all the courses registered for that semester and the Cumulative Grade Point Average (CGPA) of all the courses taken up to that semester.

19.2 The GPA will be calculated according to the formula

$$GPA = \frac{\sum_i (Ci)(GPi)}{\sum_i Ci}$$

where C_i is the number of credits assigned for i^{th} course
GP_i - Grade point obtained in the i^{th} course
For the cumulative grade point average (CGPA) a similar formula is used except that the sum is over all the courses taken in all the semesters completed up to the point in time.

I and W grades will be excluded for GPA calculations.

U, I and W grades will be excluded for CGPA calculations.

19.3 Classification of the award of degree will be as follows:

CGPA	Classification
8.50 and above, having completed in first appearance in all courses	First class with Distinction
6.50 and above, having completed within a period of 2 semesters beyond the programme period.	First Class
All others	Second Class

However, to be eligible for First Class with Distinction, a candidate should not have obtained U or I grade in any course during his/her study and should have completed the P.G. Programme within a minimum period covered by the minimum duration (clause 3.1) plus authorized break of study, if any (clause 8). To be eligible for First Class, a candidate should have passed the examination in all courses within the specified minimum number. of semesters reckoned from his/her commencement of study plus two semesters. For this purpose, the authorized break of study will not be counted. The candidates who do not satisfy the above two conditions will be classified as second class. For the purpose of classification, the CGPA will be rounded to first decimal place. For the purpose of comparison of performance of candidates and ranking, CGPA will be considered up to three decimal places.

20 ELIGIBILITY FOR THE AWARD OF THE MASTERS DEGREE

20.1 A student shall be declared to be eligible for the award of the Masters Degree, if he/she has:

i) registered for and undergone all the core courses and completed the Project Work,

ii) successfully acquired the required credits as specified in the Curriculum corresponding to his/her programme within the stipulated time,

iii) successfully completed the field visit/industrial training, if any, as prescribed in the curriculum.

iv) has no dues to the Institution, Hostels and Library.

v) no disciplinary action is pending against him/her

20.2 The award of the degree must be approved by the University.

21.0 POWER TO MODIFY:

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

****

CURRICULUM
FOR M.Tech.
POWER ELECTRONICS AND DRIVES

M.TECH. (POWER ELECTRONICS AND DRIVES)
(FOUR SEMESTER-FULL TIME)

PROGRAMME OBJECTIVES:

- To impart education and to train graduate engineers in the field of Power Electronics which has a significant role in the 21st century and beyond, in Industrial, commercial, residential, aerospace, utility and military applications, with the emphasis on Energy Saving and solving Environmental Pollution problems.
- To engage the graduates in research activities leading to innovative applications of technology like interfacing of Power Electronic controllers with non-conventional energy sources for its effective utilization, improvising the present systems with the help of Artificial Intelligence techniques, for the benefit of mankind and to become responsible citizens of the country, with a willingness to serve the society.
- To provide scope to work in Production, Maintenance and Research and development division in leading core companies to face the challenges of the future.

CURRICULUM

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C	TC
Theory							
1	MA 615	Applied Mathematics for Electrical Engineers	3	1	0	4	
2	EE 621	Modelling and Analysis of Electrical Machines	3	1	0	4	
3	EE 622	Advanced Power Semiconductor Devices	3	0	0	3	
4	EE 623	Analysis of Power Converters	3	0	0	3	
5	EE 624	Analysis of Inverters	3	0	0	3	
6		Elective - I	3	0	0	3	
PRACTICAL							
7	EE 625	Modelling & Simulation Laboratory	0	0	3	2	**22**

SEMESTER II

Sl. No	Course Code	Course	L	T	P	C	TC
Theory							
1	EE 626	Simulation of Power Electronic Systems	3	0	0	3	
2	EE 627	Solid State DC Drives	3	0	0	3	
3	EE 628	Solid State AC Drives	3	0	0	3	
4	EE 629	Embedded control of Electrical Drives	3	0	2	4	
5		Elective - II	3	0	0	3	
6		Elective - III	3	0	0	3	
PRACTICAL							
7	EE 630	Power Electronics and Drives Lab	0	0	3	2	**21**

SEMESTER III

Sl. No	Course Code	Course	L	T	P	C	TC
Theory							
1		Elective IV	3	0	0	3	
2		Elective V	3	0	0	3	
3		Elective VI	3	0	0	3	
PRACTICAL							
4	EE 721	Project Work (Phase -I)	0	0	12	6	**9**

SEMESTER IV

Sl. No	Course Code	Course	L	T	P	C	TC
PRACTICAL							
1	EE 721	Project work (Phase -II)	0	0	35	18*	**24***

TOTAL CREDITS 76

Note: * Credits for Project work (Phase-I) of third semester will be accounted along with Project work (Phase-II) of fourth semester

List of Electives

Course Code	Course Title	L	T	P	C
EEY031	Digital Signal Processing	3	0	0	3
EEY032	Digital Signal Processors	3	0	0	3
EEY033	Advances in Power Electronics	3	0	0	3
EEY034	Power Electronics In Wind and Solar Power Conversion	3	0	0	3
EEY035	Power Electronic Applications to Power Systems	3	0	0	3
EEY036	Robotics and Factory Automation	3	0	0	3
EEY037	Advanced Control of Electric Drives	3	0	0	3
EEY038	SCADA and DCS	3	0	0	3
EEY039	Microcontrollers and Applications	3	0	0	3
EEY040	Converters, Applications & Design	1	2	0	3
MEY012	Research Methodology	3	0	0	3
EEY004	Special Electrical Machines	3	0	0	3
CSY098	Soft Computing Techniques	3	0	0	3
EE 604	Systems Theory	3	0	0	3
EEY014	High Voltage Direct Current Transmission	3	0	0	3
EE 608	Flexible AC Transmission Systems	3	0	0	3
EEY015	Wind Energy Conversion Systems	3	0	0	3
EEY016	Power Electronics for Renewable Energy Systems	3	0	0	3
EEY005	Power Quality	3	0	0	3

SYLLABUS
FOR M.Tech.
POWER ELECTRONICS AND DRIVES

SEMESTER - I

		L	T	P	C
MA 615	APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS	3	1	0	4

COURSE OBJECTIVE:

The aim of this course is to acquire the knowledge and applications of norm matrix, Linear Programming problem solving techniques and its applications, applications of calculus of variations and to acquire knowledge of application of queuing theory in electrical engineering problems.

1. ADVANCED MATRIX THEORY **9**

Eigen-values using QR transformations - Generalized Eigen vectors - Canonical forms - Singular value decomposition and applications - Pseudo inverse - Least square approximations.

2. LINEAR PROGRAMMING **9**

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

3. ONE DIMENSIONAL RANDOM VARIABLES **9**

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

4. QUEUEING MODELS **9**

Poisson Process - Markovian queues - Single and multi Server models - Little's formula - Machine interference model - Steady state analysis - Self service queue.

5. COMPUTATIONAL METHODS IN ENGINEERING **9**

Boundary value problems for ODE - Finite difference methods - Numerical solution of PDE - Solution of Laplace and Poisson equations - Liebmann's iteration process - Solution of heat conduction equation by Schmidt explicit formula and Crank-Nicolson implicit scheme - Solution of wave equation.

L = 45 T = 15 TOTAL = 60 Hrs

REFERENCES:

1. Bronson, R., ‘Matrix Operation’, Schaum's outline series, Tata McGraw -Hill, New York, (1989).
2. Taha, H. A., Operations Research: An Introduction, seventh edition, Pearson Education, Asia, New Delhi (2002).
3. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, “Probability and Statistics for Engineers & Scientists”, Asia, 8^{th} Edition, (2007).
4. Donald Gross and Carl M. Harris, “Fundamentals of Queueing theory”, 2^{nd} edition, John Wiley and Sons, New York (1985).
5. Grewal, B.S., “Numerical methods in engineering and science”, 7^{th} edition, Khanna Publishers, 2007.

EE 621	MODELLING AND ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

The aim of this course is to expose the students to the Electro-Mechanical energy conversion techniques and to impart knowledge on Reference frame theory, Transformational variables, Analysis of conventional machines (DC machines, Induction machines and synchronous machines) using the Reference frame theory to predict torque, output and performance of the machine.

1. PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 8

General expression of stored magnetic energy-Co-energy and force/torque Example using single and doubly excited system.

2. BASIC CONCEPTS OF ROTATING MACHINES 9

Calculation of air gap mmf and per phase machine inductance using physical machine data-Voltage and torque equations of DC machine- three phase symmetrical induction machine and salient pole synchronous machines in phase variable form.

3. INTRODUCTION TO REFERENCE FRAME THEORY 11

Static and rotating reference frames- transformation relationships, examples using static symmetrical three phase R, R-L, R-L-M and R-L-C circuits Application of reference frame, theory to three phase symmetrical induction and synchronous machines - Dynamic direct and quadrature axis - Model in arbitrarily rotating reference frames Voltage and torque - Equations derivation of steady state phasor relationship from dynamic model - Generalized theory of rotating electrical machine and Kron's primitive machine.

4. DETERMINATION OF SYNCHRONOUS MACHINE DYNAMIC EQUIVALENT CIRCUIT PARAMETERS 8

Standard and derived machine time constants-Frequency response test Analysis and dynamic modelling of two phase asymmetrical induction machine and single phase induction machine.

5. SPECIAL MACHINES 9

Permanent magnet synchronous machine - Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines - Construction and operating principle - Dynamic modelling and self controlled operation; Analysis of Switched Reluctance Motors.

L = 45

T = 15 Total = 60 Hrs

TEXT BOOKS

1. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans "Electric Machinery", Tata McGraw - Hill, Fifth Edition, 1992.
2. R. Krishnan, "Electric Motor & Drives: Modelling, Analysis and Control", Prentice Hall of India, 2001.

REFERENCES

1. C.V.Jones, "The Unified Theory of Electrical Machines", Butterworth, London, 1967.
2. Miller, T.J.E. "Brushless permanent magnet and reluctance motor drives" Clarendon Press, Oxford, 1989.

EE 622 ADVANCED POWER SEMICONDUCTOR DEVICES

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to study the analysis, modelling of power semiconductor devices and to acquaint the students with construction, theory and characteristics of devices like MOSFETS, BJTs, IGBTs, Thyristor, High power devices, Intelligent power modules Pulse power devices , Novel device structures in Si, SiC, GaAs and diamond, Programmable intelligent power modules and their protection circuitry.

1. INTRODUCTION 9

Power switching devices overview - Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability - (SOA); Device selection strategy - On-state and switching losses - EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics - rating.

2. CURRENT CONTROLLED DEVICES 9

BJT's - Construction, static characteristics, switching characteristics - Negative temperature co-efficient and secondary breakdown - Power darlington - Thyristors - Physical and electrical principle underlying operating mode-Two transistor analogy - Concept of latching - Gate and switching characteristics converter grade and inverter grade and other types - Series and parallel operation - Comparison of BJT and Thyristor - Steady state and dynamic models of BJT & Thyristor.

3. VOLTAGE CONTROLLED DEVICES 9

Power MOSFETs and IGBTs - Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.

4. FIRING AND PROTECTING CIRCUITS 9

Necessity of isolation, pulse transformer, optocoupler - Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protection - Design of snubbers.

5. THERMAL PROTECTION 9

Heat transfer - Conduction, convection and radiation - Cooling Liquid cooling, vapour Phase cooling - Guidance for hear sink selection - Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design - Mounting types.

L=45

Total = 45 Hrs

TEXT BOOKS

1. B.W. Williams, "Power Electronics Circuit Devices and Applications", Tata McGraw-Hill, 1992.

2. Rashid M.H., "Power Electronics Circuits, Devices and Applications, " Prentice Hall India, Third Edition, New Delhi, 2004.

REFERENCES

1. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw-Hill, 2001.

2. Mohan, Undeland and Robins, "Power Electronics - Concepts, applications and Design", John Wiley and Sons, Singapore, 2000.

EE 623	ANALYSIS OF POWER CONVERTERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to make the students learn the fundamentals of power electronic components, circuit analysis techniques, design skills, acquire basic understanding of various power converter modules used to build power electronics system and acquire the ability to select and design suitable power converter modules/ system in order to meet requirements of industrial applications.

1. SINGLE PHASE AC-DC CONVERTER 9

Uncontrolled, half controlled and fully controlled converters with R-L, R-L-E loads and Freewheeling diodes - Continuous and discontinuous models of operation - Inverter operation - Dual converter - Sequence control of converters - Performance parameters, harmonics, ripple, distortion, power factor - Effect of source impedance and overlap.

2. THREE PHASE AC-DC CONVERTER 9

Uncontrolled and fully controlled - converter with R, R-L, R-L-E - Loads and freewheeling diodes - Inverter operation and its limit - Dual inverter - performance parameters - Effect of source impedance and over lap

3. DC-DC CONVERTERS 9

Principles of step-down and step-up converters - Analysis of buck, boost, buck-boost and Cuk converters - Time ratio and current limit control - Full bridge converter - Resonant and quasi - Resonant converters.

4. AC VOLTAGE CONTROLLERS 9

Principle of phase control - single phase and three phase controllers - Various configurations - Analysis with R and R-L loads.

5. CYCLOCONVERTERS 9

Principle of operation - Single phase and three phase cycloconverters - Power circuits and gating signals.

L = 45
Total = 45 Hrs

TEXT BOOKS

1. Ned Mohan,Undeland and Robbin, "Power Electronics: converters, Application and design" John Wiley and sons.Inc,New York,1995.
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, New Delhi, 1995.

REFERENCES

1. P.C Sen., "Modern Power Electronics", Wheeler publishing Co, First Edition, New Delhi-1998.
2. P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003.

EE 624	ANALYSIS OF INVERTERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

PURPOSE:

To enable the students to understand the operating principle and steady state analysis of various inverters.

INSTRUCTIONAL OBJECTIVES:

- To understand the operation of various inverter circuits.
- To design the various types of inverter circuits and apply these circuits to practical applications.
- To analyze the single phase voltage source inverter forced commutated inverters- three phase VSI with three phase loads.
- To know the operation of single phase and three phase CSI
- To know the operation and applications of multilevel inverters
- To know the operation of the various types of resonant inverters.

1. SINGLE PHASE INVERTERS 9

Introduction to self commutated switches, MOSFET, IGBT - Principle of operation of half and full bridge inverters - Performance parameters - Voltage control of single phase inverters using various PWM techniques - various harmonic elimination techniques - forced commutated Thyristor inverters.

2. THREE PHASE VOLTAGE SOURCE INVERTERS 9

180 degree and 120 degree conduction mode inverters with star and delta connected loads - Voltage control of three phase inverters, single multi pulse, sinusoidal, space vector modulation techniques.

3. CURRENT SOURCE INVERTERS 9

Operation of six-step thyristor Inverter - Inverter operation modes - Load - commutated inverters - Auto sequential current source inverter (ASCI) - Current pulsations - Comparison of current source inverter and voltage source inverters

4. MULTILEVEL INVERTERS 9

Multilevel concept - Diode clamped - Flying capacitor - Cascade type multilevel inverters - Comparison of multilevel inverters - Application of multilevel inverters

5. RESONANT INVERTERS 9

Series and parallel resonant inverters - Voltage control of resonant inverters - Class E resonant inverter - Resonant DC - Link inverters.

L = 45

Total = 45 Hrs

TEXT BOOKS

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
2. Jai P. Agrawal, "Power Electronics Systems", Pearson Education, Second Edition, 2002.

REFERENCES

1. P.C. Sen, "Modern Power Electronics", Wheeler Publishing Co, First Edition, New Delhi, 1998.
2. P.S.Bimbra, " Power Electronics", Khanna Publishers, Eleventh Edition, 2003.
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.

EE 625	**MODELLING & SIMULATION LABORATORY (Any 10 Experiments)**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**

COURSE OBJECTIVE:

The aim of this course is to enable the students to understand the modelling details of power electronic components and circuits in detail, the behavior of controlled rectifier circuits for different types of electrical loads, the working of different type of power electronic converters.

LIST OF EXPERIMENTS

1 Modelling of simple PN junction diode.

2 Modelling of silicon controlled rectifier.

3 Modelling of MOSFET / IGBT / BJT

4 Simulation of single phase semi converter
   a) R Load.
   b) RL load.
   c) RLE (Motor) load

5 Simulation of single phase fully controlled converter.
   a) R Load.
   b) RL load.
   c) RLE (Motor) Load

6 Simulation of single phase dual converter.

7 Simulation of three phase semi converter.

8 Simulation of three phase fully controlled converter

9 Simulation of single phase full bridge Inverter

10 Simulation of three phase full bridge inverter.
   a) 180 degree mode operation
   b) 120 degree mode operation

11 Simulation of PWM inverters
   a) Sinusoidal PWM
   b) Square PWM

12 Simulation of Three phase AC Voltage Controller.
   a) Lamp load
   b) Motor load

P = 45
Total = 45 Hrs

SEMESTER II

EE 626 SIMULATION OF POWER ELECTRONICS SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to expertise the students with the software packages like Matlab Simulink, Pspice, M file and the process of interfacing Matlab Simulink with M-file using S-function blocks, develop and describe dynamic behavior of basic Power Electronic circuits to meet the specific functional objectives , develop and outline operating principles and application of power electronic circuits as motor drives. In addition to learning the practical aspects of converters, load and supply side interactions, the students will also have a better understanding of the close relationship between hardware and simulation models of actual systems.

1. INTRODUCTION 9

Need for Simulation - Challenges in simulation - Classification of simulation programs - Overview of PSPICE, MATLAB and SIMULINK. Mathematical Modelling of power electronic Systems: Static and dynamic models of power electronic switches - Static and dynamic equations and state-space representation of power electronic systems.

2. PSPICE 9

File formats - Description of circuit elements - Circuit description - Output variables -Dot commands - SPICE models of Diode, Thyristor, Triac, BJT, Power MOSFET, IGBT and MCT.

3. MATLAB and SIMULINK 9

Toolboxes of MATLAB - Programming and file processing in MATLAB - Model definition and model analysis using SIMULINK - S-Functions - Converting S-Functions to blocks.

4. SIMULATION USING PSPICE, MATLAB and SIMULINK 9

Diode rectifiers -Controlled rectifiers - AC voltage controllers - DC choppers - PWM inverters - Voltage source and current source inverters - Resonant pulse inverters -Zero current switching and zero voltage switching inverters.

5. SIMULATION OF DRIVES 9

Simulation of speed control schemes for DC motors - Rectifier fed DC motors - Chopper fed DC motors - VSI and CSI fed AC motors - PWM Inverter - DC link inverter.

Total 45 Hrs

Reference Books

1 Ramshaw. E., Schuuram D. C., "PSpice Simulation of Power Electronics Circuits - An Introductory Guide", Springer, New York, 1996.

2 Chee-Mun Ong, "Dynamic Simulation of Electric Machinery: Using MATLAB/ Simulink", Prentice Hall PTR, New Jersey, 1998.

3 Ned Mohan, "Power Electronics: Computer Simulation Analysis and Education using PSPICE", Minnesota Power Electronics Research and Education, USA,1992.

4 Bimal K Bose, "Power Electronics and Variable Frequency Drives", IEEE Press, New Jersey, 1996.

5 "The PSpice User's Guide", Microsim Corporation, California, 1996.

EE 627	SOLID STATE DC DRIVES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to study and understand the operation of electric drives controlled from a power electronic converter and to introduce the design concepts of controllers. Also this course enables the students to understand the stable steady-state operation and transient dynamics of a motor-load system, to study and analyze the operation of the converter / chopper fed direct current drive and to solve simple problems, analyze the closed loop control and digital control of direct current drives, design the current and speed controllers for a closed loop solid-state direct current motor drive.

1. DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS 9

DC motor - Types-Induced emf - Speed-torque relations - Speed control - Armature and field speed control - Water Leonard control - Constant torque and constant horse power operations.

Characteristics of mechanical system - Dynamic equations - Components of torque, Types of load - Requirements of drives characteristics - multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

2. CONVERTER CONTROL 9

Principle of phase control - Fundamental relations - Analysis of series and separately excited DC motor with single-phase and three-phase converters - Waveforms, performance parameters, performance characteristics.

Continuous and discontinuous armature current operations - Current ripple and its effect on performance - Operation with freewheeling diode; Implementation of braking schemes - Drive employing dual converter.

3. CHOPPER CONTROL 9

Introduction to time ratio control and frequency modulation - Class A, B, C, D and E chopper controlled DC motor - Performance analysis, multi-quadrant control - Chopper based implementation of braking schemes - Multi-phase chopper - Related problems.

4. CLOSED LOOP CONTROL 9

Modelling of drive elements - Equivalent circuit, transfer function of self, separately excited DC motors - Linear Transfer function model of power converters; Sensing and feed back elements - Closed loop speed control - current and speed loops, P, PI and PID controllers - response comparison. Simulation of converter and chopper fed d.c drive.

5. DIGITAL CONTROL OF D.C DRIVE 9

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

L = 45

Total = 45 Hrs

TEXT BOOKS

1. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New jersy, 1989.

2. R.Krishnan, "Electric Motor Drives - Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

REFERENCES

1. Gobal K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2001.

2. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.

3. Vedam Subramanyam, "Electric Drives - Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.

EE 628 SOLID STATE AC DRIVES

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to study and understand the operation of both conventional speed control and power electronic control of induction motor, the differences between synchronous motor drive and induction motor drive, the torque control of induction machine drive, field oriented control and flux vector estimation of induction motor, the synchronous motor control using brush and brushless excitation and load commutated inverter fed drives.

1. CONVENTIONAL CONTROL OF INDUCTION MOTORS 9

Review of induction machine operation - Equivalent circuit - Performance of the machine with variable voltage, rotor resistance variation, pole changing and cascaded induction machines, slip power recovery - Static Kramer drive.

2. VSI AND CSI FED INDUCTION MOTOR CONTROL 9

AC voltage controller fed induction machine operation - Energy conservation issues - V/F operation theory - Requirement for slip and stator voltage compensation. CSI fed induction machine - Operation and characteristics.

3. FIELD ORIENTED CONTROL 9

Field oriented control of induction machines - Theory - DC drive analogy - Direct and Indirect methods - Flux vector estimation.

4. DIRECT TORQUE CONTROL 9

Direct torque control of induction machines - Torque expression with stator and rotor fluxes - DTC control strategy.

5. SYNCHRONOUS MOTOR CONTROL 9

Synchronous motor control - Brush and brushless excitation - Load commutated inverter fed drive.

L = 45

Total = 45 Hrs

TEXT BOOKS

1. Bimal K Bose, "Modern Power Electronics and AC Drives" , Pearson Education Asia 2002.

2. Vedam Subramanyam, "Electric Drives - Concepts and Applications", Tata McGraw-Hill, 1994.

REFERENCES

1. W.Leonhard , "Control of Electrical Drives", Narosa Publishing House, 1992.

2. Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press, Oxford, 1988.

EE 629 EMBEDDED CONTROL OF ELECTRICAL DRIVES

L	T	P	C
3	0	2	4

COURSE OBJECTIVE:

The objective of this course is to give hands on experience with the Microcontrollers 8051, ARM 7, PIC18FXX2 for Electrical Drives applications.

1. 8051 MICROCONTROLLER 9

Architecture - Memory organization - Addressing modes - Programming techniques using C and Assembly Instruction set - Interrupt Programming - I/O ports programming - Serial Communication Programming - Timer, and Counter Programming -- Interfacing I/O Devices.

2. ARM PROCESSOR

Introduction to ARM7 & ARM9 architecture - ARM Processor Fundamentals - ARM-THUMB mode - System Control Block Functions - Memory Accelerator Module - GPIO - UART0 / UART1- I^2C Interface / SPI Interface - Timer 0 / Timer 1 - Pulse Width Modulator - Real Time Clock - Watchdog Timer - Serial port programming for PC Communication - Keypad and LCD display Interfacing - Frequency Measurement - SPI interface based external DAC - ADC - PID Controller - Relay / SSR interfacing with and without optoisolation - Development tools for High level language - C, Device programming

3. PIC18FXX2 MICROCONTROLLER 9

Architecture - memory organization - addressing modes - instruction set - programming techniques using C and Assembly

4. PERIPHERAL OF PIC18FXX2 MICROCONTROLLER 9

Timers - Capture / Compare / PWM (CCP) Modules - Interrupts - I/O ports - I^2C bus for peripheral chip access - A/D converter - USART

5. SYSTEM DESIGN USING MICROCONTROLLERS 9

Interfacing LCD display - Keypad interfacing - AC load control - PID control of DC motor - Stepper motor control - Brushless DC motor control.

6. PRACTICAL SESSION 30

Comparison of Architectural features of various Microcontrollers - Interrupt Programming - I/O ports Programming - USART Programming - I^2C bus for peripheral chip access - Keypad and LCD display Interfacing - ADC and DAC Data Converters - PWM Signal Generation - Programming for AC load control, PID control of DC motor, Stepper motor control - Other Applications

`

L = 45 P = 30

Total = 75 Hrs

TEXT BOOKS

1. Barry B. Brey, "Applying PIC18 Microcontrollers: Architecture, Programming, and Interfacing using C and Assembly", Prentice Hall, 2007
2. Myke Predko, "Programming and customizing the 8051 microcontroller", Tata McGraw Hill 2001
3. Andrew Sloss, Dominic Symes, Chris Wright "ARM System Developer's Guide", Morgan Kaufmann, 2004
4. Mazidi, Rolin McKinlay, Danny Causey, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC 18", Prentice Hall, 2009

REFERENCES

1. Barry B. Brey, "Outlines & Highlights for Applying PIC18 Microcontrollers: Architecture, Programming, and Interfacing Using C and Assembly" -With CD, AIPI, 2009
2. Dogan Ibrahim, "Advanced PIC Microcontroller Projects in C: From USB to RTOS with the PIC18F Series", Elsevier Ltd, 2008
3. Han-Way Huang, Leo Chartrand, "PIC Microcontroller: An Introduction to Software & Hardware Interfacing", Delmar Cengage Learning, 2004
4. Ramesh Gaonkar, "Fundamentals of Microcontrollers and Applications in Embedded Systems with PIC", Delmar Cengage Learning, 2007
5. David Seal, "ARM Architecture Reference Manual", 2^{nd} Edition, Addison-Wesley.

EE 630 POWER ELECTRONICS AND DRIVES LABORATORY

L	T	P	C
0	0	3	2

COURSE OBJECTIVE:

The aim of this course is to understand the design and modelling of Electric drives in detail, and to enable the student to obtain a firm grasp of various Power Electronic Circuits and their practical applications in drives. Also this course imparts knowledge on both hardware circuitry and simulation of converter fed drives.

List of Experiments

1. Fabrication of Chopper fed DC drive using high voltage driver ICs (IR 21XX series)
2. DSP controlled AC drive.
3. Space Vector PWM based Induction motor drive using PIC 16F877A micro controller.
4. Harmonic Analysis of converter Fed Drive.
5. Fabrication of IGBT based three phase PWM inverter.
6. IGBT based three phase SVPWM inverter. Fabrication of Phase Shifted Resonant inverters using PIC 18FXXX series micro controllers.
7. Simulation of Power Electronic Systems using PSPICE
8. Modelling and Simulation of Electric Drives using MATLAB
9. Simulation of closed loop control of converter fed DC motor drive.
10. Simulation of closed loop control of chopper fed DC motor drive.
11. Simulation of VSI fed three phase induction motor drive.
12. Simulation of three phase synchronous motor and drive.

P = 45

Total = 45 Hrs

SEMESTER III

EE 721	**PROJECT WORK (PHASE I)**	**L**	**T**	**P**	**C**
		0	**0**	**12**	**6**

Refer clause 3.14 of BS ABDUR RAHMAN University Regulations

SEMESTER IV

		L	T	P	C
EE 721	**PROJECT WORK (PHASE - II)**	**0**	**0**	**35**	**18***

Refer clause 3.14 of BS ABDUR RAHMAN University Regulations

Note: * Credits for Project work (Phase-I) of third semester will be accounted along with Project work (Phase-II) of fourth semester.

ELECTIVES

EEY031 DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to design algorithms for implementation of simple finite impulse response filters, analyze a digital system using Z transforms and discrete time Fourier transforms.

1. DISCRETE TIME SIGNALS AND SYSTEMS 9

Representation of discrete time signal - classifications - Discrete time system - Basic, operations on sequential linear, Time, invariant Causal, Stable, Systems solution to differential equation - convolution sum - correlation - Discrete time Fourier series - Discrete time Fourier transform.

2. FOURIER AND STRUCTURE REALIZATION 9

Discrete Fourier transform - Properties - Fast Fourier transform - Z-transform - structure realization - Direct form - Lattice structure for FIR filter - Lattice structure for IIR Filter.

3. FILTERS 9

FIR Filter - Windowing technique - optimum equiripple linear phase FIR filter - IIR filter - Bilinear transformation technique - Impulse invariance method - Butterworth filter - Tchebyshev filter.

4. MULTISTAGE REPRESENTATION 9

Sampling of band pass signal - Antialiasing filter - Decimation by an integer factor - Interpolation by an integer factor - Sampling rate conversion - implementation of digital filter banks - Sub-band coding - Quadrature mirror filter - A/D conversion - Quantization - Coding - D/A conversion - Introduction to wavelets.

5. DIGITAL SIGNAL PROCESSORS 9

Fundamentals of fixed point DSP architecture - Fixed point number representation and computation - Fundamentals of floating point DSP architecture - Floating point number representation and computation - Study of TMS 320 C 50 processor - Basic programming, addition, subtraction, multiplication, convolution, correlation - Study of TMS 320 C 54 processor -

Basic programming - addition - subtraction - multiplication - convolution-correlation.

L = 45 Total = 45 Hrs

REFERENCES

1. John G.Proakis, Dimitris G.Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall India, 4th editions.
2. S.Salivahanan, A.Vallavaraj and C.Gnanapriya "Digital Signal Processing", Tata McGraw - Hill, 2000.
3. A.V. Oppenheim and R.W.Schafer, Englewood "Digital Signal Processing", Prentice Hall, Inc. 1975.
4. Rabiner and Gold, "Theory and Application of Digital Signal Processing", A comprehensive, Industrial - Strength DSP reference book, Prentice Hall, Inc.1975.
5. B.Venkatramani & M.Bhaskar, "Digital Signal Processors architecture, Programming and Applications", Tata McGraw - Hill, 2002.

EEY032	DIGITAL SIGNAL PROCESSORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to impart knowledge on architectural details and instruction set available for the TMS320C6x processor, Special instructions and assembler directives that are useful in Digital Signal Processing programming, the Texas instrument's software development tool named Code Composer Studio (CCS) through programming examples, Infinite Impulse response and Finite Impulse Response filtering applications and their real time implementation on the TMS320C6713, Implementation of several key DSP algorithms like Discrete Fourier Transform, Fast Fourier Transform and Least mean square algorithm etc., Input and output (I/O) with the codec on the DSK board through many programming examples., DSP/BIOS and real time data transfer (RTDX) and communication between PC and the DSK, Assembly language Programming and optimization through intrinsic functions.

1. INTRODUCTION 9

Need and benefits of Digital Signal Processing - Typical signal processing operations: Convolution, correlation, Filtering, transformation and modulation - Algorithms for signal processing - Basic architecture of DSPs' - Fundamentals of fixed point DSP architecture - Fixed point number representation and computation - Fundamentals of floating point DSP architecture - Floating point number representation and computation.

2. TEXAS PROCESSORS 9

Study of TMS 320 C 5X processor - Architecture - Addressing modes - Instruction set - Programming.

3. PERIPHERALS and INTERFACES OF DSP 9

Peripherals interface - Digital and analog Interface - Host interface - Memory interface - DMA ports - Serial ports - Applications.

4. COMMERCIAL DSP DEVICES 9

TMS C240 processor and ADSP 2181 processor- Architecture - Addressing modes - program control - Instruction and programming - Simple programs - Special features - PWM generation.

5. MOTOR CONTROL APPLICATIONS 9

Controller implementation using TMS 320 F 2407 and TMS 320 F 2812 for AC and DC motor speed control.

L = 45 T = 0

Total = 45 Hrs

REFERENCE BOOKS

1. Sanjit K. Mitra, "Digital Signals Processing: A Computer based approach," Tata McGraw - Hill, Second edition, 2004.
2. Avatar Singh and S.Srinivasan, "Digital Signal Processing: Implementation using DSP microprocessors with examples from TMS 320C54XX, Thompson Brooks/Cole, 2004.
3. K.Padmanabhan et al. "A Practical approach to Digital Signal Processing", New Age Publications, 2001.
4. B. Venkataramani et al. "Digital Signal Processor - Architecture, Programming and Applications", Tata McGraw - Hill, New Delhi 2002.
5. TMS320F/C24\x DSP controllers, Reference Guide-Literature No: SPRU160C, June 1994

EEY033 ADVANCES IN POWER ELECTRONICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE :

The aim of this course is to study the principal converter types and their recent trends, a brief review of power integrated circuits, to acquaint the students with the recent trends in converters, structure and working of FACTS, Intelligent power modules

1. RESONANT CONVERTERS 10

Zero voltage and Zero current switching ,Classification of resonant converters - Basic resonant circuit concepts - Load resonant converters - Resonant switch converters - Zero voltage switching, clamped voltage topologies -Resonant DC link Inverters and Zero voltage switching - High frequency link integral half cycle converters - Applications in SMPS and lighting.

2. IMPROVED UTILITY INTERFACE 12

Generation of current harmonics , Current harmonics and power factor - Harmonic standards and recommended practices - Need for improved utility interface - Improved single phase utility interface - Improved three phase utility interface - Electromagnetic interference.

3. FACTS AND CUSTOM POWER 14

Introductions - Principles of reactive power control in load and transmission line compensation - Series and shunt reactive power compensation - Concepts of Flexible AC Transmission System (FACTS) - Static var compensators (SVC) - Thyristor controlled reactor - Thyristor switched capacitor - Solid state power control - Static condensers - Controllable series compensation - Thyristor controlled phase-angle regulator and unified power flow control - Modelling and methods of analysis of SVC and FACTS controllers - System control and protection - Harmonics and filters, Simulation and study of SVC and FACTS under dynamic conditions.

4. EMERGING DEVICES AND CIRCUITS 9

Power Junction Field Effect Transistors - Field Controlled Thyristors - JFET based devices Vs other power devices - MOS controlled Thyristors - Power integrated circuits - New semiconductor materials for power devices.

Total = 45 Hrs

REFERENCES:

1. Ned Mohan., Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons (Asia) Pvt Ltd, Singapore, 2003.
2. Rashid, M.H., “Power Electronics Circuits, Devices and Applications”, 2004 Prentice Hall India, New Delhi.
3. Joseph Vithayathil., “Power Electronics”, Tata McGraw - Hill Series in Electrical and Computer Engineering, USA, 1995.
4. Las Zlo Gyugyi, Narain G Hingorani, “Understanding FACTS: Concepts & Technology of Flexible AC Transmission System”, The Institute of Electrical and Electronics Engineers. Inc., New York, 2000.
5. Mohan Mathur P, Rajiv K Varma, Thyristor Based FACTS Controllers for Electrical Transmission Systems, John Wiley and Sons Inc., and IEEE Press,USA, 2002.
6. Roger C Dugan, Maric F Mcgranaghan, “Electrical Power System Quality”, Tata McGraw - Hill Inc, New York, 1996.
7. Tagare D M, “Reactive Power Management”, Tata McGraw - Hill Publications, New Delhi, 2004.

EEY 034 POWER ELECTRONICS IN WIND AND SOLAR POWER CONVERSION

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to understand the working principle of different types of power conditioning systems used with wind and solar energy conversion systems, the working of maximum power point tracking algorithm in wind and solar systems, the working of different types of generators used with wind energy conversion systems, and the different types of harmonic and voltage control problems associated with wind farms.

1. INTRODUCTION 7

Trends in energy consumption - World energy scenario, Energy sources and their availability - Conventional and renewable sources - Need to develop new energy technologies.

2. PHOTOVOLTAIC ENERGY CONVERSION 9

Solar radiation and measurement - Solar cells and their characteristics - Influence of insulation and temperature - PV arrays - Electrical storage with batteries - Solar availability in India - Switching devices for solar energy conversion - Maximum power point tracking.

3. POWER CONDITIONING SCHEMES 9

DC Power conditioning Converters - Maximum Power point tracking algorithms - AC Power conditioners - Line commutated inverters - Synchronized operation with grid supply - Harmonic problem.

4. PV APPLICATIONS &WIND ENERGY SYSTEMS 9

Stand alone inverters - Charge controllers - Water pumping, Audio visual equipments - Street lighting - Analysis of PV Systems.

5. WIND ENERGY SYSTEMS 11

Basic Principle of wind Energy conversion - Nature of Wind - Wind survey in India - Power in the wind - Components of Wind Energy Conversion System (WECS)- Performance of Induction Generators for WECS - Classification of WECS,Self Excited Induction Generator (SEIG) for isolated Power Generators - Theory of self excitation - Capacitance requirements - Power conditioning schemes - Controllable DC Power from SEIGs - System performance, Grid connectors concepts - Wind farm and its accessories - Grid related problems - Generator control - Performance improvements - Different schemes - AC voltage controllers - Harmonics and PF improvement.

Total = 45 Hrs

REFERENCES:

1. Mukund R. Patel, “Wind and Solar Power Systems”, CRC Press, 2004.
2. Rai, G.D., "Non-conventional Energy Sources", Khanna Publishers, New Delhi, 2002.
3. Daniel, Hunt, V., "Wind Power - A Handbook of WECS", Van Nostrend Co., New York, 1998.
4. Thomas Markvart and Luis Castaser, “Practical Handbook of Photovoltaic's”, Elsevier Publications, UK, 2003.

EEY 035	POWER ELECTRONICS IN POWER SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to study and understand the basic concept of different types of power electronics devices, the operation of AC to DC converters and DC to AC converters, reactive power compensation using conventional methods and FACTS devices, the basic definitions and issues in power quality.

1. INTRODUCTION 9

Basic Concept of Power Electronics, Different types of Power Electronic Devices - Diodes, Transistors and SCR, MOSFET, IGBT and GTO's.

2. AC TO DC CONVERTERS 9

Single Phase and three phase bridge rectifiers, half controlled and Fully Controlled Converters with R, RL, AND RLE loads. Free Wheeling Diodes, Dual Converter, Sequence Control of Converters - inverter operation , Input Harmonics and Output Ripple, Smoothing Inductance - Power Factor Improvement effect of source impedance, Overlap, Inverter limit.

3. DC TO AC CONVERTERS 9

General Topology of single Phase and three phase voltage source and current source inverters- Need for feedback diodes in antiparallel with switches - Multi Quadrant Chopper viewed as a single phase inverter- Configuration of Single phase voltage source inverter: Half and Full bridge, Selection of Switching Frequency and Switching Device-Voltage Control and PWM strategies.

4. STATIC REACTIVE POWER COMPENSATION 9

Shunt Reactive Power Compensation - Fixed Capacitor Banks, Switched Capacitors, Static Reactor Compensator, Thyristor Controlled Shunt Reactors (TCR) - Thyristor Controlled Transformer - FACTS Technology-Applications of static thyristor Controlled Shunt Compensators for load compensation-Static Var Systems for Voltage Control, Power Factor Control and Harmonic Control of Converter fed systems.

5. POWER QUALITY 9

Power Quality - Terms and Definitions - Transients - Impulsive and Oscillatory Transients - Harmonic Distortion - Harmonic Indices - Total Harmonic Distortion

- Total Demand Distortion- Locating Harmonic Sources, Harmonics from commercial and industrial Loads -Devices for Controlling Harmonics, Passive and Active Filters -Harmonic Filter Design

L = 45 Total = 45 Hrs

REFERENCES

1. N.Mohan,T.M.Undeland and W.P.Robbins, “Power Electronics : Converter, Applications and Design”, John Wiley and Sons , 1989.
2. M.H.Rashid, “Power Electronics”, Prentice Hall of India, 1994.
3. B.K.Bose, “Power Electronics and A.C. Drives”, Prentice Hall, 1986.
4. Roger C.Dugan, Mark .F. Mc Granaghan, Surya Santaso, H.Wayne Beaty, "Electrical Power Systems Quality", Second Edition, Mc Graw Hill, 2002.
5 T.J.E. Miller, “Static Reactive Power Compensation”, John Wiley and Sons, New York,1982.
6. Mohan Mathur.R., Rajiv.K.Varma, "Thyristor Based FACTS controllers for Electrical Transmission Systems", IEEE press.1999.

EEY 036 ROBOTICS AND FACTORY AUTOMATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to Identify the basic component of manufacturing automation and categorize different types of automated production process, to understand how knowledge based system technology can improve manufacturing enterprises, to design elementary mechanism for automation and to understand the principle of industrial sensors.

1. FUNDAMENTAL CONCEPTS OF ROBOTICS 6

History, Present status and future trends in Robotics and automation - Laws of Robotics - Robot definitions - Robotics systems and robot anatomy - Specification of Robots - resolution, repeatability and accuracy of a manipulator-Robotics applications.

2. ROBOT DRIVES AND POWER TRANSMISSION SYSTEMS 7

Robot drive mechanisms, hydraulic, electric servomotor, stepper motor, pneumatic drives- Mechanical transmission method, Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws, End effectors, Types.

3. SENSORS 7

Sensor characteristics, Position sensors, Potentiometers, Encoders, Resolvers, LVDT, Velocity sensors, Tachogenerators - Encoders - Proximity sensors, Limit switches, Tactile sensors - Touch sensors - Force and torque sensors

4. VISION SYSTEMS FOR ROBOTICS 7

Robot vision systems, Image capture- cameras vision and solid state, Image representation - Gray scale and colour images, image sampling and quantization - Image processing and analysis - Image data reduction - Segmentation - Feature extraction - Object Recognition- Image capturing and communication - JPEG, MPEGs and H.26x standards, packet video, error concealment - Image texture analysis.

5. TRANSFORMATIONS AND KINEMATICS 7

Homogeneous coordinates, Coordinate reference frames - Homogeneous transformations for the manipulator - The forward and inverse problem of manipulator kinematics - Motion generation - Manipulator dynamics - Jacobian in terms of D-H matrices - Controller architecture.

6. PLC 7

Building blocks of automation, Controllers , PLC- Role of PLC in FA - Architecture of PLC - Advantages - Types of PLC - Types of Programming - Simple process control programs using Relay Ladder Logic and Boolean logic methods - PLC arithmetic functions.

7. FACTORY AUTOMATION 4

Flexible Manufacturing Systems concept - Automatic feeding lines, ASRS, transfer lines, automatic inspection - Computer Integrated Manufacture - CNC, intelligent automation. Industrial networking, bus standards, HMI Systems, DCS and SCADA, Wireless controls.

Total = 45 Hrs

REFERENCES

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 1989.
2. Fu K.S., Gomalez R.C., Lee C.S.G., "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill Book Company, 1987.
3. Mikell P Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 1986.
4. Saeed B Niku, “Introduction to Robotics Analysis, Systems, Applications Prentice Hall of India Pvt Ltd New Delhi, 2003.
5. Deh S R., "Robotics Technology and Flexible Automation", Tata McGraw - Hill Publishing, Company Ltd., 1994.

EEY 037 ADVANCED CONTROL OF ELECTRIC DRIVES

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to study the principle advances of advanced control strategies, to select appropriate DSP Controllers, PWM Inverter Control, Space Vector Modulation, Neural Network and Fuzzy Controllers based on control system, to Study the performance of advanced control schemes, and the control strategies and networking of electric drives.

1. INTRODUCTION 8

Need for advanced controls - Principal factors affecting the choice of drive, Parameter identification techniques for electric motors - Electromagnetic compatibility of electrical drives - Different options for an adjustable speed electric drive - Simulation of electrical drives, Advanced control strategies for electrical drives - DSP based control of electric drives.

2. DSP CONTROLLERS 7

TMS320 Family overview 320C24x series of DSP controllers - Architecture overview - C24x CPU Internal Bus Structure - Memory - Central Processing unit, Memory and I/O Spaces, Overview of Memory and I/O Spaces, Program control Address Modes - System Configuration and Interrupts clocks and low Power Modes Digital input / output (I/O).

3. INSTRUCTION SET 6

Assembly language Instruction - Instruction Set summary - Instruction Description - Accumulator, arithmetic and logic Instruction - Auxiliary Register and data page Pointer Instructions - TREG, PREG, and Multiply Instruction - Branch Instructions - Control Instructions - I/O and Memory instructions.

4. PWM INVERTER CONTROL

Inverter - operation principle - Inverter Switching - unipolar , Bipolar , Inverter Dead Time - Inverter Modulation , Different Types , Sine Triangle Analysis of Sine Triangle Modulation - Trapezoidal Modulation - Third harmonic Modulation - Analysis of Third harmonic Modulation , output filter requirement for different PWM Techniques.

5. SPACE VECTOR MODULATION 8

Concept of a Space Vector Components for Three-phase sine wave source/ level components for voltage source Inverter operated in square wave Mode, Synchronously Rotating Reference frame - Space Vector Modulation (SVM), principle of SVM, SVM compared to regular sampled PWM phase Lag reference for SVM, Naturally Sampled SVM , Analytical solution for SVM, Harmonic losses for SVM - placement of the Zero space vector , Discontinuous Modulation - Phase lag Reference for Discontinuous PWM - Harmonic losses for Discontinuous PWM - Single edge SVM - Switched pulse sequence - Topology of Three phase inverter - Three Phase Modulation with Sinusoidal reference , Third harmonic Reference Injection.

6. NEURAL NETWORK AND FUZZY CONTROLLERS 5

Current and speed control of induction motors - Current control algorithm sensor less motion control strategy - Induction motor controller using VHDL design. Fuzzy logic control of a synchronous generator - System representation, VHDL modelling - FPGA implementation.

7. DC & AC SERVO DRIVES 5

Block diagram - Control strategies - Diagnosis of electrical drives - Networking of electric drives - Ethernet communication.

Total = 45 Hrs

REFERENCES

1. Bimal K. Bose, "Power Electronics and Variable Frequency Drives - Technology and Application", IEEE Press, 1997.
2. Grafame Holmes. D and Thomas A. Lipo, “Pulse Width Modulation for Power Converters- Principles and Practice” - IEEE Press, 2003
3. Peter Vas, "Vector Control of AC Machines", Oxford University Press, 1990.
4. Hamid A. Toliyat and Steven G. Campbell, DSP Based Electromechanical Motion Control, CRC Pres, 2004
5. Ned Mohan, “Advanced Electric Drives: Analysis, Control and Modeling using Simulink”, John Wiley and Sons Ltd, 2001

EEY 038	SCADA AND DCS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE :

The aim of this course is to give an in depth study of SCADA and PLC, to discuss a number of software automation blocks, DCS with a number of case studies, PLC programming modules.

1. INTRODUCTION **6**

Introduction to automation tools PLC, DCS, SCADA, Hybrid DCS/PLC.

2. DCS PROJECT **9**

Development of User Requirement Specifications - Functional Design Specifications for automation tool - GAMP, FDA.

3. PROGRAMMABLE LOGIC CONTROLLERS **9**

Introduction of Advanced PLC programming, Selection of processor, Input/output modules - Interfacing of Input/output devices, Operator Interface - OPC - study of SCADA software - Interfacing of PLC with SCADA software.

4. DCS **10**

Introduction to architecture of different makes-DCS Specifications, configuration of DCS blocks for different applications - Interfacing of protocol based sensors -Actuators and PLC systems, Plant wide database management - Security and user access management - MES, ERP Interface.

5. STUDY OF ADVANCE PROCESS CONTROL BLOCKS **12**

Statistical Process Control - Model Predictive Control - Fuzzy Logic Based Control - Neural-Network Based Control Higher Level Operations: Control & Instrumentation for process optimization - Applications of the above techniques to the same standard units/processes

Total: 45 Hrs

REFERENCES

1. Gary Dunning, “Introduction to Programmable logic Controllers”, Delmar Thomson learning, 2001.
2. Webb & Reis, “Programmable logic Controllers”, (Prentice Hall), 2003.
3. Jose A. Romagnoli, Ahmet Palazoglu, 'Introduction to process Control' (CRC Taylor and Francis group).
4. “Statistical Process Control” -ISA Handbook.
5. B.G. Liptak “Handbook of Instrumentation- Process Control”.
6. Installation and user manuals of different DCS, PLC Vendors.

		L	T	P	C
EEY 039	**MICROCONTROLLERS AND APPLICATIONS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVE:

The aim of this course is to introduce Microcontroller Intel 8051, Controller 68HCII, PIC microcontrollers and their applications, to study the architecture of 8051, 68HCII, 16C74, the addressing modes and Instruction sets, to introduce the need and use of Interrupt structure, timers and to be acquainted with the applications.

1. INTRODUCTION TO MICROCONTROLLERS AND 8051 — 10

Introduction, Microcontrollers and microprocessors, history of microcontrollers, embedded versus external memory devices, 8-bit and 16-bit microcontrollers, CISC and RISC processors, Harvard and Von Neumann architecture, Architecture of 8051 - Memory organization - Register Banks - Bit addressable area - SFR - Addressing modes, Programming - MCS51 Family features: 8031/8051/8751 - MCS-51 instruction set, - MCS-51 instruction set, Interrupts, interrupts in MCS-51, timers and counters, serial communication - Power saving modes - Simple Programs using stack pointer.

2. MCS-51 APPLICATIONS — 9

Overview of 89CXX and 89C20XX Atmel microcontrollers, pin description of 89C51 and 89C2051, using flash memory square wave generation, rectangular wave generation, pulse generation, stair case ramp generation, sine wave generation, pulse width measurement, frequency counter.

3. MOTOROLA 68HC11 : — 14

Controller features - Different modes of operation and memory map - Functions of I/O ports in single chip and expanded multiplexed mode, Timer system. Input capture, output compare and pulsed accumulator features of 68HC11, Serial peripheral and serial communication interface - Analog to digital conversion features - Watchdog feature.

4. PIC 18FXX2 MICROCONTROLLERS — 16

Architecture - memory organization - addressing modes - instruction set - Timers - Capture / Compare / PWM (CCP) Modules - Interrupts - I/O ports - 1^{2}C bus for peripheral chip access - A /D converter - USART - Interfacing LCD display - Keypad interfacing - ADC and DAC interfacing - Programming techniques using C and Assembly.

5. APPLICATIONS 5

LED, push buttons, relays and latch connerctions, Sensor and other Applications - Stepper Motor Control - DC Motor Control - AC Power Control - Brushless DC Motor Control - Temperature controller system using 8051, PICI 8FXX2 and Motorola 68HC11

Total = 45 Hrs

REFERENCES

1. "8-bit Embedded Controllers", Intel Corporation, 1990.
2. John B. Peat man., "Design with Microcontrollers", Tata McGraw - Hill, Singapore, 1988.
3. John B. Peat man, “Design with PIC Microcontrollers”, Pearson Education Inc, India, 2005.
4. The 8051 Microcontroller and Embedded systems - M.A. Mazadi, J.G. Mazadi & R.D. McKinlay - pearson PHI.
5. The 8051 Microcontroller - K.J. Ayala - Thonson Mazidi, Rolin McKinlay, Danny Causey, “PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC 18”, Prentice Hall, 2009.

EEY 040 CONVERTERS, APPLICATIONS & DESIGN

L	T	P	C
1	2	0	3

COURSE OBJECTIVE:

To design & implement real time industrial application of Power Electronic equipments.

1. PROTECTION OF POWER ELECTRONIC DEVICES **7**

SCR, Triac, MOSFET, IGBT - Protection Circuits - Snubber Circuits - Ratings - safe operating Area - Heat sink Design.

2. DESIGN OF CONTROLLED CONVERTERS **10**

Gate pulse generating circuits - conventional methods, gate pulse generation using microcontroller, gate drive circuits - Pulse Transformers - Opto Triacs, Synchronisation Circuits, fully controlled fed DC motor - Open loop, closed loop.

3. DC-DC CONVERTERS **9**

Half Bridge and Full Bridge Driver ICs for MOSFET and IGBT - Phase shifted series Resonant Converters - ZCS - ZVS, DC - DC Converter for Electric Vehicle.

4. PHASE CONTROLLERS **10**

Photosensors, Temperature sensors, Micro controller Programming for phase angle control, Implementation of phase controller for illuminating lights & Electric furnace control using micro controller.

Maximum power point trackers, Grid connected inverter, Implementation of converters for solar panel.

5. SWITCHING POWER SUPPLIES **9**

Design of PWM inverters, SPPWM inverters, Design and implementation of UPS and SMPS, Harmonic analysis of inverters using Harmonic Analyser.

Total: 45 Hrs

REFERENCES

1. M.H. Rashid, “Power Electronics Handbook”, Elsevier Press, 2003.
2. Power Electronics Design Handbook “Low-Power Components and Applications” By Nihal Kularatna.
3. Power Electronics Design : A Practitioner’s Guide Keith H. Sueker.
4. Micro C Manual.
5. International Rectifiers, Application note - Catlogue.

MEY 012	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to introduce scholars a number of perspectives on research and to broaden their conceptions of what research involves. This course covers research, design, information retrieval, problem formulation, use of statistical techniques, evaluation and writing of research reports, papers and ethics in research.

1. RESEARCH PROBLEM FORMULATION **7**

Research - objectives - types, Research process, solving engineering problems Identification of research topic - Formulation of research problem, literature survey and review.

2. RESEARCH DESIGN **8**

Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle - important experimental designs, Design of experimental setup, Mathematical modelling - Simulation, validation and experimentation - Dimensional analysis - similitude.

3. USE OF STATISTICAL TOOLS IN RESEARCH **12**

Importance of statistics in research - Concept of probability - Popular distributions - Sample design. Hypothesis testing, ANOVA, Design of experiments - Factorial designs - Orthogonal arrays, Multivariate analysis - correlation and regression, Curve fitting.

4. ANALYSIS AND INTERPRETATION OF DATA **10**

Research Data analysis - Interpretation of results- Correlation with scientific facts - repeatability and reproducibility of results - Accuracy and precision - limitations, Use of optimization techniques - Traditional methods - evolutionary optimization techniques.

5. THE RESEARCH REPORT **8**

Purpose of written report - Audience - Synopsis writing - preparing papers for International Journals-thesis writing - Organization of contents - style of writing - graphs and charts - Referencing, Oral presentation and defence - Ethics in research - Patenting, IPR.

Total = 45 Hrs

REFERENCES

1. Kothari C.R., "Research, Methodology - Method and Techniques". New Age International (P) Ltd., New Delhi, Reprint 2003.
2. Doebelin, Ernest O., "Engineering Experimentation: planning, execution, reporting"- Tata McGraw - Hill International edition, 1995.
3. George E. Dieter., "Engineering Design- McGraw Hill - International edition, 2000.
4. Rao S.S. "Engineering Optimization"-theory and Practice, New Age International (P) New Delhi, reprint.
5. Madhav S. Phadke, "Quality Engineering using Robust Design", Prentice Hall, Eaglewood Cliffs, New Jersey, 1989.
6. Dan Jones, "Technical writing style", Pearson Education Company, Massachusetts, 1998.
7. Abdul Rahim R., Thesis writing: "A Manual for Researchers", New Age International (P) Ltd., 1996.

EEY 004	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to exposes the students to the principle of operation, control and performance prediction of various major special electrical machines and to impart knowledge on Special electrical machines like Stepper motors, Switched reluctance motors, Permanent magnet machines.

1. SYNCHRONOUS RELUCTANCE MOTORS 9

Constructional features: axial and radial air gap Motors - Operating principle, reluctance torque - phasor diagram, motor characteristics - Linear induction machines.

2. STEPPING MOTORS 9

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.

3. SWITCHED RELUTANCE MOTORS 9

Constructional features-principle of operation-Torque equation-Power Controllers-Characteristics and control Microprocessor based controller.

4. PERMANENT MAGNET SYNCHRONOUS MOTORS 9

Principle of operation - EMF, power input and torque expressions - Phasor diagram - Power controllers - Torque speed characteristics - Self control, Vector control, Current control schemes.

5. PERMANENT MAGNET BRUSHLESS DC MOTORS 9

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.

TOTAL: 45 Hrs

TEXT BOOKS

1. Miller, T.J.E. "Brushless permanent magnet and reluctance motor drives", Clarendon Press, Oxford, 1989.
2. Kenjo, T, "Stepping motors and their microprocessor control", Clarendon Press, Oxford, 1989.

REFERENCES

1. Kenjo. T, and Naganori, S "Permanent Magnet and brushless DC motors", Clarendon Press, Oxford, 1989.
2. Kenjo. T, "Power Electronics for the microprocessor Age", Oxford University Press Oxford, New York -1990.
3. B.K. Bose, "Modern Power Electronics & AC drives", Prentice Hall of India, Pvt.Ltd., 2008.
4. R.Krishnan, "Electric Motor Drives - Modelling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

CSY 098 SOFT COMPUTING TECHNIQUES

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to expose the students to the concepts of intelligent control, artificial neural networks and provide adequate knowledge about the feedback neural networks, to introduce the ideas of fuzzy sets, fuzzy logic and the concepts of fuzziness involved in various systems, to familiarize with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations and to introduce case studies utilizing the above and illustrate the intelligent behavior of programs based on soft computing.

1. INTRODUCTION 9

Approaches to intelligent control, Architecture for intelligent control - Symbolic reasoning system, rule-based systems, the AI approach - Knowledge representation - Expert systems.

2. ARTIFICIAL NEURAL NETWORKS 9

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model - simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron - Learning and Training the neural network-Hopfield network - Application of neural networks to load forecasting and Control.

3. FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning - Introduction to fuzzy logic modelling and control - Fuzzification, inferencing and defuzzification - Fuzzy knowledge and rule bases - Fuzzy Logic based power system stabilizer.

4. GENETIC ALGORITHM 9

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm.

5. APPLICATIONS 9

GA application to power system optimization problem, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox - Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox.

TOTAL : 45 Hrs

TEXT BOOKS

1. Jacek. M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. Kosko, B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
3. Klir G.J. & Folger T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Driankov, Hellendorrn, "Introduction to Fuzzy Control", Narosa Publishers.

REFERENCES

1. Godbole and Kahate, "Computer Communication Networks (Ascent Series)", Tata McGraw - Hill, 2003.
2. M.Schwartz, "Computer Communications", Tata McGraw Hill, 2002.
3. Achyut S Godbole, "Data Communications and Networking", Tata McGraw - Hill, 2002.
4. W.Stallings, "Data and Computer Communication", 2nd Edition New York, Macmillan, 1998.

EE 604	SYSTEM THEORY	L T P C
		3 0 0 3

COURSE OBJECTIVE:

The objective of this course is to introduce the concept of state variable representation of physical systems. Various state models and solns of state equations are discussed. Role of Eigenvalues & Eigen vectors are emphasized. Controllability, observability, stabilisability and detectability are introduced. Stability of linear and non linear systems are evaluated. The model control of Single input single output and Multiple input multiple output systems are also convered. Pole placement techniques of state feedback are also dealt with. An overview of full order and reduced order observer is discussed.

1. STATE VARIABLE REPRESENTATION 9

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

2. SOLUTION OF STATE EQUATION 9

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.

3. CONTROLLABILITY AND OBSERVABILITY 9

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

4. STABILITY 9

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.

5. MODAL CONTROL 9

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.

TOTAL = 45 Hrs

REFERENCES:

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.
2. K. Ogatta, "Modern Control Engineering", Prentice Hall of India, 2002.
3. John S. Bay, "Fundamentals of Linear State Space Systems", Tata McGraw-Hill, 1999.
4. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.
5. John J. D'Azzo, 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.

EEY 014	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to mould students to acquire knowledge about HVDC Transmission systems, to introduce the knowledge about HVDC converters and system control, the concept about on Multi-terminal DC systems, to provide adequate knowledge about power flow analysis, to give various aspects of simulation studies using HVDC systems.

1. DC POWER TRANSMISSION TECHNOLOGY **6**

Introduction - Comparison of AC and DC transmission - Application of DC transmission - Description of DC transmission system - Planning for HVDC transmission - Modern trends in DC transmission - DC breakers - Cables, VSC based HVDC.

2. ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL **12**

Pulse number, choice of converter configuration - Simplified analysis of Graetz circuit - Converter bridge characteristics - Characteristics of a twelve pulse converter- Detailed analysis of converters.

General principles of DC link control - Converter control characteristics - System control hierarchy - Firing angle control - Current and extinction angle control - Generation of harmonics and filtering - Power control - Higher level controllers.

3. MULTITERMINAL DC SYSTEMS **9**

Introduction - Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems.

4. POWER FLOW ANALYSIS IN AC/DC SYSTEMS **9**

Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow - Solution of AC-DC power flow - Case studies.

5. SIMULATION OF HVDC SYSTEMS **9**

Introduction - System simulation: Philosophy and tools - HVDC system simulation - Modelling of HVDC systems for digital dynamic simulation - Dynamic interaction between DC and AC systems.

TOTAL = 45 Hrs

TEXTBOOKS

1. K.R.Padiyar, "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.

2. J.Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.

3. P. Kundur, "Power System Stability and Control", Tata McGraw-Hill, 1993.

4. Erich Uhlmann, "Power Transmission by Direct Current", BS Publications, 2004.

5. V.K.Sood, “HVDC” and FACTS controllers - Applications of Static Converters in Power System, April 2004, Kluwer Academic Publishers.

EE 608 FLEXIBLE AC TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

The aim of this course is to understand the working principle of different types of shunt and series FACTS Controllers, derive the steady state model of FACTS devices suitable for use in power system studies, the dynamic model of FACTS devices suitable for use in transient stability programs, and to study the interaction effects of different types of FACTS devices on the steady state and dynamic behavior of power system.

1. INTRODUCTION 9

Reactive power control in electrical power transmission lines -Uncompensated transmission line - series compensation - Basic concepts of static Var Compensator (SVC) - Thyristor Controlled Series capacitor (TCSC) - Unified power flow controller (UPFC).

2. STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9

Voltage control by SVC - Advantages of slope in dynamic characteristics - Influence of SVC on system voltage - Design of SVC voltage regulator - Modelling of SVC for power flow and transient stability - Applications: Enhancement of transient stability - Steady state power transfer - Enhancement of power system damping - Prevention of voltage instability.

3. THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Operation of the TCSC - Different modes of operation - Modelling of TCSC - Variable reactance model - Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit - Enhancement of system damping.

4. VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM) - Principle of operation - V-I Characteristics. Applications: Steady state power transfer-Enhancement of transient stability - Prevention of voltage instability. SSSC-operation of SSSC and the control of power flow -Modelling of SSSC in load flow and transient stability studies. Applications: SSR Mitigation-UPFC and IPFC

5. CO-ORDINATION OF FACTS CONTROLLERS 9

Controller interactions - SVC - SVC interaction - Co-ordination of multiple controllers using linear control techniques - Control coordination using genetic algorithms.

TOTAL = 45 Hrs

REFERENCES:

1. R.Mohan Mathur, Rajiv K.Varma, “Thyristor - Based FACTS Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc. 2002.
2. Narain G. Hingorani, “Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems”, IEEE press 2000 Standard Publishers Distributors, Delhi- 110 006.
3. K.R.Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International(P) Limited, Publishers, New Delhi, 2008.
4. A.T.John, “Flexible A.C. Transmission Systems”, Institution of Electrical and Electronic Engineers (IEEE), 1999.
5. V.K.Sood, “HVDC and FACTS controllers - Applications of Static Converters in Power System”, April 2004, Kluwer Academic Publishers.

EEY 015 WIND ENERGY CONVERSION SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to introduce the basic concepts of wind energy conversion systems, to discuss the power generated using different types of wind turbines, to study about the modelling of fixed and variable speed wind turbine in WECS and about the impact of Grid connected WEC systems.

1. INTRODUCTION 9

Components of WECS-WECS schemes-Power obtained from wind-Simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine.

2. WIND TURBINES 9

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of blades-Blade profile-Power regulation-Yaw control-Pitch angle control-Stall control-Schemes for maximum power extraction.

3. FIXED and VARIABLE SPEED SYSTEMS 9

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous generator-Squirrel cage Induction generator- Model of wind speed- Model wind turbine rotor - Drive Train model- generator model for steady state & transient stability analysis - Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG.

4. INDUCTION GENERATOR MODELLING 9

Modelling of Fixed Speed Induction Generator - Axes transformation- Flux linkage equations- State equations- Fifth order model-Transient stability simulation of fixed speed induction generator using EUROSTAG 4.3 - Doubly Fed Induction generator (DFIG) modelling - modelling of DFIG in EUROSTAG-Transient stability simulation of power systems with induction generators using EUROSTAG 4.3.

5. GRID CONNECTED SYSTEMS 9

Stand alone and grid connected WECS system-Grid connection issues-Machine side & grid side controllers-WECS in various countries

TOTAL=45 Hrs

REFERENCES:

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge, 1976.
4. S.Heir "Grid Integration of Wind Energy Conversion Systems", John Wiley & Sons 1998.
5. Thomas Ackermann, “Wind Power in Power Systems”, John Wiley and Sons, 2005.
6. Andres Feijoo, Jose Cidras, Camilo Carrillo, "A third order model for the doubly fed induction machine", Electric Power System Research, Vol.56, 2000, pp.121-127.
7. Jian Zhang, Adam Dysko, John O'Reilly, William E. Leithead, "Modelling and Performance of fixed speed induction generators in power system oscillation stability studies", Electric Power System Research, Vol.78, 2008, pp.1416-1424.
8. Eurostag 4.3 Theory Manual, Part 1.

EEY 016	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE :

The aim of this course is to study about the different Renewable energy resources, the principles involved in the conversion of renewable energy sources to electrical energy, the grid converters structure and control for both single-phase and three-phase systems both in power generation like Photo Voltaic and wind turbines connected to the grid.

1. INTRODUCTION 9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, biomass, fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

2. ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9

Review of reference theory fundamentals-Principle of operation and analysis: IG, PMSG, SCIG and DFIG.

3. POWER CONVERTERS 9

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters-Selection Of inverter, battery sizing, array sizing.

Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-Matrix converters.

4. ANALYSIS OF WIND AND PV SYSTEMS 9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection issues -Grid integrated PMSG and SCIG based WECS-Grid integrated solar system.

5. HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for hybrid systems- Range and type of hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

TOTAL = 45 Hrs

REFERENCES:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.
2. Rai. G.D, "Non conventional energy sources", Khanna publishers, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishers, 1995.
4. Gray, L. Johnson, "Wind energy system", Prentice hall Inc., 1995.
5. B.H.Khan “Non-conventional Energy sources” Tata McGraw-Hill Publishing Company, New Delhi, 2006, 2nd edition.

EEY 005	POWER QUALITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

The aim of this course is to enhance the knowledge of the students in the emerging area of power quality and several key issues related to its modelling, assessment and mitigation. The course will provide a platform to an in-depth discussion on the various challenges and their possible remedies with respect to maintaining Power Quality in electricity sector, which will benefit participants from academic and R & D institutions, professional engineers from utilities, industries and policy makers.

1. INTRODUCTION 9

Introduction - Characterisation of electric power quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, voltage fluctuations, power frequency variation, Power acceptability curves - 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.

2. NON-LINEAR LOADS 9

Single phase static and rotating AC/DC converters-Three phase static AC/DC converters-Battery chargers-Arc furnaces, Fluorescent lighting-pulse modulated devices-Adjustable speed drives.

3. MEASUREMENT AND ANALYSIS METHODS 9

Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error - Analysis; Analysis in the periodic steady state, Time domain methods, Frequency domain methods - Laplace's, Fourier and Hartley transform - The Walsh Transform - Wavelet Transform.

4. ANALYSIS AND CONVENTIONAL MITIGATION METHODS 9

Analysis of power outages, Analysis of unbalance; Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers-Analysis of distortion: On-line extraction of fundamental sequence components from measured samples - Harmonic indices - Analysis of voltage sag; Detroit Edison sag score, voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages-classical load balancing problem - Open loop balancing, Closed loop balancing, current balancing-Harmonic reduction-voltage sag reduction.

5. POWER QUALITY IMPROVEMENT 9

Utility-Customer interface -Harmonic filters: passive, Active and hybrid filters -Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC -control strategies: P-Q theory, Synchronous detection method - Custom power park -Status of application of custom power devices.

TOTAL = 45 Hrs

TEXT BOOKS

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition)
3. R.C. Dugan & Co. “Electrical Systems quality”, Tata McGraw-Hill 2003.
4. “Power system harmonics” -A.J. Arrillga John Wiley and sons 2003.
5. “Power electronic converter harmonics” -Derek A. Paice, Tata McGraw-Hill IEE Press 1996.