HINDUSTAN UNIVERSITY
HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE
(Estd. u/s 3 of the UGC Act, 1956)
Padur, Kancheepuram District - 603 103.

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING

Regulations Curriculum and Syllabus 2013

M.Tech. (POWER ELECTRONICS AND DRIVES)

ACADEMIC REGULATIONS
(M.TECH./ M.B.A. / M.C.A.) (Full - Time / Part - Time)
(Effective 2013-14)

1. Vision, Mission and Objectives

1.1 The Vision of the Institute is "To make every man a success and no man a failure".

In order to progress towards the vision, the Institute has identified itself with a mission to provide every individual with a conducive environment suitable to achieve his / her career goals, with a strong emphasis on personality development, and to offer quality education in all spheres of engineering, technology, applied sciences and management, without compromising on the quality and code of ethics.

1.2 Further, the institute always strives

- To train our students with the latest and the best in the rapidly changing fields of Engineering, Technology, Management, Science & Humanities.
- To develop the students with a global outlook possessing, state of the art skills, capable of taking up challenging responsibilities in the respective fields.
- To mould our students as citizens with moral, ethical and social values so as to fulfill their obligations to the nation and the society.
- To promote research in the field of science, Humanities, Engineering, Technology and allied branches.

1.3 Our aims and objectives are focused on

- Providing world class education in engineering, technology, applied science and management.
- Keeping pace with the ever changing technological scenario to help our students to gain proper direction to emerge as competent professionals fully aware of their commitment to the society and nation.
- To inculcate a flair for research, development and entrepreneurship.

2. Admission

2.1 The admission policy and procedure shall be decided from time to time by the Board of Management (BOM) of the Institute, following guidelines issued by Ministry of Human Resource Development (MHRD), Government of India. The number of seats in each branch of the (M.TECH / M.B.A. / M.C.A.) programme will be decided by BOM as per the directives from Ministry of Human Resource Development (MHRD), Government of India and taking into account the market demands. Some seats for Non Resident Indians and a few seats for foreign nationals shall be made available.

2.2 The selected candidates will be admitted to the (M.TECH / M.B.A. / M.C.A.) programme after he/she fulfills all the admission requirements set by the Institute and after payment of the prescribed fees.

2.3 Candidates for admission to the first semester of the Master's Degree Programme shall be required to have passed an appropriate Degree Examination recognized by Hindustan University.

2.4 In all matters relating to admission to the (M.TECH / M.B.A. / M.C.A.). Programme, the decision of the Institute and its interpretation given by the Chancellor of the Institute shall be final.

2.5 If at any time after admission, it is found that a candidate has not fulfilled any of the requirements stipulated by the Institute, the Institute may revoke the admission of the candidate with information to the Academic Council.

3. Structure of the programme

3.1 The programme of instruction will have the following structure

i) Core courses of Engineering / Technology / Management.

ii) Elective courses for specialization in areas of student's choice

3.2 The minimum durations of the programmes are as given below:

Program	No. of Semesters
M.Tech.(Full-Time)	4
M.Tech.(Part -Time)	6
M.B.A. (Full - Time)	4
M.B.A. (Part - Time)	6
M.C.A.(Full - Time)	6
M.C.A.(Part -Time)	8

Every (M.TECH / M.B.A. / M.C.A.) programme will have a curriculum and syllabi for the courses approved by the Academic Council.

3.3 Each course is normally assigned certain number of credits. The following norms will generally be followed in assigning credits for courses.

- One credit for each lecture hour per week per semester
- One credit for each tutorial hour per week per semester
- One credit for each laboratory practical of three hours per week per semester.
- One credit for 4 weeks of industrial training and
- One credit for 2 hours of project per week per semester.

3.4 For the award of degree, a student has to earn certain minimum total number of credits specified in the curriculum of the relevant branch of study. The curriculum of the different programs shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below.

Program	Minimum prescribed credit range
M.Tech. (Full time / Part time)	75 - 85
M.B.A. (Full time / Part time)	85 - 95
M.C.A (Full time / Part time)	115 - 125

3.5 The medium of instruction, examination and the language of the project reports will be English.

4. Faculty Advisor

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

5. Class Committee

5.1 A Class Committee consisting of the following will be constituted by the Head of the Department for each class:

(i) A Chairman, who is not teaching the class.

(ii) All subject teachers of the class.

(iii) Two students nominated by the department in consultation with the class.

The Class Committee will meet as often as necessary, but not less than three times during a semester.

The functions of the Class Committee will include:

(i) Addressing problems experienced by students in the classroom and the laboratories.

(ii) Analyzing the performance of the students of the class after each test and finding ways and means of addressing problems, if any.

(iii) During the meetings, the student members shall express the opinions and suggestions of the class students to improve the teaching / learning process.

6. Grading

6.1 A grading system as below will be adhered to.

Range of Marks	Letter Grade	Grade points
95-100	S	10
85 - 94	A	09
75- 84	B	08
65-74	C	07
55-64	D	06
50-54	E	05
< 50	U	00
	I (Incomplete)	–

6.2 GPA & CGPA

GPA is the ratio of the sum of the product of the number of credits C_i of course "i " and the grade points P_i earned for that course taken over all courses "i" registered by the student to the sum of Ci for all "i ". That is,

$$GPA = \frac{\sum_i C_i P_i}{\sum_i C_i}$$

CGPA will be calculated in a similar manner, at any semester, considering all the courses enrolled from first semester onwards.

6.3 For the students with letter grade I in certain subjects, the same will not be included in the computation of GPA and CGPA until after those grades are converted to the regular grades.

6.4 Raw marks will be moderated by a moderation board appointed by the Vice-Chancellor of the University. The final marks will be graded using an absolute grading system. The Constitution and composition of the moderation board will be dealt with separately.

7. Registration and Enrollment

7.1 Except for the first semester, registration and enrollment will be done in the beginning of the semester as per the schedule announced by the University.

7.2 A student will be eligible for enrollment only if he/she satisfies regulation 10 (maximum duration of the programme) and will be permitted to enroll if (i) he/she has cleared all dues in the Institute, Hostel & Library up to the end of the

previous semester and (ii) he/she is not debarred from enrollment by a disciplinary action of the University.

7.3 Students are required to submit registration form duly filled in.

8. Registration requirement

8.1 **(i)** A Full time student shall not register for less than 16 credits or more than 26 credits in any given semester.

8.1 **(ii)** A part time student shall not register for less than 10 credits or more than 20 credits in any given semester.

8.2 If a student finds his/her load heavy in any semester, or for any other valid reason, he/she may withdraw from the courses within three weeks of the commencement of the semester with the written approval of his/her Faculty Advisor and HOD. However the student should ensure that the total number of credits registered for in any semester should enable him/her to earn the minimum number of credits per semester for the completed semesters.

9. Minimum requirement to continue the programme

9.1 For those students who have not earned the minimum required credit prescribed for that particular semester examination, a warning letter to the concerned student and also to his parents regarding the shortage of his credit will be sent by the HOD after the announcement of the results of the university examinations.

10. Maximum duration of the programme

The minimum and maximum period for the completion of various programs are given below.

Program	Min. No. of Semesters	Max. No. of Semesters
M.Tech (Full - time)	4	8
M.Tech (Part - time)	6	10
M.B.A. (Full Time)	4	8
M.B.A. (Part Time)	6	10
M.C.A. (Full - Time)	6	12
M.C.A (Part -Time)	8	14

11. Temporary discontinuation

11.1 A student may be permitted by the Director(academic) to discontinue temporarily from the programme for a semester or a longer period for reasons of ill health or other valid reasons. Normally a student will be permitted to discontinue from the programme only for a maximum duration of two semesters.

12. Discipline

12.1 Every student is required to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the University.

12.2 Any act of indiscipline of a student reported to the Director (Academic) will be referred to a Discipline Committee so constituted. The Committee will enquire into the charges and decide on suitable punishment if the charges are substantiated. The committee will also authorize the Director(Academic) to recommend to the Vice-Chancellor the implementation of the decision. The student concerned may appeal to the Vice-Chancellor whose decision will be final. The Director (Academic) will report the action taken at the next meeting of the Council.

12.3 Ragging and harassment of women are strictly prohibited in the University campus and hostels.

13. Attendance

13.1 A student whose attendance is less than 75% is not eligible to appear for the end semester examination for that semester. The details of all students who have attendance less than 75% will be announced by the teacher in the class. These details will be sent to the concerned HODs and Director (Academic).

13.2 Those who have less than 75% attendance will be considered for condonation of shortage of attendance. However a condonation of 10% in attendance will be given on medical reasons. Application for condonation recommended by the Faculty Advisor, concerned faculty member and the HOD is to be submitted to the Director (Academic) who, depending on the merits of the case, may permit the student to appear for the end semester examination. A student will be eligible for this concession at most in two semesters during the entire degree programme. Application for medical leave, supported by medical certificate with endorsement by a Registered Medical Officer, should reach the HOD within seven days after returning from leave or, on or before the last instructional day of the semester, whichever is earlier.

13.3 As an incentive to those students who are involved in extra curricular activities such as representing the University in Sports and Games, Cultural Festivals, and Technical Festivals, NCC/ NSS events, a relaxation of up to 10% attendance will be given subject to the condition that these students take prior approval from the officer-in-charge. All such applications should be recommended by the concerned HOD and forwarded to Director (Academic) within seven instructional days after the programme/activity.

14. Assessment Procedure

14.1 The Academic Council will decide from time to time the system of tests and examinations in each subject in each semester.

14.2 For each theory course, the assessment will be done on a continuous basis as follows:

Test / Exam	Weightage	Duration of Test Exam
First Periodical Test*	10%	2 Periods
Second Periodical Test*	10%	2 Periods
Model exam	20%	3 hours
Seminar/ Assignments/Quiz	20%	
End - semester examination	50%	3 Hours

*** Best out of the two tests will be considered.**

14.3 For practical courses, the assessment will be done by the subject teachers as below:

(i) Weekly assignment/Observation note book / lab records - weightage 60%.

(ii) End semester examination of 3 hours duration including viva - weightage 40%

15. Make up Examination/model examination

15.1 Students who miss the end-semester examinations / model examination for valid reasons are eligible for make-up examination /model examination. Those

who miss the end-semester examination / model examination should apply to the Head of the Department concerned within five days after he / she missed examination, giving reasons for absence.

15.2 Permission to appear for make-up examination / model exam will be given under exceptional circumstances such as admission to a hospital due to illness. Students should produce a medical certificate issued by a Registered Medical Practitioner certifying that he/she was admitted to hospital during the period of examination / model exam and the same should be duly endorsed by parent / guardian and also by a medical officer of the University within 5 days.

16. Project evaluation

16.1 For Project work, the assessment will be done on a continuous basis as follows:

Review / Examination	Weightage
First Review	10%
Second Review	20%
Third Review	20%
End semester Examination	50%

For end semester exam, the student will submit a Project Report in a format specified by the Director (Academic). The first three reviews will be conducted by a Committee constituted by the Head of the Department. The end - semester examination will be conducted by a Committee constituted by the Controller of Examinations. This will include an external expert.

17. Declaration of results

17.1 A candidate who secures not less than 50% of total marks prescribed for a course with a minimum of 50% of the marks prescribed for the end semester examination shall be declared to have passed the course and earned the specified credits for the course.

17.2 After the valuation of the answer scripts, the tabulated results are to be scrutinized by the Result Passing Boards of PG programmes constituted by the Vice-Chancellor. The recommendations of the Result Passing Boards will be placed before the Standing Sub Committee of the Academic Council constituted by the Chancellor for scrutiny. The minutes of the Standing Sub Committee along with the results are to be placed before the Vice-Chancellor for approval. After getting the approval of the Vice-Chancellor, the results will be published by the Controller of Examination/ Registrar.

17.3 If a candidate fails to secure a pass in a course due to not satisfying the minimum requirement in the end semester examination, he/she shall register and re-appear for the end semester examination during the following semester. However, the sessional marks secured by the candidate will be retained for all such attempts.

17.4 If a candidate fails to secure a pass in a course due to insufficient sessional marks though meeting the minimum requirements of the end semester examination, wishes to improve on his/ her sessional marks, he/she will have to register for the particular course and

attend the course with permission of the HOD concerned and the Registrar. The sessional and external marks obtained by the candidate in this case will replace the earlier result.

17.5 A candidate can apply for the revaluation of his/her end semester examination answer paper in a theory course within 2 weeks from the declaration of the results, on payment of a prescribed fee through proper application to the Registrar/Controller of Examinations through the Head of the Department. The Registrar/ Controller of Examination will arrange for the revaluation and the results will be intimated to the candidate concerned through the Head of the Department. Revaluation is not permitted for practical courses and for project work.

17.6 The weightage for internal marks in finalizing results and grades shall be waived off after completion of 5 semesters.

18. Grade Card

18.1 After results are declared, grade sheet will be issued to each student, which will contain the following details:

(i) Program and branch for which the student has enrolled.

(ii) Semester of registration.

(iii) List of courses registered during the semester and the grade scored.

(iv) Semester Grade Point Average (GPA)

(v) Cumulative Grade Point Average (CGPA).

19. Class / Division

19.1 Classification is based on CGPA and is as follows:

CGPA $\geq$ 8.0 : **First Class with distinction**

$6.5 \leq$ CGPA < 8.0 : **First Class**

$5.0 \leq$ CGPA < 6.5 : **Second Class.**

19.2 (i) Further, the award of 'First class with distinction' is subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses in his/her first appearance within the minimum duration of the programme.

(ii) The award of 'First Class' is further subject to the candidate becoming eligible to the award of the degree having passed the examination in all the courses within the below mentioned duration of the programme.

Program	**No. of Semesters**
M.Tech.(Full-Time)	5
M.Tech.(Part -Time)	7
M.B.A. (Full - Time)	5
M.B.A. (Part - Time)	7
M.C.A.(Full - Time)	7
M.C.A.(Part -Time)	9

(iii) The period of authorized discontinuation of the programme (vide clause 11.1) will not be counted for the purpose of the above classification.

20. Transfer of credits

20.1 Within the broad framework of these regulations, the Academic Council, based on the recommendation of the transfer of credits committee so constituted by the Chancellor may permit students to earn part of the credit requirement in other approved institutions of repute and status in the country or abroad.

21. Eligibility for the award of (M.TECH / M.B.A. / M.C.A.) Degree

21.1 A student will be declared to be eligible for the award of the (M.TECH / M.B.A. / M.C.A.). Degree if he/she has

i) registered and successfully credited all the core courses,

ii) successfully acquired the credits in the different categories as specified in the curriculum corresponding to the discipline (branch) of his/her study within the stipulated time,

iii) has no dues to all sections of the Institute including Hostels, and

iv) has no disciplinary action pending against him/her.

The award of the degree must be recommended by the Academic Council and approved by the Board of Management of the University.

22. Power to modify

22.1 Notwithstanding all that has been stated above, the Academic Council has the right to modify any of the above regulations from time to time subject to approval by the Board of Management.

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.Tech. (POWER ELECTRONICS AND DRIVES)

Objective of the Programme:

To get an insight to the theoretical and application aspects of various areas of Power Electronics and Drives including Devices, Converters, Inverters, Solid state drives, system theory, simulation, embedded control etc., to enable them to pursue further academic work or research and development in this field.

SEMESTER I

Sl. No.	Course	Course Title	L	T	P	C	TCH
1	PMA107	Advanced Mathematics for Electrical Engineers*	4	0	0	4	4
2	PPD101	Modeling and Analysis of Electrical Machines	3	1	0	4	4
3	PPD102	Advanced Power Semiconductor Devices	3	1	0	4	4
4	PPD103	Analysis of Power Converters $	3	1	0	4	4
5	PPD104	Analysis of Inverters**	3	1	0	4	4
6	PPD105	Special Electrical Machines*	3	1	0	4	4
		Total				**24**	**24**

***Common to M Tech(EC)& M Tech(PSE)**

****** **Common to M Tech(PSE)**

$ Common to M Tech(EC)

SEMESTER II

Sl. No.	Course	Course Title	L	T	P	C	TCH
Theory							
1.	PPD201	Computer Aided Design of Electrical Apparatus	3	1	0	4	4
2.	PPD202	Solid State DC Drives	3	1	0	4	4
3.	PPD203	Solid State AC Drives	3	1	0	4	4
4.	PPD204	Linear and Non Linear System Theory	3	1	0	4	4
5.		Elective - I	3	1	0	4	4
6.		Elective - II	3	1	0	4	4

Practical							
4.	PCE301	Power Electronics & Drives Lab	0	0	3	2	3
		Total				**26**	**27**

SEMESTER III

Sl.No.	CodeNo.	Course Title	L	T	P	C	TCH
Theory							
1	-	Elective - III	3	1	0	4	4
2	-	Elective - IV	3	1	0	4	4
3	-	Elective - V	3	1	0	4	4
Practicals							
4	PPD301	Seminar	0	0	3	1	3
5	PPD302	Project - (Phase I)	0	0	12	6	12
		Total				**19**	**27**

SEMESTER IV

Sl.No.	CodeNo.	Course Title	L	T	P	C	TCH
1	PPD401	Project - (Phase II)	0	0	24	12	24
		Total				**12**	**24**

TOTAL CREDITS - 81

ELECTIVE COURSES

Sl.No.	CodeNo.	Course Title	L	T	P	C	TCH
1	PCS101	Advanced Digital Signal Processing**	3	1	0	4	4
2	PPD701	Embedded Control of Electrical Drives	3	1	0	4	4
3	PPD702	Intelligent Control*	3	1	0	4	4
4	PPD703	Flexible AC Transmission Systems*	3	1	0	4	4
5	PAL704	Digital Signal Processors**	3	1	0	4	4
6	PPD705	High Voltage Direct Current Transmission*	3	1	0	4	4
7	PPD706	Power System for Power Electronics	3	1	0	4	4
8	PPD707	Power Quality*	3	1	0	4	4

***Common to M Tech(EC)& M Tech(PSE)**

****Common to M Tech(AE)**

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

CURRICULUM 2013

PMA107 ADVANCED MATHEMATICS FOR ELECTRICAL ENGINEERS

Common to M Tech(EC)& M Tech(PSE)

L	T	P	C
4	0	0	4

Objectives

1. To know about probability theory useful for power system
2. To know about dynamic programming For optimization techniques
3. To know about differential calculus

Out come

1. Getting idea about basic fundamentals of probability
2. Getting idea about optimization techniques
3. Getting idea about differential calculus

Common to M.E(PED)/M.E(EC)

OBJECTIVE:

To equip the students with knowledge of advanced mathematical techniques required for the analytical study of the technical subjects under power electronics.

UNIT I ADVANCED MATRIX THEORY **9**

Matrix norms - Jordan canonical form - Generalized eigenvectors - Singular value decomposition - Pseudo inverse - Least square approximations - QR algorithm.

UNIT II CALCULUS OF VARIATIONS **9**

Variation and its properties - Euler's equation - Functional dependent on first and higher order derivatives - Functional dependent on functions of several independent variables - Some applications - Direct methods: Ritz and Kantorovich methods.

UNIT III LINEAR PROGRAMMING **9**

Basic concepts - Graphical and Simplex methods -Transportation problem - Assignment problem.

UNIT IV DYNAMIC PROGRAMMING **9**

Elements of the dynamic programming model - optimality principle - Examples of dynamic programming models and their solutions.

UNIT V RANDOM PROCESSES **9**

Classification - Stationary random processes - Auto Correlation - Cross Correlations - Power spectral density - Linear system with random input - Gaussian Process.

L = 60 TOTAL = 60

REFERENCES

1. Lewis.D.W., "Matrix Theory", Allied Publishers,Chennai 1995.
2. Bronson,R, "Matrix Operations", Schaums outline Series ,McGraw Hill ,New York. 1989.
3. Elsgoltis, " Differential Equations and Calculus of Variations ", MIR Publishers, Moscow (1970).
4. Gupta.A.S., "Calculus of Variations with Applications", Prentice Hall of India,New Delhi,1999.
5. Taha, H.A., " Operations research - An Introduction ", Mac Millan publishing Co., (1982).
6. Gupta, P.K.and Hira, D.S., "Operations Research", S.Chand & Co., New Delhi, (1999).
7. Ochi, M.K. " Applied Probability and Stochastic Processes ", John Wiley & Sons (1992).
8. Peebles Jr., P.Z., "Probability random variables and random signal principles", McGraw Hill Inc., (1993).

PPD101 MODELLING &ANALYSIS OF ELECTERICAL MACHINES

L	T	P	C
3	1	0	4

Prerequisite

Power Electronics

Goal

To introduce students to modeling of electrical machines with a focus on reference frame theory and space vector.

Objectives

The course should enable the students to:

1. Know about the fundamental energy conversion methods using energy and coenergy techniques
2. Visualize the mmf distribution of electrical machines.
3. Know about the basic concept of Reference Frame Theory applies to AC machine.
4. Know about the fundamental concept of Space Vector applies to AC machines.
5. Study the construction and principle of special machines

Outcome

At the end of the course the student should be able to:

1. analyze the energy conversion of single and multi excited machines.

2. Understand the operation & able to calculate the mmf distribution of AC and DC machines
3. Gets clear idea about constructing the simplified modeling of AC machines using RFT.
4. Understand the dynamic analysis of AC machines in terms of dq windings.
5. Analyze and model the dynamic performance of special electrical machines.

UNIT I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 8

General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system

UNIT II BASIC CONCEPTS OF ROTATING MACHINES 9

Calculation of air gap MMF and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine, three phase symmetrical induction machine and salient pole synchronous machines in phase variable form.

UNIT III 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 symmerical 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

UNIT IV ANALYSIS OF INDUCTION MACHINES 8

Induction machine equations in phase quantities assisted by space vectors-Sinusoidal distributed winding; stator single-phase magnetizing and mutual inductance; per-phase magnetizing inductance; equivalent winding in a squirrel-cage rotor and rotor inductances; review of space vectors; flux-linkage and voltage equations in terms of space vectors. Dynamic analysis in terms of dq windings-stator and rotor dq windings and inductance-flux linkage and voltage equations in dq coordinates, electromagnetic torque; dq equivalent circuits; computer simulation.

UNIT V 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 modeling and self controlled operation; Analysis of Switched Reluctance Motors.

L=45, T=15, Total = 60

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.
3. Ned Mohan "Advanced electrical drives Analysis, Control and Modeling using Simulink", MNPERE, Minneapolis,USA,2011.

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

PPD102 ADVANCED POWER SEMICONDUCTOR DEVICES

L	T	P	C
3	1	0	4

Prerequisite

Power Electronics

Goal

To introduce students to new power semiconductor device technologies with a focus on fast switching devices.

Objectives

The course should enable the students to:

1. Study the key device concepts & electrical characteristics & to study the operation & characteristics of power diode.
2. Know about the construction, physics of operation, safe operating areas of power BJT & SCR.
3. Know about the construction, physics of operation, steady state & dynamic model of Power MOSFET & IGBT.
4. Know about the driving & protection circuits of power semiconductor devices.
5. Study the thermal protection of power semiconductor devices

Outcome

At the end of the course the student should be able to:

1. Understand important power semiconductor devices covering various fields of applications.
2. Understand the operation & static & dynamic performance of power BJT & SCR.
3. Describe the structure & switching behavior of MOS-Controlled devices.
4. Understand the driving & protection circuits for various power semiconductor devices.
5. Study the thermal protection of power semiconductor devices

UNIT I 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.

UNIT II 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.

UNIT III 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.

UNIT IV FIRING AND PROTECTING CIRCUITS **9**

Necessity of isolation, pulse transformer, optocopler - Gate drive circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

UNIT V THERMAL PROTECTION **9**

Heat transfer - conduction, convection and radiation; Cooling - liquid cooling, vapour phase cooling; Guidance for heat sink selection - Thermal resistance and impedance. Electrical analogy of thermal components, heat sink types and design - Mounting types.

L=45, T=15,Total = 60

TEXT BOOKS

1. B.W Williams ' Power Electronics Circuit Devices and Applications'. Wiley, 1987.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall of India, Third Edition, New Delhi, 2004.

REFERENCES

1. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
2. Mohan, Undcland and Robins, "Power Electronics - Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.

PPD103 ANALYSIS OF POWER CONVERTERS
Common to M Tech(EC)

L	T	P	C
3	1	0	4

Prerequisite

Power Electronics

Goal

To provide knowledge about the structure and functioning of different converter circuits

Objectives

The course will enable the students :

(i) To get exposed to the construction, working and performance calculation of various types of single phase converters.

(ii) To familiarize the students with the working of three phase AC-DC converters with different types of loads.

(iii) To familiarize the students with the working of DC-DC converters

(iv) To expose the students to the types of AC voltage controllers

(v) To familiarize the students with single phase and three phase cycloconverters

Outcome

After completion of the course the students are expected to be able to:

(i) Explain the theory and working of different types of single phase converters.

(ii) Explain the working of three phase converters for different load conditions

(iii) Gain knowledge about DC choppers

(iv) Explain the functioning of various AC voltage controllers

(v) Explain the working of single phase and three phase cycloconverters

UNIT I SINGLE PHASE AC-DC CONVERTER **9**

Uncontrolled, half controlled and fully controlled converters with R-L, R-L-E loads and free wheeling diodes - continuous and discontinuous modes of operation - inverter operation - Dual converter - Sequence control of converters - performance parameters: harmonics, ripple, distortion, power factor - effect of source impedance and overlap.

UNIT II THREE PHASE AC-DC CONVERTER **9**

Uncontrolled and fully controlled - converter with R, R-L, R-L-E - loads and free wheeling diode - inverter operation and its limit - dual inverter - performance parameters - effect of source impedance and overlap.

UNIT III 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.

UNIT IV AC VOLTAGE CONTROLLERS **9**

Principle of phase control: single phase and three phase controllers - various configurations - analysis with R and R-L loads.

UNIT V CYCLOCONVERTERS **9**

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

L=45, T=15,Total = 60

TEXT BOOKS:

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design” John Wiley and sons, Inc, Newyork, 1995.

2. Rashid M.H., “Power Electronics Circuits, Devices and Applications:, Prentice Hall of 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.

PPD104 ANALYSIS OF INVERTERS
Common to M Tech(PSE)

L	T	P	C
3	1	0	4

Prerequisite

Power Electronics

Goal

To provide knowledge about the structure and functioning of inverter circuits

Objectives

The course will enable the students :

(i) To get exposed to the construction, working ,voltage control and performance calculation of various types of single phase inverters.

(ii) To familiar the students with the working of three phase voltage source inverters with star and delta loads.

(iii) To familiar the students with the working of current source inverters

(iv) To expose the students to the types of multilevel invereters

(v) To familiarize the students with resonant inverters and their voltage control.

Outcome

After completion of the course the students are expected to be able to:

(i) Explain the theory and working of different types of single phase inverters.

(ii) Explain the working of three phase inverters for 180 degree and 120 degree conduction modes.

(iii) Gain knowledge about current source inverters

(iv) Explain the functioning of working of multilevel inverters and their applications

(v) Explain the working of resonant inverters.

UNIT I SINGLE PHASE INVERTERS **9**

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.

UNIT II 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.

UNIT III 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.

UNIT IV MULTILEVEL INVERTERS **9**

Multilevel concept - diode clamped - flying capacitor - cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters.

UNIT V RESONANT INVERTERS **9**

Series and parallel resonant inverters - voltage control of resonant inverters - Class E resonant inverter - resonant DC link inverters.

L = 45 T=15 Total = 60

TEXT BOOKS :

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications”, Prentice Hall of India, Third Edition, New Delhi, 2004.

2. Jan P. Agrawal, “Power Electronics Systems”, Pearson Education, Second Edition, 2002.

REFERENCE BOOK:

1. P.C. Sen., “Modern 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.

PPD105 SPECIAL ELECTRICAL MACHINES
Common to M Tech(EC)& M Tech(PSE)

L	T	P	C
3	1	0	4

Prerequisite

Goal

To provide the basic principles, control and applications of special electrical machines in industries.

Objectives

The course will enable the students to:

(i) Learn the constructional features, principle of operation ,methods of control and applications of stepper motors.

(ii) Understand the constructional features, principle of operation ,methods of control and applications of Switched reluctance motors.

(iii) Have an insight into the constructional features, principle of operation ,methods of control and applications of PMBLDC motors.

(iv) Have a clear picture of the types, the constructional features, principle of operation ,methods of control and applications of PMSM.

(v) Gain knowledge in the types, the constructional features, principle of operation ,methods of control and applications of SyRM.

Outcome

After completion of the course, the students are expected to:

(i) Realize the need for stepper motors and the various applications in industries.

(ii) Get a clear picture of the operational characteristics and the applications of SRM.

(iii) Know the various types of PMBLDC motors, rotor position sensors ,methods of control and their applications.

(iv) Get a clear idea of the features , control and the applications of PMSM.

(v) Get a clear picture of the operational characteristics and the applications of SyRM.

UNIT I 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

UNIT II SWITCHED RELUCTANCE MOTORS **9**

Constructional features, principle of operation, Torque equation, Power controllers, Characteristics and control Microprocessor based controller.

UNIT III 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 equations, Torque-speed characteristics, Controllers-Microprocessor based controller.

UNIT IV 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.

UNIT V SYNCHRONOUS RELUCTANCE MOTORS **9**

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

L = 45 T=15 Total = 60

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, 1989.
3. B.K. Bose, "Modern Power Electronics & AC drives"
4. R.Krishnan, "Electric Motor Drives - Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

SEMESTER II

PPD201 COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS

L	T	P	C
3	1	0	4

Prerequisite

Goal

To impart knowledge of formulation and solution of design problems using mathematical and Computational techniques for electrical machines

Objectives

The course should enable the students to:

1. Learn the importance of field analysis design method,
2. Understand the basic electromagnetic field equations and the problem formulation for CAD applications,
3. Become familiar with Finite Element Method as applicable for Electrical Engineering,
4. Know the organization of a typical CAD package,
5. Apply Finite Element Method for the design of different Electrical apparatus.

Outcome

At the end of the course the student should be able to:

1. Understand the conventional designs and their limitations of various electrical machines and need for field analysis based design,
2. Understand the Magnetic & Electrical vector and scalar potentials, Laplace & Poisson's Equations and energy functional ,
3. Understand the mathematical analysis of Finite Difference method , Finite element method, 2D field problems and Solution techniques,
4. Understand the Pre-processing, Modelling, Meshing, Boundary conditions and Post-processing from CAD package,
5. Understand the design applications of Solenoid Actuator, Indution Machine and Transformer.

UNIT I INTRODUCTION **5**

Conventional design procedures - Limitations - Need for field analysis based design.

UNIT II MATHEMATICAL FORMULATION OF FIELD PROBLEMS **10**

Electromagnetic Field Equations - Magnetic Vector/Scalar potential - Electrical vector /Scalar Potential - Stored energy in field problems - Inductance- Development of torque/force- Laplace and Poisson's Equations - Energy functional - Principle of energy conversion.

UNIT III PHILOSOPHY OF FEM **10**

Mathematical models - Differential/Integral equations - Finite Difference method - Finite element method - Energy minimization - Variational method- 2D field problems - Discretisation - Shape functions - Stiffness matrix - Solution techniques.

UNIT IV CAD PACKAGES **10**

Elements of a CAD System -Pre-processing - Modelling - Meshing - Material properties- Boundary Conditions - Setting up solution - Post processing.

UNIT V DESIGN APPLICATIONS **10**

Design of Solenoid Actuator - Induction Motor - Insulators - Power transformer.

L = 45 T = 15 TOTAL : 60

TEXTBOOKS :

1. S.J Salon, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London, 1995.
2. S.R.H.Hoole, Computer - Aided, Analysis and Design of Electromagnetic Devices, Elsevier, New York, Amsterdam, London, 1989.

REFERENCES :

1. P.P. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, 1983.

2. D.A.Lowther and P.P Silvester, "Computer Aided Design in Magnetics", Springer verlag, New York, 1986.

PPD202 SOLID STATE DC DRIVES

L	T	P	C
3	1	0	4

Prerequisite

EE1633 - Analysis of Power Converter

Goal

To provide knowledge about the fundamentals, operation and design of DC drives with power electronic converter and chopper

Objectives

The course will enable the students to:

(i) Know the basic DC motor fundamentals with their speed-torque relations, mutli-quadrant operation, selection of motor and characteristics of mechanical system

(ii) Give in-depth knowledge in analysis of single and three phase fully controlled converter fed DC motor drive

(iii) Give in-depth knowledge in analysis of chopper fed DC drive

(iv) Give adequate knowledge to model a DC drive with closed loop speed control with various controller

(v) Acquire knowledge about digital control of DC drive

Outcome

At the end of the course the students should be able to

(i) Select the suitable drive for the required load characteristics.

(ii) Understand the concept of Converter / Chopper control of DC motor drive.

(iii) Gain adequate knowledge about DC motor drive and various speed control methods.

(iv) Design controllers for DC drives for open loop and closed loop speed control

(v) Gain adequate knowledge about digital control of DC drive

UNIT I DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS 9

DC motor- Types, induced emf, speed-torque relations; Speed control - Armature and field speed control; Ward Leonard control - Constant torque and constant horse power operations.

Characteristics of mechanical system - dynamic equations, components of torque, types of load; Requirements of drive characteristics - multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

UNIT II 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 free wheeling diode; Implementation of braking schemes; Drive employing dual converter.

UNIT III 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.

UNIT IV CLOSED LOOP CONTROL **9**

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

UNIT V 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 T = 15 TOTAL = 60

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.
4. P.C Sen "Thyristor DC Drives", John Wiley and sons, New York, 1981.

PPD203 SOLID STATE AC DRIVES

L	T	P	C
3	1	0	4

Goal

To provide knowledge about the control of AC Drives

Objectives

The course will enable the students :

(i) To get exposed to the control of induction machine by various methods.

(ii) To know about voltage source and current source inverter fed induction machine and its operational characteristics.

(iii) To familiar the students with the direct and indirect field control method of induction machine.

(iv) To expose the students to the Direct torque control of induction machine.

(v) To familiarize the students with brush and brushless excitation in synchronous motor control.

Outcome

After completion of the course the students are expected to be able to:

(i) Calculate the performance of the induction motor by different conventional control methods.

(ii) Explain the compensation methods for CSI and VSI fed induction machine.

(iii) Gain knowledge about field oriented control of induction machine.

(iv) Explain the direct torque control of induction machine.

(v) Explain the synchronous motor control.

UNIT I 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.

UNIT II 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.

UNIT III ORIENTED CONTROL **9**

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

UNIT IV DIRECT TORQUE CONTROL **9**

Direct torque control of Induction Machines - Torque expression with stator and rotor fluxes, DTC control strategy.

UNIT V SYNCHRONOUS MOTOR CONTROL **9**

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

L = 45 T = 15 Total = 60

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.

PPD204 LINEAR AND NONLINEAR SYSTEM THEORY

L	T	P	C
3	1	0	4

Prerequisite

Control Systems

Goal

To provide an insight theory on linear and non linear control systems.

Objectives

The course should enable the students to:

1. Study the concept of state space representation of dynamic systems.
2. Study about solution of state equations of linear, nonlinear, time invariant and time varying systems and also about systems modes.
3. Know about the concepts of controllability, observability, detectability, stabilizability and reducability of time invariant and time varying systems.
4. Have an in-depth knowledge about stability of linear and nonlinear systems using Liapunov's criterion.
5. Study the concept of observable and controllable companion forms and pole placement by feedback for SISO and MIMO systems.

Outcome

At the end of the course the student should be able to:

1. Derive state space equations and draw state diagrams for physical systems
2. Solve state equations of linear, nonlinear, time invariant and time varying systems,
3. Verify if a given system is controllable, observable, detectable, stabilizable and reducable.

4. Verify if a given system is stable using Liapunov's criterion.

5. Develop observable and controllable companion forms for a given system.

UNIT I 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.

UNIT II 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 Eigenvalues and Eigenvectors.

UNIT III 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.

UNIT IV STABILITY 9

Introduction-Equilibrium Points-Stability in the sense of Liapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear continuous time autonomous systems-The direct method of Liapunov and the Linear continuous-time autonomous systems-finding Liapunov functions for nonlinear continuous time autonomous systems-Krasovskii and variable-gradiant method.

UNIT V MODEL 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.

L = 45 T = 15 Total = 60

REFERENCES:

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

PCE 301 POWER ELECTRONICS AND DRIVES LABORATORY

L	T	P	C
0	0	3	2

Prerequisite

Power Electronics Lab

Goal

To provide hands on experience on the equipment for converters, inverters, choppers and simulation of closed loop control for electrical drives.

Objectives

This will enable the students to enhance simulation skills on

1. Single Phase Semi-converter and full converter with R-L and R-L-E loads for continuous and discontinuous conduction modes.
2. Three phase full-converter with R-L-E load.
3. MOSFET, IGBT based Choppers and IGBT based single phase inverters
4. Simulation of closed loop control of converter fed DC motor drive,chopper fed DC drives.
5. Simulation of three phase induction motor drive and three phase synchronous motor drives.

Outcomes

At the end of the course, the student should be able to :

1. Understand the working of semi converters with various firing angles and different modes of conduction
2. Understand the operation of full converter
3. Analyze inverters with different types of power switches.
4. Adequate knowledge in controlling DC Motor fed by converter
5. Adequate knowledge in simulating induction motor and synchronous motor drives

List of Experiments:

1. Single Phase Semi-converter with R-L and R-L-E loads for continuous and discontinuous conduction modes.
2. Single phase full- converter with R-L and R-L-E loads for continuous and discontinuous conduction modes.
3. Three phase full-converter with R-L-E load.
4. MOSFET, IGBT based Choppers.
5. IGBT based Single phase inverters.
6. Single phase AC voltage controller.

7. Simulation of closed loop control of converter fed DC motor drive.
8. Simulation of closed loop control of chopper fed DC motor drive.
9. Simulation of VSI fed three phase induction motor drive.
10. Simulation of three phase synchronous motor and drive.

Total : 45

ELECTIVE COURSES

PCS101 ADVANCED DIGITAL SIGNAL PROCESSING
Common to M Tech(AE)

L	T	P	C
3	1	0	4

Prerequisite

Basic knowledge of random processes, Fourier Transform, auto-correlation matrices & sampling process.

Goal

To provide knowledge of digital signal processing methods and tools, including leading algorithms for various applications.

Objectives

The course will enable the students to:

(i) Know the basics of discrete random processes

(ii) Know the basics of various Spectrum estimation methods

(iii) Know the basics of linear estimators & predictors

(iv) Know the basics of various adaptive filters along with their applications

(v) Know the fundamentals of multirate digital signal processing

Outcome

At the end of the course the students should be able to

(i) Understand the various theorems & processing that are done on discrete random processes

(ii) Understand the different parametric & non-parametric spectrum estimation methods

(iii) Understand the linear predictors & Wiener filters

(iv) Understand the adaptive filters & their various applications

(v) Understand the importance of multirate digital signal processing

UNIT I DISCRETE RANDOM SIGNAL PROCESSING **9**

Discrete Random Processes- Ensemble averages, stationary processes, Autocorrelation and Auto covariance matrices. Parseval's Theorem, Wiener-Khintchine Relation- Power Spectral Density-

Periodogram Spectral Factorization, Filtering random processes. Low Pass Filtering of White Noise. Parameter estimation: Bias and consistency.

UNIT II SPECTRUM ESTIMATION **9**

Estimation of spectra from finite duration signals, Non-Parametric Methods-Correlation Method , Periodogram Estimator, Performance Analysis of Estimators -Unbiased, Consistent Estimators-Modified periodogram, Bartlett and Welch methods, Blackman -Tukey method. Parametric Methods - AR, MA, ARMA model based spectral estimation. Parameter Estimation -Yule-Walker equations, solutions using Durbin's algorithm

UNIT III LINEAR ESTIMATION AND PREDICTION **9**

Linear prediction- Forward and backward predictions, Solutions of the Normal equations- Levinson-Durbin algorithms. Least mean squared error criterion -Wiener filter for filtering and prediction , FIR Wiener filter and Wiener IIR filters ,Discrete Kalman filter

UNIT IV ADAPTIVE FILTERS **9**

FIR adaptive filters -adaptive filter based on steepest descent method-Widrow-Hoff LMS adaptive algorithm, Normalized LMS. Adaptive channel equalization-Adaptive echo cancellation-Adaptive noise cancellation- Adaptive recursive filters (IIR). RLS adaptive filters-Exponentially weighted RLS-sliding window RLS.

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING **9**

Mathematical description of change of sampling rate - Interpolation and Decimation , Decimation by an integer factor - Interpolation by an integer factor, Sampling rate conversion by a rational factor, Filter implementation for sampling rate conversion- direct form FIR structures, Polyphase filter structures, time-variant structures. Multistage implementation of multirate system. Application to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals.

L=45 T=15 Total=60

TEXT BOOK:

1. Monson H.Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc., Singapore, 2002.

REFERENCES:

1. John G. Proakis, Dimitris G.Manolakis, Digital Signal Processing Pearson Education, 2002.
2. John G. Proakis et.al. 'Algorithms for Statistical Signal Processing', Pearson Education, 2002.
3. Dimitris G.Manolakis et.al. ' Statistical and adaptive signal Processing', McGraw Hill, Newyork, 2000.
4. Rafael C. Gonzalez, Richard E.Woods, 'Digital Image Processing', Pearson Education, Inc., Second Edition, 2004.(For Wavelet Transform Topic)

PPD701 EMBEDDED CONTROL OF ELECTRICAL DRIVES

L	T	P	C
3	1	0	4

Prerequisite

Basic Microcontroller and Control system

Goal

To provide knowledge of control of electrical drives employing embedded controllers

Objectives

The course will enable the students to:

(i) Know the basic of MC68HC11 microcontroller

(ii) Know the basic of various peripherals connected to MC68HC11

(iii) Know the basic of PIC16C7X microcontroller

(iv) Know the basic of various peripherals connected to PIC16C7X

(v) Give basic of designing a microcontroller based system

Outcome

At the end of the course the students should be able to

(i) Understand the architecture, instruction set , various peripherals of MC68HC11

(ii) Program in MC68HC11 for simple arithmetic operation and comparing

(iii) Understand the architecture, instruction set , various peripherals of PIC16C7X

(iv) Program in PIC16C7X for simple arithmetic operation

(v) Design a microcontroller based system

UNIT I MC68HC11 MICROCONTROLLER **9**

Architecture memory organization - addressing modes - instruction set - programming techniques - simple programs

UNIT II PERIPHERALS OF MC68HC11 **9**

I/O ports - handshaking techniques - reset and interrupts - serial communication interface - serial peripheral interface - programmable timer - analog / digital interfacing - cache memory

UNIT III PIC 16C7X MICROCONTROLLER **9**

Architecture - memory organization - addressing modes - instruction set - programming techniques - simple operation.

UNIT IV PERIPHERAL OF PIC 16C7X MICROCONTROLLER **9**

Timers - interrupts - I/O ports - I2C bus for peripheral chip access - A/D converter - UART

UNIT V SYSTEM DESIGN USING MICROCONTROLLERS **9**

Interfacing LCD display - Keypad interfacing - AC load control - PID control of DC motor - stepper motor control - brush less DC motor control.

L = 45 T = 15 TOTAL = 60

TEXT BOOK

1. John B.Peatman, 'Design with PIC Microcontrollers,'Pearson Education, Asia 2004
2. Michael Khevi, 'The M68HC11 Microcontroller Applications in control,Instrumentation and communication', Prentice Hall, New Jersey, 1997.

REFERENCES

1. John B.Peatman, 'Design with Microcontrollers', MCGraw Hill, 1988.

PPD702 INTELLIGENT CONTROL
Common to M.Tech.(EC)/ M.Tech. (PSE)

L	T	P	C
3	1	0	4

Prerequisite

Control SystemsTo implement various phases of Compilers.

Goal

To equip the students with a knowledge of modern intelligent control techniques and their applications.

Objectives

The course should enable the students to:

1. Study the concept of approaches and architecture for intelligent control, knowledge representation and expert systems.
2. Study various concepts about artificial neural networks, types of ANN and neural network based controller.
3. Study the concept of genetic algorithm and solution of typical problems using genetic algorithm.
4. Study the various concepts of fuzzy logic control and its applications.
5. Study the applications of expert systems, fuzzy logic control, ANN and genetic algorithm.

Outcome

At the end of the course the student should be able to:

1. Understand the concepts of intelligent control and their comparisons .
2. Understand the concepts of artificial neural network, types of ANN and to design ANN based controller.
3. Understand the concept of genetic algorithm and its applications to optimization techniques.

4. Design fuzzy logic controller.

5. Understand various intelligent control applications.

UNIT I INTRODUCTION **9**

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

UNIT II 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. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller

UNIT III GENETIC ALGORITHM **9**

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT IV FUZZY LOGIC SYSTEM **9**

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system.

UNIT V APPLICATIONS **9**

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

Stability analysis of Neural-Network interconnection systems. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control system

L=45 T=15 Total=60

REFERENCES

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, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers

PPD703 FLEXIBLE AC TRANSMISSION SYSTEMS
Common to M Tech(EC)& M Tech(PSE)

L	T	P	C
3	1	0	4

Goal

To provide a knowledge of application of power electronics in the efficient design and operation of power systems.

Objectives

The course will enable the students :

(i) To get introduced to basic concepts of FACTS controllers.

(ii) To familiar the students with the working of series compensation .

(iii) To familiar the students with the working of Unified Power Flow Controller.

(iv) To expose the students to the designing of FACTS controllers.

(v) To familiarize the students with static VAR compensators

Outcome

After completion of the course the students are expected to be able to:

(i) Explain the basic compensators used in power systems.

(ii) Explain how a series compensation is done in power system

(iii) Explain the working of Unified Power Flow Controller.

(iv) Design variable structure of FACTS controllers for power system

(v) Explain the working of static VAR compensators and their applications in power system

UNIT I INTRODUCTION **9**

FACTS-a toolkit, basic concepts of static VAR compensator, resonance damper, thyristor controlled series capacitor, static condenser, phase angle regulator, and other controllers.

UNIT II SERIES COMPENSATION SCHEMES **9**

Sub-Synchronous resonance, Torsional interaction, torsional torque, compensation of conventional, ASC, NGH damping schemes, modeling and control of thyristor controlled series compensators.

UNIT III UNIFIED POWER FLOW CONTROL **9**

Introduction, Implementation of power flow control using conventional thyristors, unified power flow concept, Implementation of unified power flow controller.

UNIT IV DESIGN OF FACTS CONTROLLERS **9**

Approximate multi-model decomposition, Variable structure FACTS controllers for Power system transient stability, Non-linear variable-structure control, variable structure series capacitor control, and variable structure resistor control.

UNIT V STATIC VAR COMPENSATION **9**

Basic concepts, Thyristor controlled reactor (TCR), Thyristor switched reactor (TSR), Thyristor switched capacitor (TSC), saturated reactor (SR), Fixed Capacitor (FC).

L = 45 T=15 Total = 60

REFERENCES

1. Narin G.Hingorani, "Flexible AC Transmission", IEEE Spectrum, April 1993,pp 40-45.
2. Narin G. Hingorani, "High Power Electronics and Flexible AC Transmission Systems IEEE High Power Engineering Review, 1998.
3. Narin G.Hingorani, "Power Electronics in Electric Utilities : Role of Power Electronics infuture power systems", Proc. of IEEE, Vol.76, no.4, April 1988.
4. Einar V.Larsen, Juan J. Sanchez-Gasca, Joe H.Chow, "Concepts for design of FACTS Controllers to damp power swings ", IEEE Trans On Power Systems, Vol.10, No.2, May 1995.
5. Gyugyi L., "Unified power flow control concept for flexible AC transmission", IEEE Proc-C Vol.139, No.4, July 1992.

PAL704 DIGITAL SIGNAL PROCESSORS
Common to M Tech(AE)

L	T	P	C
3	1	0	4

Goal

To familiarize the students with modern digital processing techniques with emphasis on special processors for motor control.

Objectives

The course will enable the students :

(i) to understand about the architecture and algorithms of DSPs.Algorithms for signal processing-Basic architecture of DSPs

(ii) to understand the students about the architecture, addressing modes, instruction set, programming.

(iii) to know the students different I/O devices for DSPs for different Applications.Peripherals-Memory-Applications.

(iv) to study the D to A interface and DMA, Serial Ports.

(v) to familiarize the students about special processors available for motor control.

Outcome

After completion of the course the students are expected to be able to:

(i) get clear idea about the basic structure of DSPs.

(ii) write programming in Texas Processors once they understand the instruction set.

(iii) know the students different I/O devices for DSPs for different Applications.Peripherals- Memory-Applications

(iv) interface different external I/O devices with processor.

(v) implement different control techniques of special purpose DSPs for various applications.

UNIT I INTRODUCTION **9**

Algorithms for signal processing - Basic architecture of DSPs.

UNIT II TEXAS PROCESSORS **9**

Architecture - Addressing modes - Instruction set - Programming

UNIT III PERIPHERALS INTERFACES OF DSP **9**

Peripherals - memory - Applications.

UNIT IV EXTERNAL INTERFACE **9**

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

UNIT V SPECIAL PROCESSORS FOR MOTOR CONTROL **9**

Architecture - Special features - PWM generation - controller implementation

L = 45 T=15 Total = 60

REFERENCES

1. K.Padmanabhan et al. "A Practical approach to Digital Signal Processing", New Age Publications, 2001.
2. B. Venkataramani et al. "Digital Signal Processor - Architecture, Programming and Applications" , TMH, New Delhi 2002.
3. Texas Instruments - Manuals.

PPD705 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION
Common to M.TECH(PED)/M.TECH(EC)

L	T	P	C
3	1	0	4

Goal

To impart knowledge on design, simulation and analysis of HVDC converters and associated control system.

Objectives

The course should enable the students to:

1. Study the basics of dc power transmission technology and its modern trends,
2. Study the analysis of Graetz circuits for 6-pulse & 12-pulse converter characteristics,

3. Study the system control hierarchy and firing angle control ,
4. Study the characteristics and non-characteristics harmonics in HVDC system and types of Filters
5. Study about the simulation of converter station using HVDC Simulator software.

Outcome

At the end of the course the student should be able to:

1. Know the comparison of AC and DC transmission and application of HVDC transmission systems,
2. One can learn about the applications of different converter bridges,
3. Know the HVDC system control and start-stop DC link,
4. Know the different types of harmonics in HVDC system Filters to remove them,
5. One can learn about the modeling and analysis of HVDC system using HVDC simulator.

UNIT I DC POWER TRANSMISSION TECHNOLOGY **9**

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.

UNIT II ANALYSIS OF HVDC CONVERTERS **9**

Pulse number, choice of converter configuration-simplified analysis of Graetz circuit-converter bridge characteristics - characteristics of a twelve pulse converter-detailed analysis of converters.

UNIT III CONVERTER AND HVDC SYSTEM CONTROL **9**

General principles of DC link control-converter control characteristics-system control hierarchy-firing angle control-current and extinction angle control-starting and stopping of DC link-power control-higher level controllers-telecommunication requirements.

UNIT IV HARMONICS AND FILTERS **9**

Introduction-generation of harmonics-design of AC filters-DC filters-carrier frequency and RI noise.

UNIT V SIMULATION OF HVDC SYSTEMS **9**

Introduction-system simulation: Philosophy and tools-HVDC system simulation-modeling of HVDC systems for digital dynamic simulation.

L = 45 T=15 Total = 60

REFERENCES

1. Padiyar, K.R., "HVDC Power Transmission System", Wiley Eastern Limited, New Delhi 1990. First edition.
2. Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Wiley interscience, New York, London, Sydney, 1971.
3. Rakosh Das Begamudre, Extra high voltage AC transmission engineering New Age International (P) Ltd., New Delhi, 1990.
4. Arrillaga, J., High Voltage direct current transmission, Peter Pregrinus, London, 1983.

PPD707 POWER QUALITY
Common to M.TECH (PED)/M.TECH(EC)

L	T	P	C
3	1	0	4

Goal

To provide the fundamentals of power quality, voltage variations, analysis of power outages and power quality improvement.

Objectives

The course should enable the students to:

1. Study the basics of power quality , power quality problems and power quality standards,
2. Study about the characteristics of non-linear loads ,
3. Study Voltage, Current, Power and Energy measurements and analysis methods of Laplace's, Fourier and Hartley and Wavelet Transforms ,
4. Study the analysis and conventional mitigation methods,
5. Study about various devices used to enhance power quality.

Outcome

At the end of the course the student should be able to:

1. Know the different characteristics of electric power quality in power systems,
2. One can learn about the applications of non-linear loads ,
3. Know the applications of Hartley and Wavelet Transforms ,
4. One can learn to mitigate the power quality problems
5. One can learn about the application of FACTS device on DG side.

UNIT I 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.

UNIT II 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.

UNIT III 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.

UNIT IV 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: Detorit 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.

UNIT V 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

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, M.F. McGranaghan, S.Santoso, H.W. Beaty, Electric Power Systems Quality, 2nd edition, McGraw-Hill Companies Inc., New York, 2003.
4. A.J. Arrillga, “Power system harmonics”.
5. Derek A. Paice., “Power electronic converter harmonics”.