ELECTRICAL AND ELECTRONICS ENGINEERING

M.TECH (POWER ELECTRONICS AND DRIVES)

(NON-CBCS)

REGULATIONS, CURRICULUM AND SYLLABUS

(With effect from the Academic Year 2011 – 12)

PONDICHERRY UNIVERSITY

PUDUCHERRY – 605 014.

PONDICHERRY UNIVERSITY

PUDUCHERRY - 605 014.

REGULATIONS FOR POST GRADUATE (M.Tech.) PROGRAMME IN THE DISCIPLINE OF ELECTRICAL AND ELECTRONICS ENGINEERING (**NON-CBCS**)

(WITH EFFECT FROM JULY 2011)

M.Tech (POWER ELECTRONICS AND DRIVES)

1.0 ELIGIBILITY

Candidates for admission to the first semester of four semester M.Tech (Power Electronics and drives) should have passed B.E / B.Tech. in Electrical and Electronics Engineering / Electronics and Instrumentation Engineering / Electronic & Communication Engineering/ Instrumentation & Control Engineering through regular course of study from an AICTE approved institution or an examination of any University or authority accepted by the Pondicherry University as equivalent thereto, with at least 55% marks in the degree examination or equivalent CGPA.

Note:

1. Candidates belonging to SC/ST who have a mere pass in the qualifying examination are eligible.
2. There is no age limit for M.Tech. programmes.

2.0 ADMISSION

The admission policy for various M.Tech. programmes shall be decided by the respective institutes offering M.Tech. programmes subject to conforming to the relevant regulations of the Pondicherry University.

3.0 STRUCTURE OF M.Tech. PROGRAMME

3.1 General

3.1.1. The M.Tech. Programmes are of semester pattern with 16 weeks of instruction in a semester.

3.1.2 The programme of instruction for each stream of specialization will consist of:

(i) Core courses (Compulsory)
(ii) Electives
(iii) Laboratory
(iv) Seminar
(v) Project work

3.1.3 The M.Tech. Programmes are of 4 semester duration.

3.1.4. Credits will be assigned to the courses based on the following general pattern:

(i) One credit for each lecture period
(ii) One credit for each tutorial period
(iii) Two credits for practical course
(iv) One credits for seminar
(v) Twenty two credits for Project work divided into 8 credits for Phase-I and 14 credits for Phase – II.
(vi) One teaching period shall be of 60 minutes duration including 10 minutes for discussion and movement.

3.1.5 Regulations, curriculum and syllabus of the M.Tech. programme shall have the approval of Board of Studies and other Boards/ Committees/ Councils, prescribed by the Pondicherry University. The curriculum should be so drawn up that the minimum number of credits and other requirements for the successful completion of the programme will be as given in Table – 1.

Table 1: Minimum credits and other requirements

Sl.No.	**Description**	**Requirements**
		M.Tech (Full-Time)
1	Number of Semesters	4
2	Min. number of credits of the programme	76
3	Max. number of credits of the programme	79
4	Min. Cumulative Grade Point Average for pass	5
5	Min. successful credits needed for registering in the next semester	Sem. I: 10
		Sem. II: 25
		Sem. III: 40
6	Min. period of completion of programme (consecutive semesters)	4
7	Max. period of completion of programme(consecutive semesters)	8

8	Number of core and elective courses	14
9	Seminar	2
10	Laboratory	2
11	Project work (semesters)	2

3.1.6 A core course is a course that a student admitted to the M.Tech. programme must successfully complete to receive the degree. A student shall register for all the core courses listed in the curriculum.

3.1.7 Elective courses are required to be chosen from the courses offered by the department(s) in that particular semester from among the approved courses. A core course of one department may be chosen as an elective by a student from other department.

3.1.8 Each student is required to make a seminar presentation on any chosen topic connected with the field of specialization. Preparation and presentation of a seminar is intended to investigate an in-depth review of literature, prepare a critical review and develop confidence to present the material by the student. The seminar shall be evaluated by a Department Committee constituted for this purpose, based on a report submitted by the candidate and a viva-voce conducted at the end of the semester.

3.1.9 Project work is envisaged to train a student to analyze independently any problem posed to him/her. The work may be analytical, experimental, design or a combination of both. The project report is expected to exhibit clarity of thought and expression. The evaluation of project work will be a continuous internal assessment based on two reviews, an internal viva-voce and an external viva-voce examination.

3.1.10 The medium of instruction, examination, seminar, directed study and project work will be in English.

4.0 REQUIREMENTS TO APPEAR FOR UNIVERSITY EXAMINATION

4.1 A candidate shall be permitted to appear for university examinations at the end of any semester only if he / she secures not less than 75% overall attendance arrived at by taking into account the total number of periods in all subjects put together offered by the institution for the semester under consideration. Candidates who secure overall attendance greater than 60% and less than 75% have to pay a condonation fee as prescribed by the University along with a medical certificate obtained from a medical officer not below the rank of Assistant Director to become eligible to appear for the examinations.

4.2 A candidate to secure eligibility towards continuing the Programme, he/she must have earned the minimum number of credits at the end of each semester as given in Table – 1. If he /she fails to satisfy this criterion in any semester, he/she shall be placed on scholastic probation in the succeeding semester.

4.3 His / Her conduct shall be satisfactory as certified by the Head of the institution.

5.0 EVALUATION

5.1 Evaluation of theory courses shall be based on 40% continuous internal assessment and 60% University examination. Evaluation of laboratory course shall be based on 50% internal assessment and 50% University examination. In each course, there shall be a 3 hour University examination.

5.2 The seminar will be evaluated internally for 100 marks. The total marks for the project work for M.Tech. programmes will be 300 marks for phase-I and 400 marks for phase-II. The allotment of marks for external valuation and internal valuation shall be as detailed below:

Seminar (Internal valuation only) : **100 Marks**

First review		30 marks
Second review		30 marks
Report and Viva voce		40 marks
	Total	**100 marks**

Project work – (Phase – I): 300 Marks

Internal valuation			
	Guide		50 marks
	First Evaluation		50 marks
	Second Evaluation		50 marks
		Total	**150 marks**
External valuation			
	Evaluation (External Examiner Only)		50 marks
	Viva voce (50 for Ext.+ 50 for Int.)		100 marks
		Total	**150 marks**

Project work – (Phase – II): 400 Marks

Internal valuation			
	Guide		100 marks
	First Evaluation		50 marks
	Second Evaluation		50 marks
		Total	**200 marks**
External valuation			
	Evaluation (External Examiner Only)		50 marks
	Viva voce (75 for Ext. + 75 for Int.)		150 marks
		Total	**200 marks**

Internal valuation should be done by a committee comprising of not less than 3 faculty members appointed by the Head of the Department and approved by the Head of the Institution.

5.3 The end-semester examination shall be conducted by the Pondicherry University for all the courses offered by the department. A model question paper, as approved by the Chairperson, BOS (EEE), Pondicherry University, for each course offered under the curriculum should be submitted to the University. The University examination shall cover the entire syllabus of the course.

5.4 The University shall adopt the double valuation procedure for evaluating the end-semester examinations, grading and publication of the results. Each answer script shall be evaluated by two experts. If the difference between the total marks awarded by the two examiners is not more than 15% of end-semester examination maximum marks, then the average of the total marks awarded by the two examiners will be reckoned as the mark secured by the candidate; otherwise, a third examiner is to be invited to evaluate the answer scripts and his/her assessment shall be declared final.

5.5 Continuous assessment of students for theory courses shall be based on two tests (15 marks each) and one assignment (10 marks). A laboratory course carries an internal assessment mark of 50 distributed as follows: (i) Regular laboratory exercises and records – 20 marks (ii) Internal laboratory test– 20 marks and (iii) Internal viva-voce – 10 marks.

5.6 All eligible students shall appear for the University examination.

6.0 Grading

6.1 The assessment of a course will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying stipulated points, will be awarded as per the range of total marks (out of 100) obtained by the candidate, as detailed below in Table – 2.

TABLE 2: Letter Grade and the Corresponding Grade Point

Range of Total Marks	Letter Grade	Grade	Description
90 to 100	S	10	EXCELLENT
80 to 89	A	9	VERY GOOD
70 to 79	B	8	GOOD
60 to 69	C	7	ABOVE AVERAGE
55 to 59	D	6	AVERAGE
50 to 54	E	5	SATISFACTORY
0 to 49	F	0	FAILURE
Incomplete	FA	-	FAILURE DUE TO LACK OF ATTENDANCE/ FAILURE BY ABSENCE

6.2 A student is deemed to have completed a course successfully and earned the appropriate credit if and only if, he /she receives a grade of E and above. The student should obtain 40% of marks in the University examination in a subject to earn a successful grade.

6.3 A candidate who has been declared "Failed" in a course may reappear for that subject during the subsequent semesters and secure a pass. However, there is a provision for revaluation of failed or passed subjects provided he/she fulfills the following norms for revaluation.

(i) Applications for revaluation should be filed within 4 weeks from the date of declaration of results or 15 days from the date of receipt of marks card whichever is earlier.

(ii) The candidate should have attended all the university examinations.

(iii) The candidate should not have failed in more than two papers in the current university examination.

(iv) The request for revaluation must be made in the format prescribed and duly recommended by the Head of the Institution along with the revaluation fee prescribed by the University.

(v) Revaluation is not permitted for practical courses, seminar and project work.

6.4 The internal assessment marks secured by a student in a theory course shall be considered only during the first appearance. For the subsequent attempts, the marks secured by the student in the University examination shall be scaled up to the total marks. Further, the marks secured by the student in the University examination in the latest attempt shall alone remain valid in total suppression of the University examination marks secured by the student in earlier attempts.

7.0 DECLARATION OF RESULTS, RANK AND ISSUE OF GRADE CARD

7.1 The results will be declared and the grade cards will be issued to the students after completing the valuation process.

7.2 The grade cards will contain the following details:

(i) The college in which the candidate is studying/has studied.

(ii) The list of courses enrolled during the semester and the grades scored.

(iii) The Grade Point Average (GPA) for the semester and the Cumulative Grade Point Average (CGPA) of all enrolled subjects from first semester onwards.

7.3 GPA is the ratio of the sum of the products of the number of credits (C) of courses registered and the corresponding grades points (GP) scored in those courses, taken for all the courses and the sum of number of credits of all the courses

$$GPA = (\text{Sum of } (C \times GP) / \text{ Sum of } C)$$

The sum will cover all the courses the student has taken in that semester, including those in which he/she has secured F.

7.4 CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. FA grades are to be excluded for calculating GPA and CGPA. If a student has passed in a course after failing in earlier attempts, the grade secured by the student in the successful attempt only will be taken into account for computing CGPA.

7.5 To convert CGPA into percentage marks, the following formula shall be used:

$$\% \text{ Mark} = (\text{CGPA} - 0.5) \times 10$$

7.6 A candidate who satisfies the course requirements for all semesters and passes all the examinations prescribed for all the four semesters within a maximum period of 10 semesters reckoned from the commencement of the first semester to which the candidate was admitted, shall be declared to have qualified for the award of degree.

7.7 A candidate who qualifies for the award of the degree shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION** upon fulfilling the following requirements:

(i) Should have passed all the subjects pertaining to semesters 1 to 4 in his/her first appearance in 4 consecutive semesters starting from first semester to which the candidate was admitted.
(ii) Should not have been prevented from writing examinations due to lack of attendance.
(iii) Should have secured a CGPA of 8.50 and above for the semesters 1 to 4.

7.8 A candidate who qualifies for the award of the degree by passing all the subjects relating to semesters 1 to 4 within a maximum period of 6 consecutive semesters after his/her commencement of study in the first semester and in addition secures CGPA not less than 6.5 shall be declared to have passed the examination in **FIRST CLASS**.

7.9 All other candidates who qualify for the award of degree shall be declared to have passed the examination in **SECOND CLASS**.

7.10 A student with CGPA less than 5.0 is not eligible for the award of degree.

7.11 For the award of University rank and gold medal, the CGPA secured from 1st to 4th semester should be considered and it is mandatory that the candidate should have passed all the subjects from 1st to 4th semester in the first appearance and he/she should not have been prevented from writing the examination due to lack of attendance and should not have withdrawn from writing the University examinations.

8.0 PROVISION FOR WITHDRAWAL

A candidate may, for valid reasons, and on the recommendation of the Head of the Institution be granted permission by the University to withdraw from writing the entire semester examination as one unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire programme. Other conditions being satisfactory, candidates who withdraw are also eligible to be awarded DISTINCTION whereas they are not eligible to be awarded a rank/gold medal.

9.0 DISCONTINUATION FROM THE PROGRAMME

If a candidate wishes to temporarily discontinue the programme for valid reasons, he/she shall apply through the Head of the Institution in advance and obtain a written order from the University permitting discontinuance. A candidate after temporary discontinuance may rejoin the programme only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 4 years, including the period of discontinuance.

10.0 REVISION OF REGULATIONS AND CURRICULUM

The University may from time to time revise, amend or change the regulations of curriculum and syllabus as and when requirement for the same arises.

11.0 POWER TO MODIFY

11.1 Notwithstanding anything contained in the foregoing, the Pondicherry University shall have the power to issue directions/ orders to remove any difficulty.

11.2 Nothing in the foregoing may be construed as limiting the power of the Pondicherry University to amend, modify or repeal any or all of the above.

****

M.TECH (POWER ELECTRONICS AND DRIVES) -NON CBCS

CURRICULUM AND SCHEME OF EXAMINATION

(Total number of credits required for the completion of the Programme: 75)

Semester I

Sl.No.	Code	Subject	Hours / Week			Credits	Marks		
			L	T	P		Internal	External	Total
1	C1	Advanced Engineering Mathematics	3	1	-	4	40	60	100
2	C2	Analysis of Power converters	3	1	-	4	40	60	100
3	C3	Advanced Power Semiconductor Devices	3	1	-	4	40	60	100
4	C4	Analysis of Electrical Machines	3	1	-	4	40	60	100
5		Elective – I	3	0	-	3	40	60	100
6		Elective – II	3	0	-	3	40	60	100
PRACTICAL									
7	P1	Seminar	-	-	3	2	100	-	100
TOTAL						24	340	360	700

Semester II

Sl. No.	Code	Subject	Hours / Week			Credits	Marks		
			L	T	P		Internal	External	Total
1	C5	AC Drives	3	1	-	4	40	60	100
2	C6	DC Drives	3	1	-	4	40	60	100
3	C7	Microcontroller and DSP Based System Design	3	1	-	4	40	60	100
4	C8	Advanced Control Systems	3	1	-	4	40	60	100
5		Elective – III	3	0	-	3	40	60	100
6		Elective – IV	3	0	-	3	40	60	100
PRACTICAL									
7	P2	Power Electronics and Drives Lab	-	-	6	2	50	50	100
TOTAL						24	290	410	700

Semester III

Sl. No.	Code	Subject	Hours / Week			Credits	Marks		
			L	T	P		Internal	External	Total
1		Elective – V	3	0	-	3	40	60	100
2		Elective – VI	3	0	-	3	40	60	100
PRACTICAL									
3	P3	Project Phase – I	-	-	16	8	150	150	300
TOTAL						14	230	270	500

Semester IV

Sl. No.	Code	Subject	Hours / Week			Credits	Marks		
			L	T	P		Internal	External	Total
1	P4	Project Phase – II	-	-	28	14	200	200	400
TOTAL						14	200	200	400

C1 ADVANCED ENGINEERING MATHEMATICS **L T P C**

3 1 0 4

UNIT I Complex Variables **12**

Review of complex variables, Conformal mapping & transformations, Function of complex variables, Pole and singularity, Integration with respect to complex argument, Residues and basic theorems on residues.

UNIT II Numerical Analysis **12**

Introduction, Interpolation formulae, Difference equation, Roots of equations, Solution of simultaneous linear and non-linear equations, Solution techniques for ODE and PDE, Introduction to stabilty, Matrix eigen value and eigen vector problems.

UNIT III Optimization Technique **12**

Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient Conditions for optimization, Elements of calculus variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.

UNIT IV Linear Algebra **12**

Vector space, Linear dependence of vectors, basis, linear transformations, inner product space, rank and inverse of a matrix, solution of algebraic equations, consistency conditions, Eigen values and eigen vectors, Hermitian and Skew Hermitian matrices.

UNIT V Z-Transform **12**

Transform of standard functions - Convolution - Initial and Final value problems - Shifting Theorem - Inverse transform (Using Partial Fraction - Residues) - Solution of difference Equations using Z - Transform.

Text Books:

1. James Ward Brown & Ruel V. Churchill, Complex variable and application., Mc Graw Hill International edition .
2. John H. Mathews, Numerical Methods for Mathematics , science and Engineering, PHI
3 S.S.Rao,, Optimisation theory and application, Wiely Eastern limited
4. Hoffman & Kunze. R, Linear Algebra, PHI
5 R.K Jain, SRK Iyengar, Advanced Engineering Mathematics ,Third edition, NAROSA

Reference Books:

1. John B. Conway, Functions of one complex variable, Springer International.
2. D.C. Sanyal and K. Das, A text Book of Numeriacl analysis, U.N. Dhar & Sons Pvt. Ltd.

C2 ANALYSIS OF POWER CONVERTERS **L T P C**

3 1 0 4

UNIT I SINGLE PHASE AC-DC CONVERTERS **12**

Static Characteristics of power diode, SCR and GTO, 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-reactive power and power balance in converter circuits

UNIT II THREE PHASE AC-DC CONVERTERS **12**

Semi and fully controlled converter with R, R-L, R-L-E - loads and free wheeling diodes– inverter operation and its limit – dual converter– performance parameters – effect of source impedance and over lap – 12 pulse converter.

UNIT - III DC-DC CONVERTERS **12**

Topologies of dc-dc switch mode converter: Buck,Boost,Buck-Boost,Cuk – Analysis and design in continuous and discontinuous conduction modes; Classification of Choppers – Analysis of Type-A chopper, step up chopper – AC chopper.

UNIT - IV AC-AC CONVERTERS **12**

Static Characteristics of TRIAC- Principle of phase control: single phase and three phase controllers – various configurations – analysis with R and R-L loads. Principle of operation of single phase-Three phase to single phase-three phase to three phase cycloconverter-Input and output performances-Harmonics-output voltage and frequency range-control circuit of cycloconverter.

UNIT - V INVERTERS **12**

Introduction to self commutated switches : MOSFET and IGBT - Principle of operation of single phase half and full bridge inverters – 180 degree and 120 degree conduction mode of three phase inverters with star and delta connected loads - Performance parameters – Voltage control of single phase, three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques.- Current source inverters.

TEXT BOOKS

1 Ned Mohan, Undeland and Robbins, "Power Electronics: concepts, applications and design", John wiley and sons, Singapore,2000.

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

3 Jai P.Agrawal, “Power Electronics Systems”, Pearson Education, Second Edition, 2002.

REFERENCES

1 Dewan, S.B. and Straugher A., "Power Semiconductor Circuits", John Wiley and sons, 1975.

2 Dubey G.K., Doralda S.R., Joshi A., and sinha R.M.K., "Thyristorised power controllers", Wiley Eastern Limited, 1986.

3 Sen P.C., "Thyristor DC Drives", John Wiley and sons. 1981.

4 Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson (2/e), 2003.

C3 ADVANCED POWER SEMICONDUCTOR DEVICES **L T P C**

3 1 0 4

UNIT – I INTRODUCTION **12**

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 **12**

BJTs - Construction, static characteristics, switching characteristics- Negative temperature coefficient and secondary breakdown - Power Darlington - Thyristors - Physical and electrical principle underlying operating mode - Two transistor analogy - Effect of α and i_{co} on i_a - 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 and Thyristor.

UNIT - III VOLTAGE CONTROLLED DEVICES **12**

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 **12**

Necessity of isolation - pulse transformer - opto-coupler; Gate drive circuit for SCR, MOSFET, IGBTs and base driving for power BJT - overvoltage, over current and gate protections, Design of snubbers

UNIT - V THERMAL PROTECTION **12**

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.

TEXT BOOKS

1. B.W. Williams, "Power Electronics - Devices, Drivers, Applications and passive components", Macmillan, (2/e), 1992.

2. Rashid M.H., "Power Electronics circuits, Devices and Applications", Prentice Hall India, Third Edition, Newdelhi, 2004.

3. Jayanth Baliga-----

Reference Books

1. M.D. 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.

C4 ELECTRICAL MACHINE ANALYSIS **L T P C**
3 1 0 4

UNIT I Basic Principles for Analysis **12**

Introduction, Magnetically coupled circuit, Electromechanical Energy Conversion, Machine windings and Air gap MMF, Winding inductances and voltage equations.

UNIT II Reference Frame Theory **12**

Introduction, Basic idea of Reference Frame, Synchronously rotating Reference Frame and Generalized Theory, Kron's primitive Machine and its mathematical Model, equation of voltage, power and torque, Other standard reference frames, Equation of transformation: change of variables, Transformation between reference frames, transformation of a balanced set, balanced steady state phasor relationship and voltage equations.

UNIT III DC Machines **12**

Introduction, Voltage and torque equations in machine variables, Basic types of the machine, Dynamic characteristics of permanent magnet and DC Shunt Motors, Time domain Block Diagrams and state equations, Solution of Dynamic equation by Laplace Transformation.

UNIT IV Induction Machines **12**

Introduction, Voltage and torque equations in machine variables, Equations of Transformation for rotor circuit, Voltage and Torque Equations in Arbitrary reference Frame Variables, Analysis of steady state operation, Free acceleration characteristics viewed from other reference frame, Dynamic performance during sudden change in load torque, Linearized model, Eigen values and small displacement stability, Reduced order equations and dynamics.

V Synchronous Machines **12**

Introduction, Voltage and torque equations in machine variables, Voltage and Torque Equations in Arbitrary reference Frame Variables, Voltage and Torque Equations in Rotor Reference Frame Variables, Torque Equations in Substitute variables, Analysis of steady state operation, Dynamic Performance during a sudden change in Input torque, Linearized model, Eigen values and small displacement stability, Reduced order equations and dynamics.

Text Books:

1. P.C. Krause, "Analysis of electric machinery and Drives", McGraw Hill, New York, 1986 References:
2. Ong Moon Lee "Dynamics Simulation of Electical Machines" Prentice Hall
3. Bimbhra P.S., "Generalized Circuit Theory of Electrical Machines", Khanna Publishers, Delhi, 5th Edition, 1995.
4. Adkins B., " The General Theory of Electrical Machines", John Wiley Sons, 1957.
5. Seely S., "Electro-Mechanical Energy Conversion", McGraw Hill, 1962.

ReferenceTexts:

1. R.Krishnan, "Electric Motor Drives, Modeling, Analysis and Control" , Prentice Hall of India, 2002
2. Samuel Seely, " Eletomechanical Energy Conversion", Tata McGraw Hill Publishing Company
3. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill,5th Edition, 1992

C5 AC DRIVES **L T P C**
3 1 0 4

UNIT I INTRODUCTION TO INDUCTION MOTORS **12**

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

UNIT II VSI AND CSI FED INDUCTION MOTOR CONTROL **12**

AC voltage controller circuit - six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed IM variable frequency drives comparison

UNIT III ROTOR CONTROLLED INDUCTION MOTOR DRIVES **12**

Static rotor resistance control - injection of voltage in the rotor circuit - static scherbius drives - power factor considerations - modified Kramer drives

UNIT IV FIELD ORIENTED CONTROL **12**

Field oriented control of induction machines - Theory - DC drive analogy - Direct and Indirect methods - Flux vector estimation - Direct torque control of Induction Machines - Torque expression with stator and rotor fluxes, DTC control strategy.

UNIT V SYNCHRONOUS MOTOR DRIVES **12**

Wound field cylindrical rotor motor - Equivalent circuits - performance equations of operation from a voltage source - Power factor control and V curves - starting and braking, self control - Load commutated Synchronous motor drives - Brush and Brushless excitation .

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.
3. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Yersy, 1989.
4. R.Krishnan, "Electric Motor Drives - Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

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.

C6 DC DRIVES **L T P C**
3 1 0 4

UNIT I DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS 12

DC motor- Types, induced emf, speed-torque relations; Speed control - Armature and field speed control; Ward Leonard control - Constant torque and constant horse power operation - Introduction to high speed drives and modern drives.
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.

UNIT II CONVERTER CONTROL 12

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 12

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 12

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 d.c drive.

UNIT V DIGITAL CONTROL OF DC DRIVE 12

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 of single phase ,three phase and chopper circuits.

TEXT BOOKS

1. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Yersy, 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", Narosal 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 wiely and sons, New York, 1981

C7 MICROCONTROLLER AND DSP BASED SYSTEM DESIGN **L T P C**
3 1 0 4

UNIT I PIC 16C7X MICROCONTROLLER **12**

Architecture memory organization – Addressing modes – Instruction set – Programming techniques – simple programs

UNIT II PERIPHERALS OF PIC 16C7X **12**

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

UNIT III MOTOR CONTROL SIGNAL PROCESSORS **12**

Introduction- System configuration registers - Memory Addressing modes - Instruction set – Programming techniques – simple programs

UNIT IV PERIPHERALS OF SIGNAL PROCESSORS **12**

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

UNIT V APPLICATIONS OF PIC AND SIGNAL PROCESSORS **12**

Voltage regulation of DC-DC converters- Stepper motor and DC motor control- Clarke's and parks transformation-Space vector PWM- Control of Induction Motors and PMSM.

TEXT BOOKS:

1. John B.Peatman , 'Design with PIC Microcontrollers,' Pearson Education, Asia 2004
2. Hamid A.Toliyat, Steven Campbell, 'DSP based electromechanical motion control', CRC Press
2. Myke Predko, " Programming and customizing the PIC Microcontroller", 3rd edition, Tata McGraw – Hill, 2008.

REFERENCE BOOKS :

1. Myke Predko, " Programming and customizing the PIC Microcontroller", 3rd edition, Tata McGraw – Hill, 2008.

C8 ADVANCED CONTROL SYSTEMS **L T P C**

3 1 0 4

1. CLASSICAL CONTROLLER DESIGN: **12**

Proportional(P)-Integral(I)-Derivative(D)-PI-PD - PID Controllers-Characteristics-Design-Controller Tuning- - Ziegler-Nichol's method and cohen coon method – Damped oscillation method

2. STATE SPACE DESCRIPTION &DESIGN: **12**

Review of state model for systems-state transition matrix –controllability-observability-Kalman decomposition-state feedback-output feedback-design methods-pole placement Controller -full order and reduced order observers-dead beat control

3. NON LINEAR SYSTEMS: **12**

Types of non-linearity-typical examples-describing function method-phase plane analysis stability Analysis of nonlinear systems- Lyapunov function – Construction of Lyapunov Function- Lyapunov's direct method- Lyapunov's indirect method

4. OPTIMAL CONTROL: **12**

Statement of optimal control problem – Problem formulation and forms of optimal control – Performance measures for optimal control – Selection of performance measure – Various methods of optimization- Necessary conditions for optimal control – Linear Quadratic regulator problem-Algebraic Riccati Equation –Solving ARE using Eigen vector method

5. DIGITAL CONTROL SYSTEMS: **12**

Pulse transfer function-State equation – Solutions – Realization – Controllability – Observability – Stability – Jury's test.-Digital Controller Design-Direct design method –Pole Placement controller-Dead beat Control- Discrete-Linear Quadratic regulator.

TEXT BOOKS:

1. J.Nagrath and M.Gopal "Control System Engineering", new age international publishers, 2003
2. M.Gopal "Modern Control System Theory", New Age International Ltd., 2002.
3. Ogata" Modern Control Systems"

REFERENCES:

1. Donald P.Eckman,Automatic Process Control",Wiley Eastern Ltd.,New Delhi,1993.
2. Benjamine C.Kuo,"Digital Control Systems",Oxford University Press,1992.
3. B.Sarkar," Control system design-The Optimal Approach",Wheeler Publishing ,New Delhi,1997

P2 . POWER ELECTRONICS AND DRIVES LAB

LIST OF EXPERIMENTS

1. Digital PWM generation schemes for 1-ϕ and 3-ϕ Inverters.
2. Speed control of converter/Chopper fed Dc motor.
3. Speed control of VSI fed Three phase Induction motor.
4. Microcontroller based speed control of stepper motor.
5. DSP based speed control of BLDC motor.
6. Design and Implementation of switched mode power supplies.
7. Digital firing scheme for 1-ϕ and 3-ϕ controlled rectifier.
8. Study of Unitrode ICs for the Voltage control of SMPS.
9. Simulation of Four quadrant operation of three phase induction motor.
10. Simulation of Automatic voltage regulator of three phase synchronous Generator

LIST OF ELECTIVES

EE01 SPECIAL ELECTRICAL MACHINES

EE02 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION

EE03 FLEXIBLE AC TRANSMISSION SYSTEM

EE04 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

EE05 SOFT COMPUTING TECHNIQUES

EE06 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEM

EE07 DIGITAL SIGNAL PROCESSING

EE08 MODERN POWER CONVERTERS AND RESONANT CONVERTERS

EE09 POWER QUALITY

EE01 SPECIAL ELECTRICAL MACHINES **L T P C**

3 0 0 3

UNIT I Stepper Motor **9**

Introduction, Types, Hybrid stepper motor- construction, principle of operation, two phases energized at a time, conditions for operation, different configurations, VR Stepper motor- single stack and multi stack, Drive systems and circuit for open loop and Closed loop control of stepping motor. Dynamic characteristics. Single phase stepper Motor, Expression of voltage , current and torque for stepper motor and criteria for synchronization.

UNIT II Switched Reluctance Motor **9**

Constructional features, principle of operation, Design Aspects and profile of the SRM, Torque equation, Power converters and rotor sensing mechanism, expression of torque and torque-speed characteristics,

UNIT III Permanent Magnet Materials **9**

Permanent magnet materials, properties, minor hysteresis loop and recoil line, equivalent circuit, stator frames with permanent magnets,

UNIT IV Brushless DC Motor **9**

Construction, operation, sensing and switching logic scheme, Drive and power circuit, Theoritical analysis and performance prediction, transient Analysis.

UNIT V Linear Induction Motor **9**

Construction and principle of operation of Linear Induction Motor, Approximate calculation of the force on rotor.

Text:

1. Vekatratnam, “Special Electrical Machines”, Universities Press
2. Kenjo. T and Nagamori. S, “Permanent Magnet and Brushless DC Motors”, Clarendon Press

Reference:

1 Fitzerald and Kingsley,” Electrical Machines” McGraw Hill. Miller. T. J. E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
, Oxford, 1989.
2. Kenjo. T, “Stepping Motors and their Microprocessor Control”, Clarendon Press, Oxford, 1989
3. . Krishnan R, “Switched Reluctance Motor Drives”, Modelling, Simulation, Analysis, Design and applications, CRC press

EE02 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION **L T P C**
3 0 0 3

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 MULTITERMINAL DC SYSTEM **9**

Multiterminal DC systems: Introduction - Potential application of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Operation of HVDC breaker.

UNIT V HARMONICS AND CONVERTER COMPONENT MODEL **9**

Introduction - Generation of harmonics - Design of AC filters - DC filters - Carrier frequency and RI noise. Converter model - Continuous time model - Discrete time converter model - Detailed model of the converter.

TEXT BOOKS:

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.

REFERENCE BOOKS:

1. Rakosh Das Begamudre, "Extra high voltage AC transmission Engineering", New Age International (P) Ltd., New Delhi, 2006
2. Arillaga, J., "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1998.
3. VIijay K. Sood, "HVDC & FACTS Controllers - Application of static converters in power system".
4. Jos Arillaga, Y.H.Liu, N.R. Watson, "Flexible Power Transmission" - The HVDC option-John wiley & sons ltd, 2007.

EE03 FLEXIBLE AC TRANSMISSION SYSTEM **L T P C**
3 1 0 4

UNIT I INTRODUCTION **9**

Concepts of reactive power - Load compensation - System compensation - Midpoint conditions of a symmetrical line- Passive shunt and series compensation - Synchronous condenser - Saturated reactor - Phase shifting transformer - Concept of FACTS devices.

UNIT II STATIC VAR COMPENSATOR (SVC) **9**

Tyristor Controlled Reactor (TCR) - Thyristor Switched Reactor (TSR) - Thyristor Switched Capacitor (TSC) - Fixed Capacitor - Thyristor Controlled Reactor (FC-TCR) - Thyristor Switched Capacitor - Thyristor Controlled Reactor (TSC -TCR) - V-I Characteristics of Static Var Compensator (SVC) - Advantages of slope in dynamic Characteristic - Voltage control by SVC - Design of SCV voltage regulator. Applications: Increase in power transfer capacity Enhancement of transient stability - Prevention of voltage instability.

UNIT III THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) **9**

Concept of series compensation - Thyristor Controlled Series Capacitor (TCSC) controller: Basic principle – Modes of Operation - Advantages - Analysis - Capability Characteristic, Modeling of TCSC, Applications: Open loop and closed loop control - Improvement of the system stability limit - Enhancement of system damping.

UNIT IV EMERGING FACTS CONTROLLER **9**

Static Synchronous Compensator (STATCOM): Principle of Operation - V-I Characteristic - Harmonic performance - Steady state model - SSR mitigation. SSSC: principle of operation - Control system. Unified Power Flow Controller (UPFC): Principle of Operation - Injection model. Interline Power Flow Controller (IPFC): Principle of Operation - Control structure. Evaluation of different FACTS controllers.

UNIT V SUB SYNCHRONOUS RESONANCE (SSR) **9**

NGH-SSR damping scheme - Thyristor controlled braking resistor (TCBR) - SVC mitigation of SSR - TCSC mitigation of SSR - Approximate multimodal decomposition method for the design of FACTS controllers.

TEXT BOOKS:

1. R. Mohan Mathur, Rajiv K. Varma, “Thyristor-based facts controllers for electrical transmission systems”, Wiley-IEEE, 2002.

2. K.R. Padiyar, “Facts Controllers in Power Transmission & Distribution”, New Age International Publishers.

REFERENCE BOOKS:

1. Enrique Acha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho, “FACTS: Modeling and Simulation in Power Networks”, John Wiley & Sons Ltd., 2004.

2. S. Sivanagaraju, S.Sathyabarayana, “Electric Power Transmission and Distribution”, Pearson Education, 2009.

3. Kalyan K. Sen & Mey Ling Sen, “Introduction to FACTS controllers: Theory, Modeling, and Applications”, Wiley-IEEE, 2009.

4. Narain G. Hingorani, Laszlo Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, IEEE Press Standard Publishers Distributors, 2000.

5. M.Noroozian et.al “Use of UPFC for optimal power flow control”, Transactions on Power Delivery, Vol.12, No.4, oct 1997, pp 1629-1634

EE04 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING **L T P C**
3 1 0 4

1. INTRODUCTION **9**

Review of basic field theory – electric and magnetic fields – Maxwell's equations – Laplace, Poisson and Helmoltz equations – principle of energy conversion – force/torque calculation – Electro thermal formulation.

2. SOLUTION OF FIELD EQUATIONS I **9**

Limitations of the conventional design procedure, need for the field analysis based design, problem definition , solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

3. SOLUTION OF FIELD EQUATIONS II **9**

Finite element method (FEM) – Differential/ integral functions – Variational method – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problem.

4. FIELD COMPUTATION FOR BASIC CONFIGURATIONS **9**

Computation of electric and magnetic field intensities– Capacitance and Inductance – Force, Torque, Energy for basic configurations.

5. DESIGN APPLICATIONS **9**

Insulators- Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines.

TEXT BOOKS

1..Binns.K.J, Lawrenson.P.J, Trowbridge.C.W, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.

2. Nathan Ida, Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer-Verlage, 1992.

3. Nicola Biyanchi , "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.

4. Salon.S.J, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London,

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

REFERENCE BOOKS:

1.S.R.H.Hoole, "Computer - Aided, Analysis and Design of Electromagnetic Devices", Elsevier, New York, Amsterdam, London, 1989.

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

3. A.K.Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai & Co, 5th Edition, Reprint 2002.

EE05 SOFT COMPUTING TECHNIQUES **L T P C**
3 1 0 4

UNIT I INTRODUCTION TO NEURAL NETWORKS 9

Introduction - biological neurons - Artificial neurons - activation function - learning rules - feed forward networks - supervised learning - perception networks - adaline - madaline - back propagation networks - learning factors - linear separability - Hopfield network - discrete Hopfield networks

UNIT II ARCHITECTURE – TYPES 9

Recurrent auto association memory - bi-directional associative memory - temporal associative memory - Boltzmann machine Hamming networks - self - organizing feature maps - adaptive resonance theory network - Instar - Outsar model - counter propagation network - radial basis function networks

UNIT III INTRODUCTION TO FUZZY SETS AND SYSTEMS 9

Crisp set - vaguness - uncertainty and imprecision - fuzzy set - fuzzy operation- properties - crisp versus fuzzy relations - fuzzy relation - cardinality operations, properties - fuzzy Cartesian product and composition - non - interactive fuzzy sets - tolerance and equivalence relations - fuzzy ordering relations - fuzzy morphism - composition of fuzzy relations

UNIT IV FUZZY LOGIC CONTROLLER 9

Fuzzy to crisp conversion - Lambda cuts for fuzzy sets and relations - definition methods - structure of fuzzy logic controller - database - rule base - Inference engine

UNIT V APPLICATION AND DESIGN 9

Applications of Neural network and Fuzzy system for single phase fully controlled converter, single phase ac voltage controller, DC Drive and AC Drive.Designing of controllers using Simulation Software Fuzzy Logic Toolbox - Modeling of DC Machines using Simulation Software and Simulink Toolbox

Text Books:

1. Lawrence Fausatt, “Fundamentals of neural networks”, Prentice Hall of India, New Delhi, 1994.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill International Edition, USA, 1997.
3. Bart kosko, “ Neural Networks and Fuzzy Systems”, Prentice Hall of India, New Delhi, 1994

Reference Books:

1.Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.

2. Klir.G.J. & Folger.T.A "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.

3. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.

4. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers

5. S.N.Sivanandam, S.Sumathi and S.N.Deepa, “Introduction to Neural Networks using MATLAB 6.0”, Mc Graw Hill Publishing companies Limited, 3rd Edition 2008.

6 Simopn S.Haykin, “Neural Networks: A Comprehensive Foundation”, Macmillan,1994.

7.S.Rajasekaran, G.A.Vijayalakashmi Pai, “Neural Networks, Fuzzy Logic & Genetic Algorithams: Synthesis & Applications”, PHI, 3rd Edition 2007.

EE06 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEM **L T P C**
3 1 0 4

UNIT I 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.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION **9**

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

UNIT III 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.

UNIT IV 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

UNIT V 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) techniques.

Text books:

1. Rashid .M. H “power electronics Hand book”, Academic press, 2001.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing

Company, New Delhi.

References:

1. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
2. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.

EE07 DIGITAL SIGNAL PROCESSING L T P C

3 1 0 4

UNIT I 9

Introduction to Discrete time signals - Linear shift invariant system - Stability - Properties systems - Sampling - Frequency domain representative of Discrete time signals and systems - Discrete time random signals.

UNIT II Introduction to Signal Processing 9

Review of Laplace transform, Fourier transform. Discrete Fourier transform, Fast Fourier transform, Algorithms and complexity, Introduction to linear optimal filtering.

UNIT III Digital Filter 9

Definition and anatomy of a digital filter, Frequency domain description of signals and systems, Typical application of digital filters, Replacing analog filters with digital filters, Filter categories: recursive and non-recursive.

UNIT IV Digital Filter Structures 9

The direct form I and II structures, Cascade combination of second order sections, Parallel combination of second order sections, Linear- phase FIR filter structures, Frequency sampling structure for the FIR filter.

UNIT V Effect of Word Length 9

Round off error, Truncation error, Quantization error, Limit cycle .Introduction to DSP Hardware: Application of DSP in control system and instrumentation.

Text books

1. J. C. Proakis, and D. G. Maniolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall.
2. B. Venkata Ramani, and M. Bhaskar, Digital Signal Processors, New Delhi: Tata McGraw Hill.

REFERENCE TEXTS :

1. S. K. Mitra, Digital Signal Processing,
2. Oppenheim, and R. W. Shaffer, Discrete Time Signal Processing, Prentice Hall, 1992.
3. J. Johnson, Digital Signal Processing, Prentice Hall.
4..Rabiner and Gold, “Theory and Application of Digital Signal Processing”, A comprehensive,

Industrial – Strength DSP reference book.

EE 08 MODERN POWER CONVERTERS AND RESONANT CONVERTERS **L T P C**
3 1 0 4

UNIT I POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS 9

Average power-RMS value of a waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Conduction Mode-Discontinuous Conduction Mode-Behaviour when C is large- Minimizing THD when C is small-Three phase rectifiers-Continuous Conduction Mode- Discontinuous Conduction Mode-Harmonic trap filters.

UNIT II MULTILEVEL INVERTERS 9

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

UNIT III RESONANT INVERTERS 9

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters - Soft Switching- Zero Current Switching - Zero Voltage Switching - Classification of Quasi resonant switches-Zero Current Switching of Quasi Resonant Buck converter, Zero Current Switching of Quasi Resonant Boost converter, Zero Voltage Switching of Quasi Resonant Buck converter, Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis.

UNIT IV DYNAMIC ANLYSIS OF SWITCHING CONVERTERS 9

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter, for an ideal Cuk Converter.

UNIT V CONTROL OF RESONANT CONVERTERS 9

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme-Design of Controllers: PI Controller, Variable Structure Controller, Optimal Controller for the source current shaping of PWM rectifiers.

Text books

1. Robert W. Erickson &Dragon Maksimovic" Fundamentals of Power Electronics" Second Edition, 2001 Springer science and Business media

REFERENCES

1. William Shepherd and Li zhang" Power Converters Circuits"Marceld Ekkerin,C.
2. Simon Ang and Alejandro Oliva "Power- Switching Converters" Taylor & Francis Group.

EE09 POWER QUALITY **L T P C**
3 1 0 4

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.

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.Power Quality - R.C. Duggan

REFERENCES

1. Power system harmonics –A.J. Arrillga
2. Power electronic converter harmonics –Derek A. Paice.