ACADEMIC REGULATIONS
COURSE STRUCTURE AND SYLLABI

M.TECH.
POWER ELECTRONICS & DRIVES
(Department of Electrical and Electronics Engineering)

2013 – 2014

COLLEGE OF ENGINEERING
(AUTONOMUS)

GAYATRI VIDYA PARISHAD
COLLEGE OF ENGINEERING
(AUTONOMOUS)

Accredited by NAAC with A Grade with a CGPA of 3.47/4.00

Affiliated to JNTUK-Kakinada

MADHURAWADA, VISAKHAPATNAM – 530 048

VISION

To evolve into and sustain as a Centre of Excellence in Technological Education and Research with a holistic approach.

MISSION

To produce high quality engineering graduates with the requisite theoretical and practical knowledge and social awareness to be able to contribute effectively to the progress of the society through their chosen field of endeavor.

To undertake Research & Development, and extension activities in the fields of Science and Engineering in areas of relevance for immediate application as well as for strengthening or establishing fundamental knowledge.

F O R E W O R D

Two batches of students have successfully completed the M.Tech. programme under autonomous status, which gave us a lot of satisfaction and encouragement. In the light of changing scenario of accreditation process globally, to upkeep the quality of education further, a major revision in the curriculum has been taken up with an objective to provide outcome based education.

As the college is getting funds under TEQIP-II, S.C.1.2 for up-scaling P.G education and research, two more P.G programmes in the thrust areas are being introduced from this academic year leading to a total of 13 programmes.

We could execute these changes only with the help of the commendable academicians, enthusiastic representatives from Industry and support from the representatives of affiliating University JNTU-K present in the Boards of Studies, Academic Council and Governing Body.

It is hoped that the new regulations and curriculum will enhance the all-round ability of students so that they can technically compete at global level with native ethical standards.

PRINCIPAL

MEMBERS ON THE BOARD OF STUDIES
IN
ELECTRICAL AND ELECTRONICS ENGINEERING

Prof. N.K. Kishore,
Professor of E.E.E., IIT Kharagpur, Kharagpur – 721 302.

Sri M.V.R. Krishna Rao,
AGM (ETL), Electro-Technical Lab., IADRS Building, Visakhapatnam Steel Plant, Visakhapatnam – 530 031.

Dr. C. Radhakrishna,
Global Energy Consulting Engineers Pvt. Ltd., 101, Avanthi Apartments, St. No.8, Vivekananda Nagar, Hubsiguda, Secundurabad.

Dr. K. Shanti Swarup,
ESB 349B, Department of Electrical Engg., IIT Madras, Chennai.

Dr. Ch. Sai Babu,
Professor in Electrical Engg., & Director, Academic & Planning, JNT University, Kakinada – 533 003.

Dr. M. Sydulu,
Professor in Electrical & Electronics Engg., National Institute of Technology (NIT), Warangal – 506 004.

Prof. K. A. Gopala Rao,
Principal, GVP College of Engg. for Women, Madhurawada, Visakhapatnam.

Sri T. Srinivas Kishore,
Assistant Professor, Department of E.E.E., G.M.R.I.T., Rajam.

All the Faculty Members of the Department

M.TECH. ACADEMIC REGULATIONS

(Effective for the students admitted into first year from the Academic Year 2013 - 14)

The M.Tech. Degree of Jawaharlal Nehru Technological University Kakinada shall be recommended to be conferred on candidates who are admitted to the program and fulfill all the following requirements for the award of the Degree.

1.0 ELGIBILITY FOR ADMISSION:

Admission to the above program shall be made subject to the eligibility, qualifications and specialization as per the guidelines prescribed by the APSCHE and AICTE from time to time.

2.0 AWARD OF M.TECH. DEGREE:

a. A student shall be declared eligible for the award of the M.Tech. degree, if he pursues a course of study and completes it successfully for not less than two academic years and not more than four academic years.
b. A student, who fails to fulfill all the academic requirements for the award of the Degree within four academic years from the year of his admission, shall forfeit his seat in M.Tech. Course.
c. The duration of each semester shall normally be 20 weeks with 5 days a week. A working day shall have 7 periods each of 50 minutes.

3.0 STRUCTURE OF THE PROGRAMME:

Semester	No. of Courses per Semester	Credits
	Theory + Lab	
I	(5 +1*) + 1	20
II	(5+1*) + 1	20
III	Seminar	02
III, IV	Project Work	40
	TOTAL	**82**

*Elective

4.0 ATTENDANCE:

The attendance shall be considered subject wise.

a. A candidate shall be deemed to have eligibility to write his end semester examinations in a subject if he has put in at least 75% of attendance in that subject.
b. Shortage of attendance up to 10% in any subject (i.e. 65% and above and below 75%) may be condoned by a Committee on genuine and valid reasons on representation by the candidate with supporting evidence.
c. Shortage of attendance below 65% shall in no case be condoned.
d. A student who gets less than 65% attendance in a maximum of two subjects in any semester shall not be permitted to take the end- semester examination in which he/she falls short. His/her registration for those subjects will be treated as cancelled. The student shall re-register and repeat those subjects as and when they are offered next.
e. If a student gets less than 65% attendance in more than two subjects in any semester he/she shall be detained and has to repeat the entire semester.

5.0 EVALUATION:

The performance of the candidate in each semester shall be evaluated subject-wise with 100 marks for each theory subject and 100 marks for each practical, on the basis of Internal Evaluation and External End -Semester Examination.

The question paper of the external end semester examination shall be set externally and valued both internally and externally. If the difference between the first and second valuations is less than or equal to 9 marks, the better of the two valuations shall be awarded. If the difference is more than 9 marks, the scripts are referred to third valuation and the corresponding marks are awarded.

a. A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End Semester Examination and aggregate minimum of 50% of the total marks of the End Semester Examination and Internal Evaluation taken together.

b. For the theory subjects, 60 marks shall be awarded based on the performance in the End Semester examination and 40 marks shall be awarded based on the Internal Evaluation. One part of the internal evaluation shall be made based on the average of the marks secured in the two internal examinations of 30 marks each conducted one in the middle of the Semester and the other immediately after the completion of instruction. Each mid-term examination shall be conducted for a duration of 120 minutes with 4 questions without any choice. The remaining 10 marks are awarded through an average of continuous evaluation of assignments / seminars / any other method, as notified by the teacher at the beginning of the semester.

c. For practical subjects, 50 marks shall be awarded based on the performance in the End Semester Examinations, 50 marks shall be awarded based on the day-to-day performance as Internal marks**.** A candidate has to secure a minimum of 50% in the external examination and has to secure a minimum of 50% on the aggregate to be declared successful.

d. There shall be a seminar presentation during III semester. For seminar, a student under the supervision of a faculty member(advisor), shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee. The Departmental Committee shall consist of the Head of the Department, advisor and two other senior faculty members of the department. For Seminar, there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful.

e. In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.a to 5.c), he has to reappear for the End Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate in that subject is less than 50% and he has failed in the end examination. In such a case, the candidate must re-register for the subject (s). In the event of re-registration, the internal marks and end examination marks obtained in the previous attempt are nullified.

f. In case the candidate secures less than the required attendance in any subject(s), he shall not be permitted to appear for the End Examination in those subject(s). He shall re-register for the subject(s) when they are next offered.
g. Laboratory examination for M.Tech. subjects must be conducted with two Examiners, one of them being Laboratory Class Teacher and second examiner shall be other than the Laboratory Teacher.

6.0 EVALUATION OF PROJECT / DISSERTATION WORK:

Every candidate shall be required to submit the thesis or dissertation after taking up a topic approved by the Departmental Research Committee (DRC).

a. A Departmental Research Committee (DRC) shall be constituted with the Head of the Department as the Chairman and two senior faculty as Members to oversee the proceedings of the project work from allotment of project topic to submission of the thesis.
b. A Central Research Committee (CRC) shall be constituted with a Senior Professor as Chair Person, Heads of the Departments which are offering the M.Tech. programs and two other senior faculty members from the same department.
c. Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects.)
d. After satisfying 6.0 c, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the DRC for its approval. Only after obtaining the approval of DRC the student can initiate the Project work.
e. If a candidate wishes to change his supervisor or topic of the project he can do so with the approval of the DRC. However, the Departmental Research Committee shall examine whether the change of topic/supervisor leads to a major change in his initial plans of project proposal. If so, his date of registration for the Project work shall start from the date of change of Supervisor or topic as the case may be whichever is earlier.

f. A candidate shall submit and present the status report in two stages at least with a gap of 3 months between them after satisfying 6.0 d. The DRC has to approve the status report, for the candidate to proceed with the next stage of work.

g. The work on the project shall be initiated in the beginning of the second year and the duration of the project is for two semesters. A candidate shall be permitted to submit his dissertation only after successful completion of all theory and practical subject with the approval of CRC but not earlier than 40 weeks from the date of registration of the project work. For the approval by CRC the candidate shall submit the draft copy of the thesis to the Principal through the concerned Head of the Department and shall make an oral presentation before the CRC.

h. Three copies of the dissertation certified by the Supervisor shall be submitted to the College after approval by the CRC.

i. For the purpose of adjudication of the dissertation, an external examiner shall be selected by the Principal from a panel of 5 examiners who are experienced in that field proposed by the Head of the Department in consultation with the supervisor.

j. The viva-voce examination shall be conducted by a board consisting of the supervisor, Head of the Department and the external examiner. The board shall jointly report the candidate's work as:

    A. Excellent
    B. Good
    C. Satisfactory

k. If the adjudication report is not favorable, the candidate shall revise and resubmit the dissertation, in a time frame prescribed by the CRC. If the adjudication report is unfavorable again, the dissertation shall be summarily rejected and the candidate shall change the topic of the Project and go through the entire process afresh.

7.0 AWARD OF DEGREE AND CLASS :

A candidate shall be eligible for the degree if he satisfies the minimum academic requirements in every subject and secures satisfactory or higher grade report on his dissertation and viva-voce.

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M.Tech. Degree, he shall be placed in one of the following three classes.

% of Marks secured	Class Awarded
70% and above	First Class with Distinction
60% and above but less than 70%	First Class
50% and above but less than 60%	Second Class

The grade of the dissertation shall be mentioned in the marks memorandum.

8.0 WITHHOLDING OF RESULTS:

If the candidate has not paid any dues to the college or if any case of indiscipline is pending against him, the result of the candidate shall be withheld and he will not be allowed into the next higher semester. The recommendation for the issue of the degree shall be liable to be withheld in all such cases.

9.0 TRANSITORY REGULATIONS:

a. A candidate who has discontinued or has been detained for want of attendance or who has failed after having studied the subject is eligible for admission to the same or equivalent subject(s) as and when subject(s) is/are offered, subject to 4.0 d, e and 2.0.
b. Credit equivalences shall be drawn for the students re-admitted into 2013 regulations from the earlier regulations. A Student has to register for the substitute / compulsory / pre-requisite subjects identified by the respective Boards of Studies.
c. The student has to register for substitute subjects, attend the classes and qualify in examination and earn the credits.
d. The student has to register for compulsory subjects, attend the classes and qualify in examination.
e. The student has to register for the pre-requisite courses, attend the classes for which the evaluation is totally internal.

10.0 GENERAL

1. The academic regulations should be read as a whole for purpose of any interpretation.

2. In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman, Academic Council is final.

3. The College may change or amend the academic regulations and syllabus at any time and the changes amendments made shall be applicable to all the students with effect from the date notified by the College.

4. Wherever the word he, him or his occur, it will also include she, hers.

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COURSE STRUCTURE

SEMESTER - I

Course Code	THEORY/LAB	L	P	C
13EE2201	Analysis of Power Electronic Converters-I	4	-	3
13EE2202	Solid State Control of DC Drives	4	-	3
13EE2203	Embedded Systems	4	-	3
13EE2204	Digital Control Systems	4	-	3
13EE2205	Optimization Techniques	4	-	3
13EE2206 13EE2207 13EE2208	**Elective – I** 1. Advanced Digital Signal Processing 2. High Voltage DC Transmission 3. Modern Control Theory	4	-	3
13EE2209	Power Electronics and Drives Laboratory-I	-	3	2
	TOTAL	**24**	**3**	**20**

SEMESTER – II

Course Code	THEORY/LAB	L	P	C
13EE2210	Analysis of Power Electronic Converters-II	4	-	3
13EE2211	Solid State Control of AC Drives	4	-	3
13EE2212	Analysis of Special Machines	4	-	3
13EE2213	Dynamics of Electrical Machines	4	-	3
13EE2214	Power Quality	4	-	3
13EE2215 13EE2216 13EE2217	**Elective – II** 1. Flexible AC Transmission Systems 2. Neural and Fuzzy Systems 3. Design and Simulation of Power Electronic Circuits	4	-	3
13EE2218	Power Electronics and Drives Laboratory-II	-	3	2
	TOTAL	**24**	**3**	**20**

SEMESTER – III

Course Code	SEMINAR/ PROJECT WORK	CREDITS
13EE2219	SEMINAR	2
13EE2220	PROJECT WORK (Contd..)	

SEMESTER – IV

Course code	PROJECT WORK	CREDITS
13EE2220	PROJECT WORK	40

ANALYSIS OF POWER ELECTRONIC CONVERTERS-I

Course Code: 13EE2201 **L P C**
Pre requisites: Power Electronics **4 0 3**

Course Educational Objectives: To familiarize the student with switch mode dc-dc & dc-ac converters which find wide application in industry.

Course Outcomes: At the end of the course, the students will have knowledge in

1. Different types of power semiconductor devices and their characteristics
2. Full and half controlled converters both single and three phase.
3. AC voltage controllers and cycloconverter both single and three phase
4. DC – DC switch mode converters.
5. DC-AC switch mode inverters.
6. Principle of Operation, Features of multilevel inverters.

UNIT-I POWER SEMICONDUCTOR DEVICES

Power Diodes, Power BJTs, Power MOSFETs, Thyristors, Gate Turn Off Thyristors, IGBTs, MOS-Controlled Thyristors, Comparison of Controllable Switches, Drive and Snubber Circuits, Justification for Using Idealized Device Characteristics.

UNIT-II

CONTROLLED RECTIFIERS & VOLTAGE CONTROLLERS AND CYCLOCONVERTERS

Introduction**,** Principle of phase controlled converter operation, single phase full converters, single phase dual converters, Three phase half wave converters, three phase full converters, Three phase dual converters, Power factor improvements, Single phase semiconverters, Three phase semiconverters.

Introduction, Principle of ON-OFF Control, Single phase bidirectional controllers with resistive loads, Single phase controllers with inductive loads, Three Phase full wave controllers, Single phase transformer connection changers, Single phase cycloconverters, Three phase cycloconverters.

UNIT-III

DC-DC SWITCH MODE CONVERTERS

Introduction, Control of dc-dc converters, Step down (Buck) converter-continuous conduction mode-boundary between continuous and

discontinuous conduction-discontinuous conduction mode. Step up (Boost) converter- continuous conduction mode-boundary between continuous and discontinuous conduction-discontinuous conduction mode.

Buck-Boost converter- continuous conduction mode-boundary between continuous and discontinuous conduction-discontinuous conduction mode-output voltage ripple. Buck dc-dc converter.

UNIT-IV

SWITCH MODE INVERTERS

Introduction, Basic concepts of switch mode inverters, pulse width modulated switching scheme, single phase inverters-half bridge inverters-full bridge inverters-PWM with bipolar voltage switching-PWM with unipolar voltage switching, Push-pull inverters. Three phase inverters-PWM in three phase voltage source inverters-square wave operation in three phase inverters, Ripple in the Inverter output, effect of blanking time on voltage in PWM inverters

UNIT-V

MULTI LEVEL INVERTERS

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter, Feature of Multilevel Converters, Comparisons of Multilevel Converters.

TEXT BOOKS:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "*Power Electronics*", John Wiley & Sons, 2007.
2. Md. H. Rashid, "*Power Electronics*", Pearson Education, Third Edition, 2008
3. Bimal K. Bose, "*Modern Power Electronics and AC Drives*", Prentice-hall Of India Pvt. Ltd., 2008.

REFERENCE BOOKS:

1. Philip T. Krein, "*Elements of Power Electronics*", Oxford University Press,2009.
2. L. Umanand, "*Power Electronics: Essentials & Applications*", Wiley India,2009.
3. Robert Erickson and Dragon Maksivimovic, "*Fundamentals of Power Electronics*", Springer Publications, 2001.
4. Issa Batarseh,"*Power Electronics*", John Wiley, 2003.

SOLID STATE CONTROL OF DC DRIVES

Course Code:13EE2202 **L P C**
4 0 3

Pre requisites: Power Electronics and Power Electronic Drives

Course Educational Objectives:

The Student shall be exposed to Control of DC Drives and Modelling & Simulation of DC Drives with different Controllers.

Course Outcomes: After Completion of the Course, the Student will be able to

1. Analyze the four Quadrant Operation of the DC Drives.
2. Analyze the Dual Converter Control of DC motor.
3. Analyze the Two Quadrant and Four Quadrant Control of DC Motor Drive.
4. Make the Steady State Analysis of Chopper.
5. Simulate the Speed Control DC Motor Drives.

UNIT-I

AN INTRODUCTION TO ELECTRICAL DRIVES& DYNAMICS OF ELECTRICAL DRIVES: Electrical drives, Advantages of Electrical Drives, Parts of Electrical Drives, choice of electrical drives, status of dc and ac drives. Fundamental torque equation, speed torque conventions and multi quadrant operation, equivalent values of drive parameters, components of load torques, nature and classifications of load torques, steady state stability.

UNIT-II

CONTROLLED RECTIFIER 1 PHASE AND 3 PHASE FED DC DRIVES:

Introduction, Fully Controlled Rectifier Drives, Single phase fully controlled rectifier control of DC separately excited motor-Discontinuous current-continuous current, Single phase half controlled rectifier control of DC separately excited motor Discontinuous current-continuous current. Three phase semi converter and three phase full converter control of a separately excited DC motor for continuous and discontinuous modes of operation power and power factor Addition of Free-wheeling diode Three phase dual converter control of separately excited DC motor

UNIT-III

CLOSED LOOP CONTROL OF PHASE CONTROLLED DC MOTOR DRIVES &Two-Quadrant three phase converter controlled DC motor drive, Four quadrant DC motor drive, Transfer Functions of the subsystem-DC motor and load-converter-current and speed controllers-current feedback-speed feedback.

UNIT-IV

CHOPPER CONTROLLED DC MOTOR DRIVES & CLOSED LOOP CONTROL OF CHOPPER FED DC MOTOR DRIVES: Principle of operation of the chopper, Four quadrant chopper circuit, Chopper for inversion, Chopper with other power devices, Model of the chopper, Input to the chopper, Steady state analysis of chopper controlled DC motor drives, Ratings of the devices. Speed controlled drive system, Current control loop, Pulse width modulated current controller, Hysteresis current controller, modeling of current controller, Design of current controller.

UNIT-V

SIMULATION OF DC MOTOR DRIVES: Dynamic simulations of the speed controlled DC motor drives, Speed feedback speed controller, and command current generator current controller.

TEXT BOOKS:

1. G. K. Dubey, "*Fundamentals of Electric Drives*", Narosa Publications, 1995, 2nd Edition. (Chapters 1,2)
2. R. Krishnan, "*Electric Motor Drives Modeling, Analysis and Control*", Prentice Hall India Publications, 2008. (Chapters 3,4,5)

REFERENCE BOOKS:

1.Shepherd, Hulley, Liang, "*Power Electronics and Motor Control*", 2nd Edition., Cambridge University Press,2004.
2. M. H. Rashid, "*Power Electronic Circuits, Devices and Applications*", 3rd edition, PHI Publications, 2008.
3. G. K. Dubey, "*Power Semiconductor drives*", Prentice Hall India Publications, 1989-01.
4. P. K. Sen, "*Electrical drives*", Prentice Hall India Publications,

EMBEDDED SYSTEMS

Course Code: 13EE2203 **L P C**
4 0 3

Pre requisites: Basic Knowledge of Microcontrollers.

Course Educational Objectives: To provide the student with in-depth knowledge of embedded systems including overall system design, interfacing, operating systems, data acquisition, communication protocols, and real-time performance.

Course Outcomes: After completion of the course, the student will have knowledge in

1. Basics of design aspects of Embedded Systems.
2. Fundamentals of 8051 architecture.
3. Fundamentals of Real Time Operating Systems.
4. Features of advanced architectures in ARM and SHARC processors.

UNIT-I
EMBEDDED COMPUTING:

Introduction, Complex Systems and Microprocessor, The Embedded System Design Process, Formalisms for System Design, Design Examples.

UNIT-II
THE 8051 ARCHITECTURE :

Introduction, 8051 Micro controller Hardware, Input/Output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/Output, Interrupts. The Assembly Language Programming Process, Programming Tools and Techniques, Programming the 8051. Data Transfer and Logical Instructions. Arithmetic Operations, Decimal Arithmetic. Jump and Call Instructions, Further Details on Interrupts. Interfacing with Keyboards, Displays, D/A and A/D Conversions, Multiple Interrupts, Serial Data Communication.

UNIT-III
INTRODUCTION TO REAL – TIME OPERATING SYSTEMS:

Tasks and Task states, Tasks and Data, Semaphores and Shared Data, Message Queues, Mailboxes and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment.

UNIT-IV

BASIC DESIGN USING A REAL-TIME OPERATING SYSTEM:

Principles, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory and Power, An example RTOS like UC-OS (Open Source); Embedded Software Development Tools: Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded Software into the Target System; Debugging Techniques : Testing on Host Machine, Using Laboratory Tools, An Example System.

UNIT-V

INTRODUCTION TO ADVANCED ARCHITECTURES

ARM and SHARC Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled Systems, Design Example-Elevator Controller.

Text books:

1. Wayne Wolf, "*Computers as Components*", Morgan Kaufman, 2010.
2. B.Kanta Rao, "*Embedded Systems*", PHI, First Edition, 2011
3. David E. Simon, "*An Embedded Software Primer*", Pearson Education, 2011.

Reference Books:

1. Jean. J. Labrosse,"*Embedded System building blocks*", 2nd edition, CMP publishers,1999.

2. Raj Kamal,"*Embedded Systems: Architecture, Programming and Design*", 2nd Edition, TMH, 2008.

3. Kenneth J. Ayala, "*The 8051 Microcontroller"*, Third Edition, Cenage Learning, 2010.

4. Frank Vahid, Tony Givargis, "*Embedded System Design*", JohnWiley, 2011.

DIGITAL CONTROL SYSTEMS

Course Code:13EE2204 **L P C**
4 0 3

Pre requisites: Control Systems

Course Educational Objectives:

1. To equip the students with the basic knowledge of A/D and D/A conversion
2. To understand the basics of Z- Transform
3. To study the stability analysis of digital control system
4. To gain the basic Knowledge of the design of digital control systems for different engineering models
5. To gain the basic knowledge of digital simulation and DSP Processors.

Course Outcomes:

1. This course provides a foundation in discrete-time linear control system theory.
2. Analyze, design, and synthesize digital control systems using transform techniques (root locus and frequency response) and state-space methods (pole-assignment and state estimation).
3. Analyzing and understanding the challenges to interface digital computing devices with the Analog dynamics of most real-world systems.
4. Evaluating and setting the necessary specifications for analog systems that are to be controlled by digital computing devices.
5. Designing digital devices to satisfy given specifications and to achieve desired system-behavior.
6. Understanding the Basic Concepts of Microprocessor control of control systems and custom designed chips like Galil DMC-105.

UNIT-I

SIGNAL CONVERSION AND PROCESSING

Introduction, Digital Signals and coding, Data Conversion and Quantization, Sample and Hold Devices, Sampling Period Considerations, Mathematical Modeling of the Sampling Process, Sampling Theorem, Mathematical Modeling of Sampling by Convolution Integral, Flat-Top Approximation of Finite Pulse width Sampling, Data Reconstruction and Filtering of Sampling Signals, Zero-Order Hold, First Order Hold, Polygonal Hold and Slewer Order Hold.

Z – TRANSFORMS, TRANSFER FUNCTIONS AND BLOCK DIAGRAMS

Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms. Introduction, The Pulse Transfer Function and the Z-Transfer Function, Pulse Transfer Function of the Zero- Order Hold and the Relation between G(s) and G(z), Closed loop systems- characteristic Equation, Causality and Physical Realizability, Sampled Signal Flow Graph.

UNIT-II

STATE SPACE ANALYSIS

State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations.

CONTROLLABILITY AND OBSERVABILITY

Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function.

UNIT-III

STABILITY ANALYSIS

Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion. Stability analysis using Liapunov theorems.

UNIT-IV

DESIGN OF DISCRETE-DATA CONTROL SYSTEMS

Introduction, Cascade Compensation by Continuous-Data Controllers, Design of Continuous-Data Controllers with Equivalent Digital Controllers, Digital Controllers, Design of Digital Control Systems with Digital Controllers through bilinear transformation.

UNIT- V

DIGITAL SIMULATION

Introduction, Digital Simulation- Digital Modeling with Sample and Hold Devices, State Variable Formulation, Numerical Integration, Rectangular Integration, Frequency Domain Characteristics- Frequency Warping, Frequency Prewarping.

MICROPROCESSOR AND DSP CONTROL

Introduction, Microprocessor Control of Control Systems, Single- Board Controllers with Custom-Designed Chips, The Galil DMC-105 Board, Digital Signal Processors- The Texas Instruments TMS320 DSP's, Development Systems and Support Tools.

TEXT BOOKS:

1. Kuo, "*Digital Control Systems*", 2nd Edition, Oxford University Press, 2003.

2. K.Ogata, "*Discrete-Time Control systems*", 2nd Edition, Pearson Education/PHI, 2002.

REFERENCE BOOKS:

1. M.Gopal, "*Digital Control and State Variable Methods by conventional and intelligent control system*", third edition, TMH, 2009.

2. M. Gopal,"*Modern Control Systems Theory*", Wiley Eastern,1984.

3. M. Gopal, "*Digital control engineering*" , New Age International Publications,2003

OPTIMIZATION TECHNIQUES

Course Code:13EE2205 **L P C**
4 0 3

Pre requisites: Partial differentiation, Matrices.

Course Educational Objectives:

1. To expose the student to the theory of classical optimization techniques
2. To use the optimization techniques for solving practical problems in engineering systems.
3. To use the Optimization Techniques to design and produce products and systems both economically and efficiently.
4. To solve linear, non linear, dynamic and integer problems by using optimization techniques

Course Outcomes: After the completion of the course, the student will be able

1. to analyze any problem of optimization in an engineering system by formulating a mathematical model to the problem and solving it by using appropriate optimization technique(s).
2. to design and produce products and systems both economically and efficiently by using optimization techniques.
3. to solve linear, non linear, and integer problems by using optimization techniques.

UNIT-I

INTRODUCTION AND CLASSICAL OPTIMIZATION TECHNIQUES: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems – Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints: Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints: Kuhn – Tucker conditions.

UNIT-II

A. LINEAR PROGRAMMING: Standard form of a linear programming problem – geometry of linear programming problems– motivation to the simplex method–simplex algorithm, dual LP.

B. INTEGER PROGRAMMING:
Gomory's cutting plane method, Branch and bound method.

UNIT-III
TRANSPORTATION PROBLEM:
Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems.

UNIT-IV
UNCONSTRAINED NONLINEAR PROGRAMMING: One – dimensional minimization methods:Classification, Fibonacci method and Quadratic interpolation method, Univariate method, Powell's method, steepest descent method, Davidon-Fletcher-Powell method.

UNIT-V
CONSTRAINED NON LINEAR PROGRAMMING: Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods, Introduction to Convex Programming problem.

TEXT BOOK:

1. S.S.Rao,"*Engineering optimization: Theory and practice*", 4th edition, New Age
International (P) Limited, 2009.

REFERENCE BOOKS:

1. K.V. Mital and C. Mohan " *Optimization Methods in Operations Research and systems Analysis*" , 3rd edition, New Age International (P) Limited Publishers, 1996.
2. KanthiSwarup, P.K.Gupta and Man Mohan "*Operations Research*", 15th Edition, Sultan Chand & Sons New Delhi, 2010.
3. S.D. Sharma, "*Operations Research*", 15th Edition, published by Kedarnath Ramnath, 2009.
4. G. Hadley, "*Linear Programming*", 1st edition Narosa publishing house 1997.

ADVANCED DIGITAL SIGNAL PROCESSING (ELECTIVE – I)

Course Code:13EE2206 **L P C**
4 0 3

Pre requisites: Basic Knowledge of Signals and Systems and Digital Signal Processing.

Course Educational Objectives: To make the student understand Digital filters structures, Digital filter design, DSP algorithms, Finite word length effects, error analysis and power spectrum estimation.

Course Outcomes: At the end of the course, the student will be able to

1. Understand realization of different structures of IIR and FIR Filters.
2. Understand Spectral transformations of IIR filters
3. Understand design of computationally efficient FIR digital filters
4. Learn the Quantization process, arithmetic round off and signal-to-noise ratio in low order IIR filters
5. Estimate power spectrum using various methods

UNIT-I
DIGITAL FILTER STRUCTURES:

Block diagram representation-Equivalent Structures- IIR digital filter Structures All Pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures--Computational complexity of digital filter structures.

Block diagram representation- Equivalent structure- FIR digital Filter Structures FIR cascaded Lattice Structures – Parallel- Digital Sine cosine generator-Computational complexity of digital filter structures.

UNIT-II
IIR DIGITAL FILTER DESIGN

Preliminary considerations-Bilinear transformation method of IIR filter design-design of Low pass, high pass, Band pass, and Band stop- IIR digital filters-Spectral transformations of IIR filters.

UNIT-III
FIR DIGITAL FILTER DESIGN

FIR filter design-based on Windowed Fourier series- computer aided design of Equiripple Linear Phase FIR filters- design of minimum phase FIR filters- design of computationally efficient FIR digital filters

UNIT-IV
DSP ALGORIRHM AND FINITE WORD LENGTH EFFECTS

Computation of the discrete Fourier transform- Number representation-Arithmetic Operations-handling of overflow-Tunable digital filters-function approximation.

The Quantization process and errors- Quantization of fixed -point and floating –point Numbers-Analysis of coefficient Quantization effects - Analysis of Arithmetic Round-off errors-Dynamic range scaling signal-to- noise ratio in Low -order IIR filters-Low-Sensitivity Digital filters

UNIT- V
ERRORS ANALYSIS AND POWER SPECTRUM ESTIMATION

Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters- Round-off errors in FFT Algorithms.

Estimation of spectra from Finite Duration Observation of signals – Non-parametric methods for power spectrum Estimation–parametric method for power spectrum Estimation-Estimation of spectral form-Finite duration observation of signals-Non-parametric methods for power spectrum estimation-Welch methods-Blackman & Tukey method.

TEXT BOOKS:

1. Sanjit K. Mitra , "*Digital signal processing*",2nd Edn, TMH, 1997 (UNITS – I, II, III, IV)
2. John G.Proakis, "Digital *Signal Processing principles, algorithms and Applications*", 3rd Edn. PHI, 2002. (UNITS – V)

REFERENCE BOOKS:

1. Alan V.Oppenheim, Ronald W.Shafer, "*Discrete Time Signal Processing*", 1st Edition. PHI, 1996.
2. S.Salivahanan, A.Vallavaraj, C. Gnanapriya , "*Digital Signal Processing* ", 2nd Edition, TMH, 2001
3. Lourens R. Rabinar & Bernard Gold, "*Theory and Applications of Digital Signal Processing*", 2nd Edition, TMH, 2001
4. Andreas Antoniou,"*Digital Filter Analysis and Design*", TMH, 2001

HIGH VOLTAGE DC TRANSMISSION
(ELECTIVE-I)

Course Code:13EE2207 **L P C**
4 0 3

Pre requisites: Basic knowledge of Power Transmission system, Power Electronics and Switchgear & Protection

Course Educational Objectives:
To impart the students with different technologies available for High Voltage Power System and also different control strategies for efficient operation of the power system under normal and abnormal conditions.

Course Outcomes: After completion of this Course, the student will be able to
1. Understand the complete operation of HVDC Converter stations
2. Understand the power flow control on HVDC Transmission system
3. Understand the Operation of the controller for HVDC in worst and normal operations
4. Analyze the AC / DC system interactions

UNIT-I
H.V.D.C. TRANSMISSION & STATIC POWER CONVERTERS: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration, 3-pulse, 6-pulse and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter special features of converter transformer

UNIT-II
HARMONICS IN HVDC SYSTEMS & CONTROL OF HVDC CONVERTERS AND SYSTEMS: Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters. Control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control.

UNIT-III

INTERACTION BETWEEN HV AC AND DC SYSTEMS: Voltage interaction, Harmonic instability problems and DC power modulation.

UNIT-IV

MTDC SYSTEMS: Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

UNIT-V

TRANSIENT OVER VOLTAGES IN HVDC SYSTEMS & CONVERTER FAULTS AND PROTECTION IN HVDC SYSTEMS: Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults, Converter faults, over current protection - valve group, and DC line protection. Over voltage protection of converters, Surge Arresters.

TEXT BOOKS:

1. E.W. Kimbark, "*Direct current Transmission*", Wiley Inter Science , NewYork,1971. (Chapter 1,2 and 5)

2. J.Arillaga, "*H.V.D.C.Transmission*", Peter Peregrinus ltd.,London UK 1983.

3. K.R.Padiyar, "High *Voltage Direct current Transmission*", Wiely Eastern Ltd., New Delhi, 1992. (Chapter-3,4)

REFERENCE BOOKS:

1. E.Uhlman, "*Power Transmission by Direct Current*", Springer Verlag, Berlin Helberg ,1985.

2. S Rao, "*EHV-AC & HVDC Transmission Engineering &Practice*", Khanna Publishers, Second Edition 1996.

MODERN CONTROL THEORY
(ELECTIVE-I)

Course Code: 13EE2208 **L P C**
4 0 3

Pre requisites: Control Systems, Basic Mathematics

Course Educational Objectives: This Course introduces

1. Mathematical modeling of dynamic systems and development of state space models.
2. Analysis of control systems in state space. Concepts of controllability & observability.
3. Non linear systems and their characteristics
4. Stability analysis techniques
5. Optimal control system

Course Outcomes: At the end of the course, the student will be able to

1. Develop mathematical models of dynamic system in state space.
2. Understand non linear systems & their characteristics.
3. Analyze control system behavior with controllability & observability.
4. Analyze stability of non linear systems using Lyapunov method.

UNIT-I: STATE VARIABLE ANALYSIS AND LTI SYSTEMS

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear operators–The concept of state –State Equations for Dynamic systems – Time invariance and Linearity – Non uniqueness of state model – State diagrams for Continuous – Time state models. Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations– State transition matrix and its properties.

UNIT-II: NON LINEAR SYSTEMS

Introduction – Non Linear Systems – Types of Non –Linearities – Saturation – Dead – Zone –Backlash –Jump Phenomenon etc; -Singular Points –Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions. Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

UNIT-III: CONTROLLABILITY AND OBSERVABILITY

General concept of Controllability - General concept of Observability, Controllability tests for Continuous – Time Invariant systems - Observability tests for Continuous- Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model. State Feedback Controller design through Pole Assignment – state observers: Full order and Reduced order.

UNIT-IV: STABILITY ANALYSIS

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

UNIT-V: OPTIMAL CONTROL

Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental concepts, functionals, variation of functionals – fundamental theorem of Calculus of variations – boundary conditions – constrained minimization formulation using Hamiltonian method–Linear Quadratic regulator

TEXT BOOKS:

1. M. Gopal, "*Modern Control System Theory*", New-Age International, 1984.

2. Ogata. K,, "*Modern Control Engineering*", Prentice Hall, 1997.

REFERENCES:

1. Donald K. Kirk, "*Optimal Control Theory - An Introduction*", Dover Publications, 2004

POWER ELECTRONICS AND DRIVES LABORATORY-I

Course Code: 13EE2209

L	P	C
0	3	2

Pre requisites: Power Electronics, Power Electronics & Drives

Course Educational Objectives:

The lab is intended for the students to get hands on experience in understanding power semiconductor devices, converter circuits and drives through simulation and experimentation.

Course Outcomes:

At the end of the course, the students will be able to design & understand the performance of various power electronic converter circuits and drives for various industrial applications.

LIST OF EXPERIMENTS
(ANY TEN EXPERIMENTS TO BE PERFORMED)

1. SPICE Simulation of Three phase full converter using RL E Load.
2. SPICE Simulation of three phase AC Voltage controller using RL load.
3. SPICE Simulation of Three phase inverter with Sinusoidal PWM control for R-Load.
4. SPICE Simulation of single phase current source inverter with RL Load.
5. SPICE Simulation of dc-dc converters.
6. SPICE Simulation of a resonant converter.
7. Performance and operation of 3- phase Semi-Converter with R & R-L load
8. Performance and operation of 3- phase Full-Converter with R & R-L load..
9. Performance & Operation of a four quadrant Chopper fed D.C. Drive
10. Performance & Operation of a 3-phase A.C. Voltage controller with motor load.

11 .Single Phase PWM Inverter with R & R-L load
12. Operation of 3-phase PWM Inverter with R & R-L load.
13 .DC Series motor controller using Jones Chopper.
14. Speed control of 1-Phase Induction Motor using cycloconverter.

Textbooks:

1. Ned Mohan, Tore M. Undelan and William P. Robbins, "*Power Electronics*", John Wiley & Sons, 2007.

2. Md. H. Rashid, "*Power Electronics*", Pearson Education, Third Edition, 2008.

3. Bimal K. Bose, "*Modern Power Electronics and AC Drives*", Prentice-hall Of India Pvt. Ltd,2008.

4. Rashid, M., "*Simulation of Power Electronic Circuits usingPSPICE*", PHI, 2006.

ANALYSIS OF POWER ELECTRONIC CONVERTERS-II

Course Code:13EE2210 **L P C**
4 0 3

Pre requisites: Power Electronics

Course Educational Objectives: To familiarize the student with switch mode dc & ac power supplies, resonant converters, space vector PWM which find wide application in industry.

Course Outcomes: At the end of the course, the students will be able to understand

1. Resonant converters-Zero voltage and zero current switching.
2. Switching DC power supplies.
3. Power conditioners and Uninterruptible power supplies.
4. Principles of PWM & space vector PWM.
5. Concept of current harmonics and their adverse effects

UNIT-I
RESONANT CONVERTERS:

Introduction, Switch mode inductive current switching, zero voltage and zero current switchings, Classification of resonant converters-load resonant converters-resonant switch converters-resonant dc link converters. Basic resonant circuit concepts-series resonant circuits-parallel resonant circuits. Load resonant converters-series loaded resonant dc-dc converters- parallel loaded resonant dc-dc converters. Resonant switch converters-ZCS resonant switch converters-ZVS resonant converters, Comparison of ZCS and ZVS topology.

UNIT-II
SWITCHING DC POWER SUPPLIES:

Introduction, Linear power supplies, overview of switching power supplies, Flyback converters (derived from buck-boost converters), forward converter (derived from step-down converter), push-pull converter (derived from step-down converter).Half bridge converter (derived from step down converter), full bridge converter (derived from step down converter), current source dc-dc converters.

UNIT-III

POWER CONDITIONERS AND UNINTERRUPTIBLE POWER SUPPLIES:

Introduction, Power line disturbances-types of disturbances-sources of disturbances-effect of sensitive equipment, power conditioners, UPSs-rectifiers-batteries-Inverters-static transfer switch.

UNIT-IV

SPACE VECTOR PWM:

Principle of PWM, Principle of space vector PWM, converter switching states, linear or under modulation region, over modulation region, implementation steps.

UNIT-V

OPTIMIZING THE UTILITY INTERFACE WITH POWER ELECTRONIC SYSTEMS:

Introduction, generation of current harmonics, current harmonics and power factor, harmonic standards and recommended practices, need for improved utility interface, improved single phase utility interface, improved three phase utility interface, electromagnetic interference.

TEXT BOOKS:

1. Ned Mohan, Tore M. Undelan and William P. Robbins, "*Power Electronics*", John Wiley & Sons, 2007.
2. Md. H. Rashid, "*Power Electronics*", Pearson Education, Third Edition, 2008.
3. Bimal K. Bose, "*Modern Power Electronics and AC Drives*", Prentice-hall Of India Pvt Ltd,2008.

REFERENCE BOOKS:

1. Philip T.Krein, "*Elements of Power Electronics*", Oxford University Press,2009.
2. L. Umanand, "*Power Electronics:Essentials & Applications*", Wiley India, 2009.
3. Robert Erickson and Dragon Maksivimovic, "*Fundamentals of Power Electronics*", Springer Publications, 2001.
4 Issa Batarseh, "*Power Electronics*", John Wiley,2003.

SOLID STATE CONTROL OF AC DRIVES

Course Code: 13EE2211 **L P C**
4 0 3

Pre requisites: Power Electronics and Power Electronics & Drives

Course Educational Objectives:.
The Student shall be exposed to Control of AC Drives and Modeling & Simulation of AC Drives with different Controllers

Course Outcomes: After Completion of the Course, the Student will be able to
1. Understand the Operation and Control of AC Drives
2. Model and Simulate the AC Drives.
3. Analyze different Scalar Control Methods
4. Analyze the current Fed Inverter control methods.
5. Analyze the equations governing the Vector Control

UNIT-I
INTRODUCTION & VOLTAGE SOURCE INVERTER FED INDUCTION MOTOR DRIVES: Review of steady-state operation of Induction motor, Equivalent circuit analysis, torque-speed characteristics. Scalar control- Voltage fed Inverter control-Open loop volts/Hz control-Speed control with slip regulation-Speed control with torque and Flux control-Current controlled voltage fed Inverter Drive.

UNIT-II
CURRENT SOURCE INVERTER FED INDUCTION MOTOR DRIVES & SLIP POWER RECOVERY SCHEMES: Current-Fed Inverter control-Independent current and frequency control-Speed and flux control in Current-Fed Inverter drive-Volts/Hz control of Current-Fed Inverter drive-Efficiency optimization control by flux program, Slip Power Recovery Drives-Static Kramer Drive-Phasor Diagram-Torque Expression-Speed Control of Kramer Drive-Static Scherbius Drive-Modes of Operation.

UNIT-III

VECTOR CONTROL OF INDUCTION MOTOR: Principles of vector control, Direct vector control, derivation of indirect vector control, implementation block diagram; estimation of flux, flux weakening operation.

UNIT-IV

CONTROL OF SYNCHRONOUS MOTOR DRIVES: Synchronous motor and its characteristics- Control strategies Constant torque angle control- power factor control, constant flux control, flux weakening operation, Load commutated inverter fed synchronous motor drive, motoring and regeneration, phasor diagrams.

UNIT-V

PMSM DRIVES & VARIABLE RELUCTANCE MOTOR DRIVE: Characteristics of permanent magnet, synchronous machines with permanent magnet, vector control of PMSM- Motor model and control scheme. Variable Reluctance motor drives- Torque production in the variable reluctance motor -Drive characteristics and control principles Current control variable reluctance motor servo drive

TEXT BOOK:

1. B. K. Bose, "*Modern Power Electronics and AC Drives*", Pearson Publications- 2008. (Chapter 1,2)

2. R. Krishnan, "*Electric Motor Drives Modeling, Analysis &control*", Pearson Education, 2008. (Chapter 3,4,5)

REFERENCE BOOKS:

1. MD Murphy & FG Turn Bull "*Power Electronics control of AC Motors*" Pergman Press, 1st Edition, 1998.

2. G.K. Dubey" *Fundamentals of Electrical Drives*", Narosa Publications, 1995.

3. G.K. Dubey, "*Power Semiconductor drives*", Prentice hall.

ANALYSIS OF SPECIAL MACHINES

Course Code:13EE2212 **L P C**
4 0 3

Pre requisites: Mathematics, Networks and Electrical Machines.

Course Educational Objectives:

To familiarize the student with Special Electrical Machines which find wide application in industry. (Special Electrical Machines deals with Stepper Machines, Switched Reluctance Machines, Permanent Magnet Brushless DC Machines, Permanent Magnet Synchronous Machines and Servo Machines.)

Course Outcomes: At the end of the course, the students will be able to evaluate the performance of

1. Stepper Motor.
2. Switched Reluctance Motor and Servo Motor.
3. Permanents Magnet Brushless DC Motor.
4. Permanents Magnet Synchronous Motors.
5. Linear Motors and AC Tachometers.

UNIT-I
STEPPER MOTORS

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

UNIT-II
SWITCHED RELUCTANCE MOTORS & SERVOMOTORS

Switched Reluctance Motor Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, and Drive Concept. Servomotor – Types – Constructional features – Principle of Operation – Characteristics - Control – Microprocessor based applications.

UNIT-III

PERMANENT MAGNET BRUSHLESS DC MOTORS

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

UNIT-IV

PERMANENT MAGNET SYNCHRONOUS MOTORS

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

UNIT-V

LINEAR MOTORS & AC TACHOMETERS

Linear Motors: Linear Induction Motor (LIM) Classification – Construction – Principle of operation – Concept of Current sheet – Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications. Schematic diagram, AC Tachometer Operating principle, numerical problems.

Text Books:

1. Kenjo, T, "*Stepping Motors and their Microprocessor control*", Clarendon Press, Oxford, 1989.
2. Kenjo, T and Naganori, S, "*Permanent Magnet and brushless DC motors*", Clarendon Press, Oxford, 1989.
3. M. Gopal, "*Control Systems-Principle and Design*", Tata McGraw-Hill Publishing Company Limited, Second reprint 1999.

Reference Books:

1. Miller, T.J.E. "*Brushless Permanent Magnet and Reluctance Motor Drives*", Clarendon Press, Oxford, 1989.
2. Naser A and Boldea I, "*Linear Electric Motors: Theory, Design and Practical Application*", Prentice Hall Inc., New Jersey,1987
3. Floyd E Saner,"*Servo Motor Applications*", Pittman USA, 1993.
4. P. S. Bimbra, "*Generalized Theory of Electrical Machines*", Khanna publications-5th edition-1995.

DYNAMICS OF ELECTRICAL MACHINES

Course Code: 13EE2213 **L P C**
4 0 3

Pre requisites: Electrical Machines

Course Educational Objectives:

To impart the students with dynamic modeling, simulation and control theory for electric machinery and associated power electronic drive systems that find a wide range of applications in electric power engineering careers

Course Outcomes: At the end of the course, the student will be able to

1. Understand the principle of control of Induction machine
2. Analyze symmetrical 2 phase induction machine
3. Model a separately excited DC motor, Shunt DC Motor, Series DC motor.
4. Model a three phase synchronous machine

UNIT-I: MODELING CONCEPTS

Basic Two-pole machine representation of commutator machines, 3-ph synchronous machine with and without damper bars and 3-ph induction machine, Kron's primitive machine-voltage, current and torque equations. Real time model of a two phase induction machine-transformation to obtain constant matrices-thee phase to two phase transformation- power equivalence.

UNIT-II MODELING OF THREE PHASE INDUCTION MACHINE

Generalized model in arbitrary reference frame- Electromagnetic torque – Derivation of commonly used induction machine models- Stator reference frame model- Rotor reference frame model- Synchronously rotating frame model- Equations in flux linkages - per unit model- Dynamic Simulation- Small signal equations of induction machine – derivation DQ flux linkage model derivation – control principle of Induction machine.

UNIT-III

SYMMETRICAL AND UNSYMMETRICAL 2 PHASE INDUCTION MACHINE

Analysis of symmetrical 2 phase induction machine-voltage and torque equations for unsymmetrical 2 phase induction machine voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine-analysis of steady state operation of unsymmetrical 2 phase induction machine- single phase induction motor - Cross field theory of single-phase induction machine.

UNIT-IV SYNCHRONOUS MACHINE MODELING

Mathematical model of a sep. excited DC motor- steady state and transient analysis - Transfer function of a sep. excited DC motor – Mathematical model of a DC series motor, shunt motor- linearization techniques for small perturbations. Synchronous machine inductances – voltage equations in the rotor's DQ0 reference frame- electromagnetic torque-current in terms of linkages.

UNIT-V DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINE

Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria- simulation of three phase synchronous machine – modeling of PMSM.

TEXT BOOKS:

1. R.Krishnan "*Electric Motor Drives - Modeling, Analysis& control*" -Pearson Publications-1st edition -2002
   (For chapter III,IV,V)
2. P.C.Krause, Oleg Wasynczuk, Scott D. Sudhoff "*Analysis of Electrical Machinery and Drive systems"* — Second Edition-IEEE Press (for Chapters VI, VII,VIII)

REFERENCES:

1. Chee Mun Ong "*Dynamic simulation of Electric machinery using Matlab / Simulink*" –Prentice Hall
2. D.P.Sengupta &J.B.Lynn :"*Electrical Machine Dynamics*",The Macmillan Press Ltd.
3. C.V. Jones :"*The Unified Theory of Electrical Machines*" Butterworth, London.
4. Woodson & Melcher, "*Electromechanical Dynamics*", John Wiley & Sons.

POWER QUALITY

Course Code:13EE2214 **L P C**
4 0 3

Pre requisites: Basic knowledge in Electrical Networks, Electrical Machines, Power Electronics.

Course Educational Objectives:

To study and understand the definitions, various power quality problems and their mitigation and measuring techniques.

Course Outcomes: After completion of the course, the student should be able to know

1. Basic concepts of power quality issues.
2. Voltage and current during the fault period of a given power system.
3. Sags and phase angle jumps in different types of faults.
4. Various equipment behavior with voltage sags.
5. Various interfacing devices between system and equipment to mitigate the sags and interruptions

UNIT-I: INTRODUCTION AND EMC STANDARDS

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, purpose of standardization, IEC electromagnetic compatibility standards, European voltage characteristics.

UNIT-II LONG INTERRUPTIONS AND SHORT INTERRUPTIONS

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

Short interruptions – definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage

and current at post fault period, stochastic prediction of short interruptions.

UNIT-III

VOLTAGE SAG – CHARACTERIZATION – SINGLE PHASE AND THREE PHASES:

Voltage sag – definition, causes of voltage sag, voltage sag magnitude and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems and voltage sag duration.

Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags

UNIT-IV

PQ CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS:

Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation methods of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

UNIT-V

MITIGATION OF INTERRUPTIONS AND VOLTAGE SAGS

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time, changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

TEXT BOOKS:

1. Math H J. Bollen, "*Understanding Power Quality Problems: Voltage Sags and Interruptions*", 1st Indian edition, IEEE Press,2001.(All units)
2. C.Sankaran, "*Power Quality*", First Indian reprint, CRC press, 2009 (Part of Unit-I).

REFERENCES:

1. Roger Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Beaty, "*Electrical Power Systems Quality*", McGraw-Hill Professional Publishing, Second Edition, November 2002.
2. J. Arrillaga, N. R. Watson, S. Chen, "*Power System Quality Assessment*", John Wiley & Sons, 2000.

FLEXIBLE AC TRANSMISSION SYSTEMS (ELECTIVE-II)

Course Code:13EE2215 **L P C**
4 0 3

Pre requisites: Power Electronics and Power Systems

Course Educational Objectives:

To impart the students with various FACTS devices which are used for proper operation of existing AC system more flexible in normal and abnormal conditions.

Course Outcomes: After completion of the course, the student will be able to

1. Understand the operations of different FACTS devices.
2. Select the controllers for different Contingencies.
3. Analyze the different FACTS devices in different stability conditions.
4. Select an appropriate FACTS device for a particular application.

UNIT-I

FACTS CONCEPTS: Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

UNIT-II

VOLTAGE SOURCE CONVERTERS: Single Phase Three Phase Full Wave Bridge Converter Transformer Connections for 12 Pulse 24 And 48 Pulse Operation. Three Level Voltage Source Converter, Pulse Width Modulation Converter, Basic Concept of Current Source Converters, and Comparison of Current Source Converters With Voltage Source Converters

UNIT-III

STATIC SHUNT COMPENSATION: Objectives of Shunt Compensation, Midpoint Voltage Regulation Voltage Instability Prevention, Improvement of Transient Stability, Power Oscillation Damping, Methods of controllable VAR Generation, Variable Impedance Type Static VAR Generators Switching Converter Type VAR Generators Hybrid VAR Generators.

UNIT-IV

SVC AND STATCOM: The Regulation and Slope Transfer Function, Dynamic Performance, Transient Stability Enhancement And Power Oscillation Damping ,Operating Point Control And Summary Of Compensator Control.

UNIT-V

STATIC SERIES COMPENSATORS: Concept of Series Capacitive Compensation, Improvement of Transient Stability, Power Oscillation Damping, Subsynchronous Oscillation Damping. Functional Requirements of GTO Thyristor Controlled Series Capacitor(GCSC), Thyristor Switched Series Capacitor(TSSC), And Thyristor Controlled Series Capacitor(TCSC) Control Schemes for GCSC TSSC and TCSC

TEXT BOOK:

1. N.G. Hingorani and L. Gyugui "*Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems*", B.S. Publications, Indian Reprint 2000

REFERENCE BOOKS

1. R.MohanMathur, Rajiv K Varma, "*Thyristor based FACTS Controller for Electrical Power Systems*" , John Wiley Sons,2011.

2. X.P.Zhang, C.Rehtanz, B.Pal "*Flexible AC Transmission System Modelling and Control*" Springer,2006

NEURAL & FUZZY SYSTEMS
(ELECTIVE-II)

Course Code:13EE2216 **L P C**
4 0 3

Pre requisites: Optimization & Set Theory

Course Educational Objectives: To impart the knowledge of Neural Networks and Fuzzy Logic Control and use these for controlling real time systems.

Course Outcomes: At the end of the course, the student

1. achieves an understanding of the technical potential and the advantages and limitations of the learning and self organizing systems of today
2. can apply the methods and produce applications in their working life
3. gets exposure with the new and exciting applications of "vague" knowledge processing and experience the impact on popular dynamical systems

UNIT-I Introduction to Neural Networks

Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN. Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

UNIT-II FEED FORWARD NEURAL NETWORKS

Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the

Perceptron Model, Applications. Credit Assignment Problem, Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Back propagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

UNIT-III ASSOCIATIVE MEMORIES

Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory (Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory), Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network.

UNIT-IV
SELF ORGANIZING MAPS AND ADAPTIVE RESONANCE THEORY

Introduction, Competitive Learning, Vector Quantization, Self-Organized Learning Networks, Kohonen Networks, Training Algorithms, Linear Vector Quantization, Stability-Plasticity Dilemma, Feed forward competition, Feedback Competition, Instar, Outstar, ART1, ART2, Applications.

NEURAL NETWORK APPLICATIONS: Process identification, Function Approximation, control and Process Monitoring, fault diagnosis and load forecasting.

UNIT-V CLASSICAL & FUZZY SETS

Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions. Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

TEXT BOOKS:

1. Jacek M. Zuarda, "*Introduction to Artificial Neural Systems*", Jaico Publishing House, 1997.

2. Timothy.J.Ross," *Fuzzy logic with Engineering Applications*", International Editions 1997, TMH Publishers**.**

REFERENCES:

1. N. Yadaiah and S. Bapi Raju "*Neural and Fuzzy Systems Foundation, Architectures and Applications*", Pearson Education.

2. James A Freeman and Davis Skapura, "*Neural Networks* ", Pearson, 2002.

3. Simon Hykins "*Neural Networks*", Pearson Education.

4. C. Eliasmith and CH. Anderson, "*Neural Engineering*", PHI.

5. Bork Kosko "*Neural Networks and Fuzzy Logic System*", PHI Publications.

6. Rajasekharan and Rai "*Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications*" PHI Publication. Ion

DESIGN AND SIMULATION OF POWER ELECTRONIC CIRCUITS
(Elective-II)

Course Code:13EE2217 **L P C**
4 0 3

Pre requisites: Basics of Power Electronics

Course Educational Objectives: To study

1. Basics of simulation, Analysis of power electronic systems
2. Different algorithms for analysis, Future trends in simulation
3. Fourier analysis of harmonics, modeling of power electronic devices
4. Time domain analysis, Fourier analysis of power electronic devices, Simulation of power electronic circuits for different types of loads.

Course Outcomes:

After completion of the course, the student should be able to know about

1. Simulation basics
2. Power electronic systems analysis
3. Simulation of power electronic circuits for different types of loads
4. Simulation of power electronic circuits for different type of loads.

UNIT-I: SIMULATION TECHNIQUES-I

Importance of Simulation – Methods of analysis of power electronic systems - Analysis of power electronic systems in a sequential manner–coupled and decoupled systems

UNIT-II: SIMULATION TECHNIQUES-II

Various algorithms for computing steady state solution in power electronic systems – Future trends in computer simulation.

UNIT-III: MODELING OF POWER ELCTRONIC DEVICES

Introduction – AC sweep and DC sweep analysis – Transients and the time domain analysis – Fourier series and harmonic components, BJT, FET, MOSFET and its model- Amplifiers and Oscillator – Non- linear devices.

UNIT-IV: SIMULATION OF POWER ELECTRONIC CIRCUITS

Introduction – Schematic capture and libraries – Time domain analysis – System level integration and analysis – Monte Carlo analysis Sensitivity/ stress analysis – Fourier analysis.

UNIT-V: CASE STUDY

Simulation of Converters, Choppers, Inverters, AC voltage controllers, and Cyclo-converters feeding R, R-L, and R-L-E loads, Simulation of Converters, Choppers, Inverters, AC voltage controllers, and Cyclo-converters feeding R, R-L, and R-L-E loads

TEXT BOOKS:

1. Rashid, M., "*Simulation of Power Electronic Circuits using PSPICE*", PHI, 2006.

REFERENCES:

1. Rajagopalan, V. "*Computer Aided Analysis of Power Electronic systems*"- Marcell Dekker Inc., 1987.

2. John Keown "*Microsim, Pspice and circuit analysis*"-Prentice Hall Inc., 1998.

POWER ELECTRONICS AND DRIVES LABORATORY-II

Course Code:13EE2218 **L P C**
0 3 2

Pre requisites: Power Electronics, Power Electronics & Drives

Course Educational Objectives:

The lab is intended for the students to get hands on experience in understanding power semiconductor devices, converter circuits and drives using MATLAB/SIMULINK software.

Course Outcomes:

At the end of the course, the students will be able to design, model and simulate various power electronic converter circuits and drives for various industrial applications by using MATLAB/SIMULINK software.

LIST OF EXPERIMENTS (ANY TEN EXPERIMENTS TO BE PERFORMED)

1. Simulation of Chopper fed DC motor using MATLAB/ SIMULINK
2. Development and Simulation of 3-phase PWM Inverter with sinusoidal pulse-width modulation using MATLAB/ SIMULINK
3. Characteristics of induction machines under balanced and symmetrical conditions for the following using MATLAB/ SIMULINK
    a. dq model in synchronous reference frame
    b. dq model in stator reference frame
    c. dq model in rotor reference frame
4. Simulation of v/f control of an induction motor drive using MATLAB/SIMULINK
5. Simulation of Open-loop v/f control of a synchronous motor drive using MATLAB/SIMULINK.

6. Simulation of a GTO based chopper circuit using MATLAB/ SIMULINK
7. Operation of a single phase PWM rectifier with R load.
8. Performance & speed control of 3 phase slip ring Induction motor by Static Rotor Resistance controller.
9. Three phase PWM Pulse generation using Micro controller
10. Microprocessor based speed control of three phase Induction Motor
11. Braking Test of three phase induction motor
12. Speed control of single phase induction motor.
13. Microcontroller based slip ring Induction motor speed Control using static KRAMMER drive.
14. Speed Control of DC Shunt Motor using SCR Dual converter.
15. Closed loop speed Control of PMDC motor using SCR Converter.

Textbooks:

1. Ned Mohan, Tore M. Undelan and William P. Robbins, "*Power Electronics*", John Wiley & Sons, 2007.

2. Md. H. Rashid, "*Power Electronics*", Pearson Education, 3rd Edition, 2008.

3. Bimal K. Bose, "*Modern Power Electronics and AC Drives*", Prentice-hall Of India Pvt. Ltd, 2008.

4. Rashid, M., "*Simulation of Power Electronic Circuits using PSPICE*", PHI, 2006.