ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

POWER ELECTRONICS AND ELECTRIC DRIVES

Department of Electrical and Electronics Engineering

M.Tech Two Year Degree Course

(Applicable for the batch admitted from 2014-15)

GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)

Seshadri Rao Knowledge Village

GUDLAVALLERU - 521 356, Krishna District, Andhra Pradesh

CONTENTS

M.Tech - Power Electronics and Electric Drives

ACADEMIC REGULATIONS

M.Tech - Power Electronics and Electric Drives

ACADEMIC REGULATIONS

1. Duration of the Program

The duration of the program is two academic years consisting of four semesters. However, a student is permitted to complete the course work of M.Tech program in the stipulated time frame of **FOUR** years from the date of joining.

2. Minimum Instruction Days

Each semester consists of a minimum of ninety instruction days.

3. Program Credits

Each specialization of the M.Tech programs is designed to have a total of 80 credits and the student shall have to complete the two year course work and earn all the 80 credits for the award of M.Tech Degree.

4. Attendance Regulations

4.1 A student shall be eligible to appear for End Semester Examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

4.2 Condoning of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester will be considered for genuine reasons such as medical grounds and participation in co-curricular and extra-curricular activities and shall be granted only after approval by a committee duly appointed by the college. Student should submit application for medical leave along with medical certificate from a registered medical practitioner within three days from reporting to the class work after the expiry of the medical leave. In case of participation in co-curricular and extra-curricular activities, either in the college or other colleges, students must take prior written permission from HoD concerned and should also submit the certificate of participation from the organizer of the event within three days after the completion of the event. Only such cases will be considered for condoning attendance shortage.

4.3 A student shall be eligible to claim for condonation of attendance shortage only once during the two years (four semesters) course work.

4.4 A student will not be promoted to the next semester unless he satisfies the attendance requirement of the current semester. He may seek re-admission for that semester when offered next.

4.5 Shortage of Attendance below 65% in aggregate shall in *NO* case be condoned.

4.6 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examination of that semester and their registration shall stand cancelled.

4.7 A fee stipulated by the college shall be payable towards condoning attendance shortage.

5. Examinations and Scheme of Evaluation

5.1 Theory Courses:

Each theory course shall be evaluated for a total of 100 marks, consisting of 40 marks for internal assessment and 60 marks for semester end examination.

***Internal Assessment*:**

i) Out of 40 marks for internal assessment, 20 marks are for continuous assessment in the form of assignment and seminar and 20 marks are based on two mid-term examinations.

ii) Of the 20 marks for continuous assessment, 10 marks each for assignment and seminar.

iii) Each mid-term examination is conducted for 40 marks with two hours duration. Each mid-term examination consists of four questions, each for 10 marks. All the questions need to be answered.

iv) Sum of the 75% marks of best scored mid-term examination and 25% marks of other mid-term examination are scaled down for 20 marks.

***External Assessment*:**

Semester End Examination will have 8 questions, each for 12 marks, out of which 5 questions are to be answered.

5.2 Laboratory Course:

i) For practical subjects the distribution shall be 40 marks for Internal Evaluation and 60 marks for the End-Examinations. There shall be continuous evaluation by the internal subject teacher during the semester for 40 internal marks. Of the 40 marks for internal, 30 marks shall be for day-to-day performance (20 marks for day-to-day evaluation and 10 marks for Record) and 10 marks for an internal laboratory test conducted towards the end of semester.

ii) Semester End examination shall be conducted by the teacher concerned and external examiner for 60 marks.

5.3 Seminar:

For seminar, a student under the supervision of a faculty member, shall collect the literature on an advanced topic related to his specialization and critically review the literature and submit it to the department in a report form two weeks before the end of the 3rd semester and shall make an oral presentation before the Departmental Review Committee consisting of the supervisor and a senior faculty member / Head of the Department. There

shall be an internal evaluation for 50 marks in the form of viva-voce examination and assessment of report and its presentation. There will be NO external evaluation.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register by paying the prescribed fee at the beginning of 4th semester or subsequent semesters. He has to submit a fresh report two weeks before the end of that semester and appear for the evaluation by the committee.

5.4 Comprehensive Viva-Voce:

Comprehensive Viva-Voce examination is conducted for 50 marks at the end of third semester in all the subjects of first two semesters of the course by a committee consisting of two senior faculty members of the department. There will be NO external evaluation.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register by paying the prescribed fee at the beginning of 4th semester or subsequent semesters and undergo Viva-Voce examination towards the end of that semester.

5.5 Project Work:

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

i) A Project Review Committee (PRC) shall be constituted for each specialization with Head of the Department as Chairman and two other senior faculty members.

ii) Registration of Project Work: A candidate who has been promoted to 3rd semester shall be eligible to register for the project work.

iii) The eligible candidate can choose his project supervisor and submit the title, objective, abstract and plan of action of the proposed project work to the department for approval by the PRC. The candidate whose proposal is approved by the PRC shall register for the project work. The minimum duration of project work will be 36 weeks from the date of registration.

iv) If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the PRC. In case of such changes, the candidate has to register afresh.

v) There shall be three reviews on the progress of the project work by the PRC with an interval of 12 weeks. The candidate needs to submit a report on the progress of his work and present it before the PRC for assessment. The PRC may suggest for an extension of date of submission of dissertation if the progress of work is not satisfactory or absent himself for the review.

vi) A candidate who has passed all the theory, laboratory, seminar and comprehensive viva-voce examinations and shown satisfactory progress of project work is permitted to submit the dissertation after 36 weeks from the date of registration.

vii) If a candidate fails to submit the dissertation by the end of the 4th semester, he has to take the permission for an extension by paying the semester(s) tuition fee.

viii) Three copies of the Project Thesis certified by the supervisor shall be submitted to the Department.

ix) Project evaluation and Viva-Voce examination is conducted at the end of 4th semester by a committee consisting of Project Supervisor, senior faculty of the department, HoD and an External Examiner nominated by the Chief Controller of Examinations out of a panel of three examiners suggested by the department.

The following grades are awarded for the project work:

i. Excellent
ii. Very Good
iii Good
iv. Satisfactory
v. Unsatisfactory

The Grade “unsatisfactory” is treated as Fail. Failed Students should take supplementary examination after making required modifications, if any, in the dissertation with a minimum gap of 8 weeks by paying the required examination fee.

6. Criteria for Passing a Course and Award of Grades:

6.1 Criteria for Passing a Course:

i) A candidate shall be declared to have passed in individual theory/ drawing / design course / laboratory if he secures a minimum of 50% aggregate marks (internal & semester end examination marks put together), subject to securing a minimum of 40% marks in the semester end examination.

ii) The candidate shall be declared to have passed in seminar / comprehensive viva-voce if he secures 50% marks.

iii) The candidate shall be declared to have successfully completed the project work if he secures a minimum of ‘satisfactory’ grade in the project evaluation and viva-voce examination.

iv) On passing a course of a program, the student shall earn assigned credits in that course.

6.2 Method of Awarding Letter Grade and Grade Points for a Course:

A letter grade and grade points will be awarded to a student in each course based on his performance, as per the grading system given below.

Theory Course (%)	Laboratory (%)	Grade Points	Letter Grade
³ 90	³ 90	10	S
³ 80 & < 90	³ 80 & < 90	9	A
³ 70 & < 80	³ 70 & < 80	8	B
³ 60 & < 70	³ 60 & < 70	7	C
³ 50 & < 60	³ 50 & < 60	6	D
< 50	< 50	0	F (Fail)

S : Outstanding **A** : Excellent **B** : Very Good
C : Good **D** : Fair

6.3 Calculation of Semester Grade Point Average (SGPA)* for semester:

The performance of each student at the end of the each semester is indicated in terms of SGPA. The SGPA is calculated as given below:

SGPA = $\frac{\sum(CR \times GP)}{\sum CR}$ for each semester.

where CR = Credits of a course
GP = Grade Points awarded for a course

* SGPA is calculated for a candidate who passed all the courses in that semester.

6.4 Eligibility for Award of M.Tech Degree:

A student will be declared eligible for the award of the M.Tech Degree if he fulfills the following academic regulations.

(a) Pursued a course of study for not less than two academic years and not more than four academic years.

(b) Registered for **80** credits and secured all **80** credits.

(c) Students, who fail to complete their Two years Course of study within Four years or fail to acquire the **80** Credits for the award of the degree within four academic years from the year of their admission shall forfeit their seat in M.Tech course and their admission shall stand cancelled.

6.5 Calculation of Cumulative Grade Point Average (CGPA)* for Entire Program:

The CGPA is calculated as given below:

CGPA = $\frac{\sum(CR \times GP)}{\sum CR}$ for entire program.

where CR = Credits of a course
GP = Grade points awarded for a course

* CGPA is calculated for a candidate who passed all the prescribed courses excluding project work.

6.6 Award of Division:

After satisfying the requirements prescribed for the completion of the program, the student shall be eligible for the award of M.Tech Degree and shall be placed in one of the following grades:

CGPA	Class	Letter Grade	Description
³ 7.5	First Class with Distinction	A	Excellent
³ 6.5 & < 7.5	First Class	B	Good
³ 6.0 & < 6.5	Second Class	C	Fair

7. Supplementary Examinations :

i) Supplementary examinations will be conducted once in a year along with regular examinations.

ii) Semester end supplementary examinations shall be conducted till next regulation comes into force for that semester after the conduct of the last set of regular examinations under the present regulation.

iii) Thereafter supplementary examinations will be conducted in the equivalent courses as decided by the Board of Studies concerned.

8. Readmission Criteria :

A candidate, who is detained in a semester due to lack of attendance has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling the required norms stipulated by the college and by paying the required tuition fee and special fee in addition to paying an administrative fee of Rs. 1,000/-.

9. Break in Study :

Student, who discontinues the studies for what-so-ever reason, can get readmission into appropriate semester of M.Tech program only with the prior permission of the Principal of the College, provided such candidate shall follow the transitory regulations applicable to the batch he joins. An administrative fee of Rs.2,000/- per each year of break in study, in addition to the prescribed tuition and special fees should be paid by the candidate to condone his break in study.

10. Transitory Regulations:

A candidate, who is detained or discontinued in a semester, on readmission shall be required to do all the courses in the curriculum prescribed for the batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed such courses in the earlier semester(s) he was originally admitted into and he will be offered

substitute subjects in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

10.1 A student who is following JNTUK curriculum and detained due to shortage of attendance at the end of the first semester of first year shall join the autonomous batch of first year first semester. Such students shall study all the courses prescribed for the batch in which the student joins and considered on par with regular candidates of Autonomous stream and will be governed by the autonomous regulations.

10.2 A student who is following JNTUK curriculum, detained due to shortage of attendance at the end of the second semester of first year shall join with the autonomous batch in the second semester. Such candidates shall be required to pass in all the courses in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the courses of the semester(s) of the batch which he had passed earlier and substitute subjects are offered in place of them as decided by the Board of Studies. The student has to clear all his backlog subjects of first semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree. The total number of credits to be secured for the award of the degree will be sum of the credits of first semester under JNTUK regulations and the credits prescribed in second semester in which a candidate seeks readmission and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

11. Withholding of Results

If the student has not paid the dues, if any, to the College or if any case of indiscipline is pending against him, his examinations results and degree will be withheld.

12. Malpractices :

i) The Principal shall refer the cases of malpractices in internal assessment tests and semester end examinations to a malpractice enquiry committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the erring students based on the recommendations of the committee.

ii) Any action by the candidate trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder.

DISCIPLINARY ACTION FOR MALPRACTICES/IMPROPER CONDUCT IN EXAMINATIONS

Nature of Malpractices / Improper conduct		Punishment
If the candidate		
1.a	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers, cameras, bluetooth devices etc. or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination.)	Expulsion from the examination hall and cancellation of the performance in that subject only.
b	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through Cell phones with any candidates or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The hall ticket of the candidate shall be cancelled.

3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for the examinations of the remaining subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the impostor is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles the Answer book or takes out or arranges to send out the question paper during the examination or answer book during or after the examination.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent / Assistant Chief Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in or around the examination hall or organises a walkout or instigates others to walkout or threatens the officer-in-charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the Officer-in-charge or any person on duty in or outside the examination hall of any of his relations or indulges in any other act of misconduct or mischief which results in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the Officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat.
9	If student of the college who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clauses 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to the police and a police case is registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester examinations.

12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be referred to the Chief Superintendent of Examinations for future action towards suitable punishment.

iii) The involvement of the staff, who are in charge of conducting examinations, valuing examination papers and preparing / keeping records of documents related to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and appropriate disciplinary action will be taken after thorough enquiry.

13. Other Matters

i) Physically challenged candidates who have availed additional examination time and a scribe during their BE / B.Tech or equivalent examinations will be given similar concessions on production of relevant proof/ documents. Students who are suffering from contagious diseases are not allowed to appear either for internal or semester end examinations.

ii) The students who participated in coaching / tournaments held at State / National / International levels through University / Indian Olympic Association during semester end external examination period will be promoted to subsequent semesters as per the guidelines of University Grants Commission Letter No. F.1-5/88 (SPE/PES), dated 18-08-1994.

iii) The Principal shall deal in an appropriate manner with any academic problem which is not covered under these rules and regulations, in consultation with the Heads of the Departments and subsequently such actions shall be placed before the Academic Council for ratification. Any emergency modification of regulation, approved in the meetings of the Heads of the Departments shall be reported to the Academic Council for ratification.

14. General

i) The Academic Council may, from time to time, revise, amend or change the regulations, schemes of examination and /or syllabi.

ii) The academic regulations should be read as a whole for the purpose of any interpretation.

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

iv) Wherever the word he, him or his occurs, it will also include she, her and hers.

COURSE STRUCTURE

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SYLLABUS

M.Tech - Power Electronics and Electric Drives

COURSE STRUCTURE

I Semester

Sl. No.	Name of the Course / Laboratory	No.of Periods per week		No.of Credits
		L	P	
1	ARM Architecture and Programming	4	-	3
2	Electrical Machine Modeling and Analysis	4	-	3
3	Analysis of Power Electronic Converters	4	-	3
4	Electric Drives - I	4	-	3
5	Elective - I	4	-	3
6	Elective - II	4	-	3
7	Power Electronics Systems Simulation Lab	-	6	3
	Total	**24**	**6**	**21**

II Semester

Sl. No.	Name of the Course / Laboratory	No.of Periods per week		No.of Credits
		L	P	
1	Switched Mode Power Converters	4	-	3
2	Electric Drives - II	4	-	3
3	Flexible AC Transmission Systems	4	-	3
4	Digital Signal Processing and Applications	4	-	3
5	Elective - III	4	-	3
6	Elective - IV	4	-	3
7	Power Electronics and Drives Lab	-	6	3
	Total	**24**	**6**	**21**

III Semester

Sl. No.	Name of the Course / Laboratory	No.of Credits
1	Seminar	2
2	Comprehensive Viva-Voce	2
3	Dissertation (Initiated in third semester)	-
	Total	**4**

IV Semester

Sl. No.	Name of the Course / Laboratory	No.of Credits
1	Dissertation (Carried out in third & fourth semesters)	34
	Total	**34**

Electives:

I Semester	II Semester
Elective - I	**Elective - III**
Power Semiconductor Devices & Protection	Renewable Energy Sources
Engineering Optimization	AI Techniques
HVDC Transmission Systems	Smart Grid
Elective - II	**Elective - IV**
Power System Dynamics and Stability	Custom Power Devices
Special Machiens and Control	Digital Control Systems
Modern Control Theory	Computer Aided Design of Electrical Machines

SYLLABUS

ARM ARCHITECTURE AND PROGRAMMING

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Pre - requisite:

Basic knowledge on Microcontroller 8051, Programming (preferably C), Computer Architecture and Computer logic design.

Course Objectives:

- To introduce the basic concepts of ARM architecture and processor families.
- To familiarize the various concepts of Registers, Instruction sets, Interrupts and vector tables.
- To impart the ARM programming skills.

Learning Outcomes:

Students will be able to

- understand the architecture of the ARM microcontrollers and ARM Processor Families.
- apply the concepts of Registers, Thumb Instruction sets, Memory organization and Interrupts.
- develop a real time application using ARM.

UNIT - I: ARM Architecture

ARM Design Philosophy, Registers, Program Status Register, Instruction Pipelines, Interrupts and Vector Table, Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation, Access Permissions, Context Switch.[Textbook1,2]

UNIT - II: ARM Programming Model – I

Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions. [Textbook1]

UNIT - III: ARM Programming Model – II

Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single and Multi-Register Load-Store Instructions, Stack, Software Interrupt Instructions [Textbook1]

UNIT - IV: ARM Programming

C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation, Conditional Execution and Loops. [Textbook1]

UNIT - V: **Embedded ARM Applications**

ARM Processor Families, VLSI Ruby II Advanced Communication Processor, ISDN Subscriber Processor, One C™ VWS22100 GSM chip, Ericsson-VLSI Bluetooth Baseband Controller, ARM 7500 and ARM 7500FE. [Textbook 1]

Text Books:

1. ARM Systems Developers Guide- Design & Optimizing System Software - Andrew N. Sloss, Dominic Symes, Chris Wright, 2004, Elsevier.
2. ARM System-on-Chip Architecture, Addison Wesley – 2 Edition.

References:

1. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes / Cole, 1999, Thomas Learning.
2. Embedded Systems - Architecture Programming and Design – Raj Kamal, 2nd ed., 2008, TMH.
3. Designing with PIC Microcontrollers- John B. Peatman, 1998, PH Inc.

ELECCTRICAL MACHINE MODELING AND ANALYSIS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the concepts of Kron's primitive machine.
- To familiarize with modeling of Electrical Machines.

Learning Outcomes:

Students will be able to

- analyze the steady state and transient behavior of d.c machine.
- apply transformation techniques for modeling of an electrical machine.
- develop a mathematical model to an electrical machine for specific application.
- develop a small signal model for the dynamic analysis of a.c machine.

UNIT - I: Basic concepts of Modeling

Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.

UNIT - II: DC Machine Modeling

Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis-Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor- Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations.

UNIT - III: Reference frame theory & Small Signal modeling

Real time model of a two phase induction machine- three phase to two phase transformation-Power equivalence.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 reference frame model. Equations in flux linkages-per unit model- Small signal equations of Induction machine-derivation-DQ flux linkage model derivation.

UNIT - IV: 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 - V: Modeling & Dynamic Analysis of Synchronous Machine

Synchronous machine inductances –voltage equations in the rotor's dq0 reference frame-electromagnetic torque-current in terms of flux linkages-simulation of three phase synchronous machine- modeling of PM Synchronous motor. Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria.

Text Books:

1. Analysis of Electrical Machinery and Drive systems – P.C.Krause, Oleg Wasynczuk,Scott D.Sudhoff -IEEE Press – 3rd Edition- 2013
2. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995

Reference Books:

1. Electric Motor Drives-Modeling, Analysis& control -R.Krishnan- Pearson Publications-1st edition -2002
2. Dynamic simulation of Electric machinery using Matlab / Simulink –Chee Mun Ong-Prentice Hall Publications-1998

ANALYSIS OF POWER ELECTRONIC CONVERTERS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with Operation of three phase AC voltage controllers and its applications.
- To introduce the concepts of Operation and power factor improvement methods in both single phase and three phase converters.
- To familiarize with Voltage control methods in single phase and three phase inverters.

Learning Outcomes:

Students will be able to

- analyze various types of power electronic converters with different loads.
- identify appropriate AC voltage controller for a particular application.
- apply different power factor improvement methods for converters.
- select an appropriate voltage control technique for an inverter.
- analyze different types of multilevel inverter topologies.
- design a suitable power electronic converter for a given application

UNIT - I: AC Voltage Controllers

Single Phase AC Voltage Controllers with PWM control only –synchronous tap changers - ThreePhase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive,Resistive –inductive loads-Effects of source and load inductances –Application- numericalProblems.

UNIT - II: Single Phase and Three Phase AC-DC Converters

Single phase full and half Converters with inductive load – Power factor improvements:
Extinction angle control-symmetrical angle control - single phase sinusoidal PWM-Single phase series converters. Three Phases full and half Converter with inductive load –Harmonic analysis -Power factor improvements-three phase PWM-twelve pulse converters-Numerical problems .

UNIT - III: Power Factor Correction Converters

Single-phase single stage boost power factor corrected rectifier, power circuit principle of Operation, and steady state- analysis, three phases boost PFC converter

UNIT - IV: PWM Inverters

Single phase full bridge inverters - sinusoidal PWM – modified PWM – phase displacement
Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical Problems - Three-Phase Inverters- Sinusoidal PWM-60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link Inverter - numerical problems.

UNIT - V: Multi Level Inverters

Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter-Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

Text Books:

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
2. Power Electronics- Ned Mohan, Tore Mundelein and William P.Robbins – JohnWiley& Sons -2nd Edition,2002.

Reference Books:

1. Power Electronics – Lander –Mc.Graw Hill ,2009
2. Modern power Electronics and AC Drives – B.K.Bose- Prentice Hall; First edition , October 2001.
3. Power Converter Circuits – William Shepherd & Li Zhang ,CRC Press, 12-Mar-2004.

ELECTRIC DRIVES - I

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the operating principle of DC drives.
- To familiarize with the speed control of DC drive with different controlled converters.

Learning Outcomes:

Students will be able to

- apply the knowledge of Mathematics and physical science in analyzing the performance of DC drives.
- develop DC drive using different converters.
- design a suitable compensating capacitor in three phase controlled converters.
- identify operational problems of chopper controlled DC motor drives.
- select an appropriate Drive to meet specified performance requirements.
- simulate a dynamic model of DC drive.

UNIT - I: Speed Torque characteristics of DC Motors

Separately excited DC motors, Shunt motor, series motor and compound motor.

UNIT - II: Controlled Bridge Rectifiers with DC Motor Load

Controlled Bridge Rectifier (1-Ô) with DC Motor Load:
Separately excited DC motors with rectified single phase supply- single phase semi converter and single phase full converter for continuous and discontinuous modes of operation – power and power factor.
Controlled Bridge Rectifier (3-Ô) with DC Motor Load:
Three phase semi converter and three phase full converter for continuous and discontinuous modes of operation – power and power factor – Addition of Free wheeling diode – Three phase double converter.

UNIT - III: Three phase naturally commutated bridge circuit as a rectifier or as an inverter

Three phase controlled bridge rectifier with passive load impedance, resistive load and ideal supply –Highly inductive load and ideal supply for load side and

supply side quantities, shunt capacitor compensation, three phase controlled bridge rectifier inverter.

Closed loop control of phase controlled DC motor Drives

Open loop Transfer functions of DC Motor drive- Closed loop Transfer function of DC Motor drive –Phase-Locked loop control.

UNIT - IV: Chopper controlled DC motor drives

Principle of operation of the chopper – Four quadrant chopper circuit – Chopper for inversion – Steady state analysis of chopper controlled DC motor drives – rating of the devices.
Closed loop control of chopper fed DC motor Drives-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 – command current generator – current controller.

Text Books:

1. Power Electronics and Motor Control – Shepherd, Hulley, Liang – II Edition, Cambridge University Press India Pvt Ltd,2011.
2. Electric Motor Drives Modeling, Analysis & control -R. Krishnan First Edition - Pearson Education 2010.

Reference Books:

1. Power Electronic Circuits, Devices and Applications – M. H. Rashid – Third Edition Pearson Education 2011.
2. Fundamentals of Electric Drives – G. K. Dubey –Second Edition, Narosa Publications – 2010.
3. Power Semiconductor Controlled drives – G. K. Dubey First Edition,Prentice-Hall 1989.

Elective - I

POWER SEMICONDUCTOR DEVICES AND PROTECTION

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with static and dynamic performances of power semiconductor devices.
- To introduce fundamental concepts about the protection of power electronic devices.

Learning Outcomes:

Students will be able to

- analyze the characteristics of power semiconductor devices.
- design snubber circuits for power semiconductor devices.
- select a suitable power semiconductor device for a given application.
- identify an appropriate protection scheme for power devices.

UNIT - I: Overview Of Power Switching Device

Introduction to power switching device classification of device, controlled and un-controlled device, I-V characteristics of idea and real switching device Power Diodes:Device structure and i - v characteristics, rating & specifications, switching characteristics, reveres recovery, classifications of various diode: schotky diode, line frequency diodes, fast recovery diodes

UNIT - II: Power Transistors

Device structure and i-v characteristics, rating & specifications, switching characteristics, on to off and off to on state transitions, on/off transition loss analysis, driver circuits

UNIT - III: Power MOSFETs

Device structure and i - v characteristics, rating & specifications, switching characteristics, on to off and off to on state transitions, on/off transition loss analysis, driver circuits

UNIT - IV: IGBT

Device structure and i - v Characteristics, rating & specifications, switching Characteristics, ON to OFF and OFF to ON state transitions, ON/OFF

transitions, loss analysis, Comparison of all the above device with reference to power handling capability, frequency of operation, driver circuit, emerging power switching device

UNIT - V: Protection of the Switching Device

Device protection against over voltage/current,di/dt and dv/dt; safe operating area, design of snubbers for power devices.

Text Books:

1. Power Electronics:devices,drives and applications by -B.W.Wiliams ,Mc.Graw hill 2nd edition,1992.
2. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008

Reference Books:

1. Power Electronics: L.Umanand,IND-W, 2nd edition, 2009
2. B. Jayant Baliga, “Fundamentals Of Power Semiconductor Devices”, Springer-Verlag Publication, New Delhi , 1st Edition, 2008.
3. Robert Perret, “Power Electronics Semiconductor Devices”, Wiley-ISTE Publications,New Delhi , New Edition, 2009.
4. Joseph Vithayathil, “Power Electronics :Principles and Applications”, McGraw – Hill Education India, New Delhi, 2010.
5. Mohan, Ned. et.al, “Power Electronics Converters, Applications and Design”, Wiley India Pvt. Ltd., New Delhi, 3rd Edition 2007.
6. Muhammad H. Rashid, “Power Electronics Hand Book”, Academic Press, New Delhi, 1st Edition, 2001.

Elective - I

ENGINEERING OPTIMIZATION

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To emphasize various categories of existing engineering problems.
- To familiarize different optimization techniques and approaches.

Learning Out Comes:

Students will be able to

- apply the knowledge of Mathematics in analyzing an Engineering Problem.
- develop an optimization problem in standard form and assess the optimality of a solution.
- analyze multi objective and multidisciplinary optimization problems.
- construct algorithm for constrained and unconstrained nonlinear optimization problem of multiple variables.
- select an appropriate optimization technique for a system.

UNIT - I: Introduction

Standard form of linear programming problem (L.P.P), Geometry of L.P.P., Graphical solution, Formulation of design problems as mathematical programming problems, classification of optimization problems.

UNIT - II: Linear Optimization

Simplex method, Big-M method, two phase Simplex method, duality in optimization, duals of linear and quadratic programming problems.

UNIT - III: Unconstrained Optimization

Introduction to optimum design, General principles of optimization, Problem formulation & their classifications, Single variable and multivariable optimization. Techniques of unconstrained minimization- Golden section, Random, pattern and gradient search methods, Interpolation methods.

UNIT - IV: Constrained Optimization

Optimization with equality and inequality constraints, Direct methods, Indirect methods using penalty functions, Lagrange multipliers, Geometric programming.

UNIT - V: Advanced Optimization

Multi stage optimization, dynamic programming, stochastic programming, Multi objective optimization.

Text Books:

1. Rao, S. S., “Engineering Optimization: Theory and Practice”, 4th edition, Wiley, ISBN 978-0-470-18352-6.
2. Ravindran, K. M. Ragsdell, G. V. Reklaitis., “Engineering Optimization: Methods and Applications”, 2nd Edition ISBN: 978-0-471-55814-9.

Reference Books:

1. S.Kalavathi., “Operation Research”, 2nd Edition, Vikas Publications.
2. Taha, Hamdy, Operations Research, 7th edition, Macmillan Publishing Company.

Elective - I

HVDC TRANSMISSION SYSTEMS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the concepts of HVDC Transmission.
- To familiarize with various converters , controllers and networks used in HVDC Transmission.

Learning Outcomes:

Students will be able to

- design the voltage level and ratings of the HVDC system for a given amount of power transfer.
- identify the suitable converter and its control scheme in HVDC Transmission.
- estimate the amount of reactive power to be compensated for a given HVDC Transmission system.
- develop a suitable model for a given AC- DC network.
- choose appropriate protecting device for various faults in HVDC stations.
- design a suitable filter to eliminate harmonics in the HVDC System.

UNIT - I: Basic Concepts

Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC &DC Transmission, Application of DC Transmission System – Planning & Modern trends in D.C. Transmission.

UNIT - II: Analysis Of HVDC Converters

Choice of Converter configuration – analysis of Graetz – characteristics of 6 Pulse & 12 Pulse converters –Cases of two 3 phase converters in star –star mode – their performance. Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current and extinction angle control – Effect of source inductance on the system; Starting and stopping of DC link; Power Control.

UNIT - III: Reactive Power Control And In HVDC

Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategies sources of reactive power-AC Filters – shunt capacitors-synchronous condensers.

UNIT - IV: Power Flow Analysis in AC/DC Systems

Modelling of DC Links-DC Network-DC Converter-Controller Equations-Solution of DC loadflow – P.U.System for d.c. quantities-solution of AC-DC Power flow-Simultaneous method-Sequential method.

UNIT - V: Converter Faults, Harmonics & Protection

Converter faults – protection against over current and over voltage in converter station – surge arresters – DC breakers –Audible noise-space charge field-corona effects on DC lines-Radio interference. Generation of Harmonics, Characteristics and Non- Characteristics harmonics, Calculation of voltage & Current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters –Design of High pass filters.

Text Books:

1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar,
   New Age International (P) Limited Publishers, First Edition, 2005.
2. EHVAC and HVDC Transmission Engineering and Practice – S.Rao. Khanna Publishers, 1990.

Reference Books:

1. HVDC Transmission – J.Arrillaga. published by the institution of electrical engineering, London, UK, 1998.
2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons, First Edition.
3. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications, First Edition.

Elective - II

POWER SYSTEM DYNAMICS AND STABILITY

I – Semester

Practical	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the concepts of Synchronous machine dynamics.
- To familiarize with various power system stability criterions.

Learning Outcomes:

Students will be able to

- develop synchronous machine model.
- differentiate various power system stability considerations.
- analyze to enhance transient stability.
- analyze Small signal stability for Single Machine Infinite Bus (SMIB) system.
- design a Power System Stabilizer ((PSS) to enhance small signal stability.

UNIT - I: Introduction to System Dynamics

System dynamics- synchronous machine representation –classical model-load modelling concepts-modelling of excitation systems-modelling of prime movers.

UNIT - II: Power System Stability Considerations

Power system stability considerations – definitions-classification of stability-rotor angle and voltage stability state space representation of synchronous machine connected to a infinite bus

UNIT - III: Transient Stability and Improvement

Transient stability-swing equation-equal area criterion-solution of swing equation-Numerical methods-Euler method-Runge-Kutte method-critical clearing time and angle-effect of excitation system and governors,Multimachine stability – extended equal area criterion-transient energy function approach. – transient stability enhancement – high speed fault clearing – steam turbine fast valving-high speed excitation systems.

UNIT - IV: Small Signal Stability

Small signal stability – state space representation – eigen values- modal matrices-small signal stability of single machine infinite bus system – synchronous machine classical model representation-effect of field circuit dynamics-effect of excitation system.

UNIT - V: Small Signal Stability Improvement

Small signal stability of multimachine system, small signal stability enhancement-Power System Stabilizers (PSS)-Design of PSS

Text Books:

1. K.R.Padiyar “Power System Dynamic Stability and Control”. John Wile Interline Publishing, 1st edition 1996.
2. P.S. Kundur, “Power System Stability and Control” Mc.Graw –Hill, Nework, 1st edition 2000.

Reference Books:

1. G.Rogers, “Power System Oscillations”, Kluwer Academic Publishers, 2nd edition, 2000.
2. P.M.Anderson and A.A. Found. “Power System Control and Stability”,The Lowa State University Press, 1st edition 1997.
3. J.Machowski, J.W.Bialek and J.R.Bumby, “Power System Dynamic and Stability”, John Wiley and Sons Ltd. 1997.

Elective - II

SPECIAL MACHINES AND CONTROL

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with the constructional details and operating principle of special machines.
- To understand the performance characteristics of special machines.

Learning Outcomes:

Students will be able to

- describe the construction and operating principle of various motors.
- differentiate Electronic and mechanical commutator.
- design different types of control techniques.
- select an appropriate motor for a given application.

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:

Permanent Magnet Synchronous Motors(PMSM) and Switched Reluctance Motors(SRM)

PMSM: Power electronic Controllers, Torque speed characteristics, Self control, Vector control, Current control.

SRM: Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, Drive Concept.

UNIT - III: Permanent Magnet Brushless DC Motors

Concept of electronic commutation, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Speed control by microcontroller.

UNIT - IV: Servomotors and AC Tachometers

Servomotors: Servomotor – Types – Constructional features – Principle of Operation – Characteristics – Control – Microprocessor based applications.

AC Tachometer: AC Tachometers Schematic diagram, Operating principle, numerical problems

UNIT - V: 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.

Text Books:

1. Special Electrical Machines -K.Venkatratnam-University Press.
2. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th Edition

Reference Books:

1. Miller, T.J.E. “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenjo, T, “Stepping Motors and their Microprocessor control”, Clarendon Press,Oxford, 1989.
3. Naser A and Boldea I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987
4. Floyd E Saner,”Servo Motor Applications”, Pittman USA, 1993.
5. Kenjo, T and Naganori, S “Permanent Magnet and brushless DC motors”, Clarendon Press, Oxford, 1989.

Elective - II

MODERN CONTROL THEROY

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To understand the concept of stability, controllability and observability of LTI systems.
- To understand the use of classical nonlinear techniques such as phase plane, describing functions.
- To familiarize with the design of state feedback controllers and observers for a given system.

Learning Outcomes:

Students will be able to

- construct state diagram for a given continuous time state model.
- compute the solution for a given state model of linear continuous systems.
- select an appropriate stability criterion for the design of non linear systems.
- analyze controllability and observability from state model.
- design a state feedback controller and observer to meet the desired specifications.

UNIT - I: State Variable Analysis

Linear Continuous time models for physical systems – Existence and Uniqueness of Solutions to Continuous Time State Equations, Solution of Linear Time varying continuous Time State Equations, State transition matrix and it's properties.

UNIT - II: 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- Controllabe subspace, unobservable subspace.

UNIT - III: Non Linear Systems

Introduction – non linear systems, characteristics of non linear systems, types of non linearities – saturation , dead – zone , backlash , relay, hysteresis; singular points – Introduction to linearization of nonlinear 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 - 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: State Feedback Controllers and Observers

State Feedback Controller design through Pole Assignment – state observers: Full order and Reduced order.

Text Books:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition, 1996.
2. Modern control engineering – K.Ogata, prentice Hall Of India, 3rd edtion, 1998.

Reference books:

1. Control system Engineering – I.J. Nagarath, M.Gopal. New Age International Publications, 5th edition.
2. Systems and Control - Stainslaw H. Zak, Oxford Press, 2003.
3. Automatic feedback control system synthesis – Truxal, International student edition.
4. Modern Control Systems - Richard C. Dorf and Robert H. Bishop, 11th Edition Pearson Edu,India, 2009.

POWER ELECTRONIC SYSTEMS SIMULATION LAB

I – Semester

Practical	: 6	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with characteristics of power electronic switches.
- To emphasize on usage of power electronics and electric drives in everyday life.

Learning Outcomes:

Students will be able to

- analyze the characteristics of power electronic switches.
- develop switching pattern for the switches in a converter.
- design converter for machine and load specifications.
- apply various load phenomenon's to analyze the converters.

List of Experiments

Any Ten experiments from the following list are required to be conducted

1. (a). Simulation of Single Phase Full Converter using R, RL, RL & E Load with and without Freewheeling Diode
   (b). Simulation of Single Phase Full Converter using R, RL, RL & E Load with and without LC Filter.
2. (a). Simulation of three phase full converter using R, RL load
   (b). Simulation of three phase full converter using RL load with LC Filter
3. (a). Simulation of Asymmetrical Pulse Width Modulation
   (b). Simulation of symmetrical Pulse Width Modulation
4. (a). Simulation of Single Phase Voltage Source Inverter with Sinusoidal PWM control for R-load
   (b). Simulation of Single Phase Current Source Inverter with Sinusoidal PWM control for R-load
5. (a). Simulation of Three Phase Voltage Source Inverter with Sinusoidal PWM control for R-load
   (b). Simulation of Three Phase Current Source Inverter with Sinusoidal PWM control for R-load

6. (a). Simulation of Single phase AC voltage controller with and without PWM control for RL load
   (b). Simulation of Three phase AC voltage controller with and without PWM control for RL load
7. (a). Simulation of DC-DC Buck converter
   (b). Simulation of DC-DC Boost converter
   (c). Simulation of DC-DC Buck-Boost converter
8. Simulation of Single Phase symmetrical & asymmetrical Cyclo-Converter with R-load
9. Cascade position control of DC motor drive (P, PI, PID controllers) using MATLAB/simulink.
10. Simulation of DC Motor with controlled AC rectification.
11. (a). Simulation of Capacitor-start Capacitor-run Single Phase Induction motor using MATLAB/simulink
    (b). Simulation of VSI fed Capacitor-start Capacitor-run Single Phase Induction motor using MATLAB/simulink
12. (a). Speed control of Permanent Magnet Synchronous Motor using MATLAB/simulink
    (b). Speed control of Brush Less DC Motor using MATLAB/simulink
    (c). Speed control of Switched Reluctance Motor using MATLAB/simulink

Reference Books:

1. Fundamentals of *Power Electronics* With *MATLAB*: Randall Sbaffer.
2. MATLAB and SIMULINK for Engineers Agam Kumar Tyagi.
3. Modeling and Simulation Using MATLAB Simulink-Dr.Shailendra Jain.

SWITCHED MODE POWER CONVERTERS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with the operation of single switch isolated converters, push pull and isolated bridge converters.
- To introduce the concepts of dynamic behavior of buck and boost converters and its linearization techniques
- To expose to the operation and performance of ZVS and ZCS converters.

Learning Out comes:

Students will be able to

- analyze the operation of single switch bridge and isolated converters.
- design small signal models of buck and boost converters.
- design various types of controllers for specific applications.
- analyze the concepts of ZVS and ZCS for L - type and M- type resonant converters.
- distinguish the operation techniques of ZVS and ZCS.

UNIT - I: Isolated Converters

Requirement for isolation in the switch-mode converters, transformer connection, Forward and flyback converters, power circuit and steady-state analysis. Half bridge and full-bridge converter**s,** Power circuit and steady-state analysis.

UNIT - II: Dynamic Analysis Of Dc-Dc Converters

Formulation of dynamic equation of buck and boost converters, averaged circuit models, linearization technique, small-signal model and converter transfer functions.

UNIT - III: Controller Design

Review of frequency-domain analysis of linear time-invariant systems, concept of bode plot, phase and gain margins, bandwidth, controller specifications, proportional(P), proportional plus integral (PI), proportional plus integral plus integral controller (PID), selection of controller parameters.

UNIT - IV: Resonant Converters

Classification of Resonant converters-Basic resonant circuits- Series resonant circuit-parallel resonant circuits- Resonant switches.

UNIT - V: Quasi-Resonant Converters

Quasi-Resonant Converters-I: Concept of Zero voltage switching, principle of operation, analysis of M-type and L-type Buck or boost Converters. Concept of Zero current switching, principle of operation,analysis of M-type and L-type Buck or boost Converters.

Textbooks:

1. Fundamentals of Power Electronics – Robert Erickson and Dragon Maksivimovic, Springer Publications.,2nd editon 2001.
2. Power Electronics –Issa Batarseh- John Wiely &Sons, 2004.

Reference Books:

1. Elements of Power Electronics - Philip T.Krein – Oxford University Press,1997.
2. Power Electronics: L.Umanand, IND-W, 2nd edition, 2009.

ELECTRIC DRIVES - II

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the principles of Steady state operation of various ac drives.
- To familiarize with the speed control methods of different ac drives.

Learning Outcomes:

Students will be able to

- analyze steady state operation of Induction motor.
- apply various control schemes on Induction motor.
- describe the operational characteristics of slip power recovery schemes.
- identify operational problems of ac drives.
- select an appropriate ac drive for particular application.

UNIT - I: Introduction

Review of steady-state operation of Induction motor, Equivalent circuit analysis, torque-speed characteristics.

UNIT - II: Inverter Fed Induction motor drives

Voltage Source Inverter Fed Induction motor drives: 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.

Current Source Inverter Fed Induction motor drives:

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 schemes

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, BLDC and Variable Reluctance Motor Drives

Characteristics of permanent magnet, synchronous machines with permanent magnet, vector control of PMSM- Motor model and control scheme. Modeling of PM brushless dc motor, drive scheme –Threephase full wave Brushless dc motor -Sinusoidal type of Brushless dc motor - current controlled Brushless dc motor Servo driveVariable 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. Electric Motor Drives Modeling, Analysis & control -R. Krishnan First Edition - Pearson Education 2010.
2. Modern Power Electronics and AC Drives –B. K. Bose- First Edition Pearson Publications,2010

Reference Books:

1. Power Electronics control of AC motors – MD Murphy & FG Turn Bull Pergman Press - 1st edition-1988
2. Fundamentals of Electric Drives – G. K. Dubey –Second Edition, Narosa Publications –2010.
3. Power Semiconductor Controlled drives – G. K. Dubey First Edition,Prentice-Hall 1989.

FLEXIBLE AC TRANSMISSION SYSTEMS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To Introduce the Flexible AC Transmission System devices, basic types of FACTS controllers and different types of converters and their operation in different modes.
- To expose the practical problems associated with the operation of Power system and the necessity of FACTS devices.

Learning Outcomes:

Students will be able to

- apply the knowledge of FACTS devices for enhancing power handling capacity in the transmission network.
- understand the fundamental principles and control practices associated with FACTS controllers.
- analyze different types of FACTS controllers.
- identify the operational related problems of transmission system and suggest suitable remedial measures.
- select an appropriate FACTS controller to meet specified performance requirements.

UNIT - I: FACTS Concepts

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 converters, 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 and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.

UNIT - V: Static Series Compensators

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

Text Books:

1. “Understanding FACTS Devices” N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:—Standard Publications

Reference Books:

1. HVDC & FACTS Controllers: applications of static converters in power systems - Vijay K.Sood- Springer publishers
2. Sang.Y.H and John.A.T, “Flexible AC Transmission systems” IEEE Press (2006).

DIGITAL SIGNAL PROCESSING AND APPLICATIONS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with the concepts of DFT, FFT, IIR and FIR filters.
- To understand the architecture of TMS320F281x processor.

Learning Outcomes:

Students will be able to

- perform the DFT and FFTof a sequence.
- design IIR and FIR Filters for given specifications.
- analyze the decimation and interpolation on signals.
- use TMS320F281x processor for Signal Processing applications.

UNIT - I: Introduction to Digital Signal Processing

Digital signal processing system, sampling theorem, discrete time sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) Radix-2, Decimation and Interpolation.

UNIT - II: IIR Filter Design

Design of IIR Filters from Analog Filters, Analog Filters Approximations: Butterworth and Chebyshev; Frequency Transformations, General Considerations in Digital Filter Design, Bilinear Transformation Method, and Impulse Invariance Technique.

UNIT - III: **FIR Filter Design**

Symmetric and Anti Symmetric FIR Filters, properties of FIR digital filters,design of Linear–Phase FIR Filters using Fourier series Method and Rectangular, Hanning, Hamming, Blackman and Keiser Windows;

UNIT - IV: **Effects of Finite Word Length in Digital Filters**

Introduction, Rounding and Truncation Errors, Quantization Effects in Analog-to-Digital Conversion of Signals, Coefficient Quantization effects in Direct Form Realization of IIR Filters and FIR filters, Scaling.

UNIT - V: **TMS320F281x- Digital Signal Processor**

Features of TMS320F281x, functional overview, memory map , brief description of C28x CPU, memory bus(Harvard Architecture), interrupt sources, System Control.

Text Books:

1. John G.Proakis, DimitrisG.Manoliks, “Digital signal processing principles, Algorithms and Applications”, 3rd Edition, 2000, PHI. (Units: I to III)
2. S Salivahanan, A Vallavaraj, and C Gnanapriya, “Digital Signal Processing”,Tata McGraw Hill (Unit-IV)

Reference Books:

1. TMS320F2812 – Digital Signal Processors, Data Manual of Texas Instruments.(Unit-V)
2. Alan Oppenheim and Ronald W.Schafer, “DigitalSignalProcessing”, PHI 2000.
3. Sanjit K.Mithra, “Digital Signal Processing A computer Based approach”, Tata McGraw Hill, 2nd Edition, 2000.

Elective - III

RENEWABLE ENERGY SOURCES

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To understand the concepts of solar radiation and operating principles of different types of collectors.
- To familiarize with the potential of wind energy and the principles of Bio-conversion.

Learning Outcomes:

Students will be able to

- describe the principles of solar radiation.
- analyze the performance characteristics of vertical and horizontal axis wind mills.
- identify the conversion techniques of tidal and geothermal energy.
- select a suitable direct energy conversion technique for suitable application.

UNIT - I: Principles of Solar Radiation

Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation- Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

UNIT - II: Wind Energy Conversion System

Wind Energy Conversion System–Siting–Rotor selection–Annual energy output–Horizontal axis wind turbine(HAWT)–Vertical axis wind turbine (VAWT)–Rotor design considerations–Numberofblades–Solidity-Bladeprofile–Upwind/Downwind–Yawsystem–Tower–Brakingsystem.

Synchronous and asynchronous generators and loads–Integration of wind energy converters to electrical networks–Inverters–Control system–Requirement and strategies–Noise–Applicationsofwindenergy.

UNIT - III: Bio-Mass

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience.

UNIT - IV: Tidal, Wave and Geothermal energy

Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse. Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience. Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifier energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

UNIT - V: Direct Energy Conversion

Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications,MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

Text Books:

1. Non-Conventional Energy Sources G.D. Rai New Delhi khanna publishers 5th edition 2013.

Reference Books:

1. Renewable Energy Resources John Twidell and Tony Weir ,E & F.N.Spon london routledge 3rd edition 2014
2. Renewable Energy Resources Basic Principles and Applications G.N.Tiwari and M.K.Ghosal Harrow U.K. Alpha science international 2005
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme New Delhi TMH 3rd edition 2010
4. Solar Energy Thermal Processes,/Duffie & Beckman Hoboken john wiley 4th edition 2013.

Elective - III

AI TECHNIQUES

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the concept of Artificial Intelligence (AI).
- To familiarize with the architecture, principle of operation of Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.

Learning Outcomes:

Students will be able to

- understand the concepts of Neural Networks.
- apply various learning methods to train Neural Network architectures.
- differentiate the crisp and fuzzy sets.
- design Fuzzy logic Controller for an Engineering application
- select an appropriate AI technique for a specific application.

UNIT - I: Introduction to Neural Networks

Introduction to Neural Networks: Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Essentials of Neural Networks: Neural network Architectures-knowledge representation learning process-learning tasks and their rules

UNIT - II: Feed Forward Neural Networks (FFN)

Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications. Multi Layer Feed Forward Neural Networks (MLFFN) Generalized delta rule, delta rule for Multi Layer Feed Forward Neural Networks, Concept of Back Propagation, Back Propagation algorithm, Advantages and Disadvantages of Back Propagation

UNIT - III: ANN Memories and Applications

ANN Paradigms, Hebbian Learning, Bidirectional Associative Memory (BAM) architecture, BAM training and Hope field networks.
Neural Network Applications: load forecasting, fault identification, process control and identification.

UNIT - IV: Introduction to Fuzzy Logic

Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT - V: Fuzzy Logic System Components and Applications

Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods. Fuzzy Logic Applications: Speed control of Drives, Process Control -P, PI, PD, and PID Controllers.

Text Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – 6th impression, PHI Publication.
2. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 6th impression 1997.

Reference Books:

1. Neural Networks-James Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks-Simon Hakins, 2nd impression Pearson Education.
3. Neural Engineering by C.Eliasmith and CH.Anderson, PHI.
4. Neural Networks and Fuzzy logic System by Bart kosko, PHI Publications

Elective - III

SMART GRID

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Prerequisite: Distribution systems and Measuring instruments.

Course Objectives:

- To acquaint with the smart technologies, smart meters and power quality issues in smart grids.
- To expose to high performance computing for Smart Grid applications.

Learning Outcomes:

Students will be able to

- understand the features of Smart Grid.
- assess the role of automation in Transmission/Distribution.
- apply Evolutionary Algorithms for the Smart Grid/Distribution Generation.
- identify a suitable Communication Technology for Smart Grid.
- apply Control strategies for smart grid with sophisticated techniques.

UNIT - I: Introduction to Smart Grid

What is Smart Grid? Evolution of Electric Grid, Need for Smart Grid, Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid.

UNIT - II: Smart Grid Architecture

Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs – Transmission Automation – Distribution Automation – Renewable Integration.

UNIT - III: Tools and Techniques for Smart Grid

Computational Techniques – Static and Dynamic Optimization Techniques – Computational Intelligence Techniques – Evolutionary Algorithms – Artificial Intelligence techniques.

UNIT - IV: Distribution Generation Technologies

Introduction to Renewable Energy Technologies – Micro grids – Storage Technologies –Electric Vehicles and plug – in hybrids – Environmental impact and Climate Change – Economic Issues.

UNIT - V: Communication Technologies and Control techniques in Smart Grid System

Introduction to Communication Technology – SynchroPhasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS). Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

Text books:

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid:Technology and Applications', Wiley, 2012.
3. Martin T. Hagan , Howard B.Demuth, M, and Mark H. Beale 'Neural network design', Vikas Publishing House, 2003.
4. Zurada, J.M., 'Introduction to Artificial Neural Systems', Jaico publishing house, Bombay,1992.

References:

1. Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, 'Smart Grid Technologies: Communication Technologies and Standards' IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang 'Smart Grid – The New and Improved Power Grid: A Survey' , IEEE Transaction on Smart Grids.
3. Zimmermann, H.J., 'Fuzzy set theory and its applications', Allied publishers limited, Madras, 2001.

Elective - IV

CUSTOM POWER DEVICES

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To emphasize on various power quality problems, their origin and mitigation methods
- To familiarize with Operation of custom power devices and their applications.
- To introduce the concept of compensation by custom power devices.

Learning Outcomes:

Students will be able to

- identify various power quality problems in power system.
- analyze different types of custom power devices.
- analyze different power factor improvement methods in converters.
- apply various control methods in inverters for reactive power compensation.
- select and design a suitable custom power device for a given application.

UNIT - I: Introduction to Electric Power Quality and Custom Power Devices

Electric Power Quality, Power Electronic applications in Power Transmission Systems, Power Electronic applications in Power Distribution Systems. Power Quality terms and Definitions, Power Quality Problems. Custom Power, Classification of Custom Power Devices - Network reconfiguration type, compensating Type.

UNIT - II: Overview of Custom Power Devices

Compensation Devices for Voltage Sags and Momentary Interruptions - Backup Energy Supply Devices - Battery UPS - Super Conducting Magnetic Energy Storage systems - Flywheel - Voltage Source Converter - Multi-level converters.

UNIT - III: Reactive Power and Harmonic Compensation Devices

Reactive power and harmonic compensation devices **-** Static Var Compensator - Topologies - Direct Connected Static Var Compensation for Distribution Systems - Static Series Compensator - Static Shunt Compensator (DSTATCOM) - Interaction with Distribution Equipment and System - Installation Considerations.

UNIT - IV: Source Transfer Switches, Solid State Limiting and Breaking Devices

Source Transfer Switch - Static Source Transfer Switch (SSTS) - Hybrid source transfer switch - High-speed mechanical source transfer switch - Solid state current limiter - Solid state breaker.

UNIT - V: Application of Custom Power Devices In Power Systems

P-Q theory - Control of P and Q - Dynamic Voltage Restorer (DVR) - Operation and control - Interline Power Flow Controller (IPFC) - Operation and control - Unified Power Quality Conditioner (UPQC) - Operation and control.

Text Books:

1. Power Quality Enhancement Using Custom Power Devices — Power Electronics and Power Systems, Gerard Ledwich, Arindam Ghosh, Kluwer Academic Publishers, 2002, 1st edition
2. Instantaneous Power Theory and Applications to Power Conditioning By Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, Published by jhon wiley & sons, 2007, 1st edition

Reference Books:

1. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000.
2. Custom Power Devices - An Introduction, Arindam Ghosh and Gerard Ledwich, Springer, 2002, 1st edition
3. Roger C Dugan, et.al, “Electrical Power Systems Quality”, 3rd Edition, TMH, 2012.
4. “Power Quality in Power System and Electrical Machines” by Ewald Fuchs, Mohammad A. S. Masoum Academic Press, Elsevier, 2009. 1st edition.

Elective - IV

DIGITAL CONTROL SYSTEMS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To expose the students to the stability analysis of closed loop systems in the Z-plane.
- To introduce digital compensators in frequency domain.
- To familiarize with the design of state feedback controllers.

Learning Outcomes:

Students will be able to

- apply the knowledge of z-transform and inverse z-transforms for analyzing the signals.
- apply the fundamental principles to convert an analog signal to discrete signal.
- describe and determine the stability of discrete time system by using different techniques.
- design digital compensators in frequency domain.
- apply the concept of controllability to design an appropriate digital feedback controller to meet specified performance requirements.
- apply the concept of observability to design a digital observer for estimating unmeasured states of practical plants.

UNIT - I: Introduction to Digital Control systems

Introduction – advantages of digital control system –Sampling theorem-Quantization –— Mathematical modeling – Data reconstruction and filtering of sampled signals – zero –order-hold.

Z-transforms, difference equation – solution by recursion and z-transform, Relation between s-plane to z-plane, Pulse transfer function of zero-order-hold.

UNIT - II: Stability Analysis

Relation between G(s) and G (z) - bilinear transformation, Digital control system-pulse transfer function –z transform analysis of open loop, closed loop systems – modified z- transfer function – stability of linear digital control system- Stability tests - Jury stability test.

UNIT - III: Design of Discrete Time Control System by Conventional Methods

Root loci- Frequency domain analysis – Bode plots – Gain margin and phase margin. Design of Digital control system based on Root Locus Technique. Digital controllers – Design using bilinear transformation – realization of digital PID controllers.

UNIT - IV: State Space Analysis

State equation of discrete data systems, solution of discrete state equations, state transition matrix: Z-transform method. Relation between state equation and transfer function. Concept of controllability and observability.

UNIT - V: State Feedback Controllers and Observers

Digital State observer: Design of the full order and reduced order state observer – pole placement design by state feedback, Design of Dead Beat controller – some case studies. Stability analysis of discrete time systems based on Lyapunov approach.

Text Books:

1. Discrete-Time Control systems - K. Ogata, PHI/Addison-Wesley Longman Pte. Ltd., India, Delhi, 2nd edition, 1995.
2. Digital Control Systems - Kuo, Oxford University Press, 2nd edition, 1992.
3. Digital control and state variable methods – M.Gopal, Tata McGraw Hill, India, 4th edition, 1997.

Reference Books:

1. Digital control of dynamic systems – Gene F. Frankin, J.David powell, Michael workman, pearson education, 3rd edition 2000.
2. Continuous and Discrete Control Systems – Dorsay, McGraw – Hill.
3. Digital control Systems – C.H.Houpis and G.B.Lamount, McGraw Hill, 1985.

Elective - IV

COMPUTER AIDED DESIGN OF ELECTRICAL MECHINE

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the need for field analysis based design.
- To familiarize with the stored energy in field oriented systems.

Learning Outcomes:

Students will be able to

- develop the mathematical formulation of field oriented problems**.**
- apply the concept of FEM to electrical Systems.
- select an appropriate solution technique for a field oriented problem
- design electrical components and systems using CAD Packages.

UNIT - I: Introduction to Mathematical formulation of Field problems

Conventional design procedures, Limitations, Need for field analysis based design. Development of torque/force, Electromagnetic Field Equations, Magnetic Vector/Scalar potential, Electrical Vector/Scalar potential.

UNIT - II: Stored Energy Principles

Stored energy in field problems, Inductances, Laplace and Poisson's Equations, Energy functional, Principle of energy conversion.

UNIT - III: Philosophy of FEM

Mathematical Models -Differential/Integral equation s -Finite Difference method -Finite Element Method -Energy minimization -Variational method -2D Field problems - Discretisation- Shape functions -Stiffness matrix -Solution techniques

UNIT - IV: CAD Packages

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

UNIT - V: Design Applications

Design of Solenoid Actuator, Induction Motor, Switched Reluctance Motor, Synchronous Machines.

Text books:

1. Silvester and Ferrari, "Finite Elements for Electrical Engineers", 3rd edition, Cambridge University press, 1983
2. S.R.H.Hoole, Computer- Aided, Analysis and Design of Electromagnetic Devices, 2nd edition, Elsevier, New York, Amsterdam, London, 1989.
3. D.A. Lowther and P.P.Silvester, Computer Aided Design in Magnetics, 2rd edition Springer, Verlag, New York, 1956.

References Books:

1. S.J.Salon, "Finite Element Analysis of Electrical Machines" Kluwer Academic Publishers, London, 1995.
2. C. W. Trowbridge, "An Introduction to Computer Aided Electromagnetic Analysis"' Vector Field Ltd.
3. User Manuals of MAGNET, MAXWELL & ANSYS. Software Pvt.Ltd.

POWER ELECTRONICS AND DRIVES LAB

II – Semester

Practical	: 6	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To provide hands-on- experience on various Power Electronic converters.
- To expose students to various motion control schemes of electric machines.

Learning Outcomes:

Students will be able to

- test, measure and determine the various parameters of three phase converters and provide valid conclusions on the performance of these different power converters
- select suitable DC drive for specific application
- diagnose the various causes of harmonics and design a PWM converter
- design converter fed dc drives and chopper fed dc drives

List of the Experiments:

1. 3 -Ö Ac Voltage Controller on Motor Load.
2. 3 -Ö Full Converter With R & RL Loads
3. 3 -Ö Full Converter With Dc Motor Drive
4. Four Quadrant Chopper Drive Using Dc Motor
5. 1-Ö IGBT based PWM Inverter on R& RL Loads
6. 3 -Ö IGBT based PWM Inverter on R & RL Load
7. 3 -Ö SCR based Inverter Drive For AC Motor Module
8. Speed Controller Of 3 -Ö Slip-ring Induction Motor by Static Rotor Resistance Controller
9. 3 -Ö PWM Pulse Generator Module
10. DSP Based V/F Control Of Induction Motor
11. 3 -Ö PWM Pulse Generation using FPGA
12. FPGA based 3 -Ö IGBT inverter.