



**2 Year M. Tech Degree Course  
(Semester System)  
w. e. f 2010 – 2011  
Power Systems Engineering**

# **Academic Regulations & Syllabus**

**VELAGAPUDI RAMAKRISHNA  
SIDDHARTHA ENGINEERING COLLEGE  
(AUTONOMOUS)  
(Sponsored by Siddhartha Academy of General & Technical Education)  
VIJAYAWADA-520 007**



# **VELAGAPUDI RAMAKRISHNA SIDDHARTHA ENGINEERING COLLEGE**

**(Autonomous)**

**Kanuru, Vijayawada – 520 007**

**(Approved by AICTE, Accredited by NBA, and ISO 9001: 2008 Certified)**

**(Affiliated to Jawaharlal Nehru Technological University, Kakinada)**

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## **Academic Regulations for M.Tech(VR10) w.e.f: 2010-2011 (Common to all branches)**

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## 1. INTRODUCTION

Academic Programmes of the College are governed by rules and regulations as approved by the Academic Council, which is the highest Academic body of the Institute. These academic rules and regulations are effective from the academic year 2010-11, for students admitted into two year PG programme offered by the college leading to Master of Technology (M.Tech) in various specializations offered by respective departments as given in Table 1.

## 2. PROGRAMMES OFFERED

Presently, the college is offering Post Graduate programmes in Engineering with the following specializations:

**Table 1: List of Specializations**

S.No	Specialization	Department
1	Structural Engineering	Civil Engineering
2	Computer Science and Engineering	Computer Science and Engineering
3	Communications and Signal Processing	Electronics & Communication Engineering
4	Telematics	
5	Power Systems Engineering	Electrical & Electronics Engineering
6	CAD/CAM	Mechanical Engineering
7	Thermal Engineering	

## 3. DURATION OF THE PROGRAMME

The duration of the programme is two academic years consisting of four semesters. A student is permitted to complete the postgraduate programme in a stipulated time frame of 4 years from the date of joining. Otherwise he/she shall forfeit their seat in M.Tech Programme and the admission shall stand cancelled.

## 4. MINIMUM INSTRUCTION DAYS

Each semester, normally consists of a minimum of 90 instruction days with about 30 to 35 contact periods per week.

## 5. ELIGIBILITY CRITERIA FOR ADMISSION

The eligibility criteria for admission into M.Tech programme are as per the guidelines of APSICHE .

### 5.1 CATEGORY –A Seats:

- These seats will be filled by the Convener, PGCET Admissions.

### 5.2 CATEGORY –B Seats :

- These seats will be filled by the College as per the guidelines of APSICHE

## 6. PROGRAMME STRUCTURE

Every specialization of the M.Tech programme shall have six theory courses and two practical / mini project / seminar courses in each of first and second semesters. A major project is offered in third and fourth semesters.

### 6.1 Course Code and Course Numbering Scheme

Course Code consists of eight characters in which the first four are alphabets and rest are numerals. First four characters are described in Table 2 and 3.

**Table 2: First and Second Character description**

First Two Characters	Name of the Department
CE	Civil Engineering Department
CS	Computer Science and Engineering Department
EC	Electronics & Communication Engineering Department
EE	Electrical & Electronics Engineering Department
ME	Mechanical Engineering Department

Third and fourth character represents specialization offering as mentioned in Table No. 3.

**Table 3: Third and Fourth Character description**

Next Two Characters	Name of the Specialization
SE	Structural Engineering
CS	Computer Science and Engineering
SP	Communications and Signal Processing
TM	Telematics
PS	Power Systems Engg
CC	CAD/CAM
TE	Thermal Engineering

Fifth and sixth characters represent semester number and syllabus version number of the course offered.

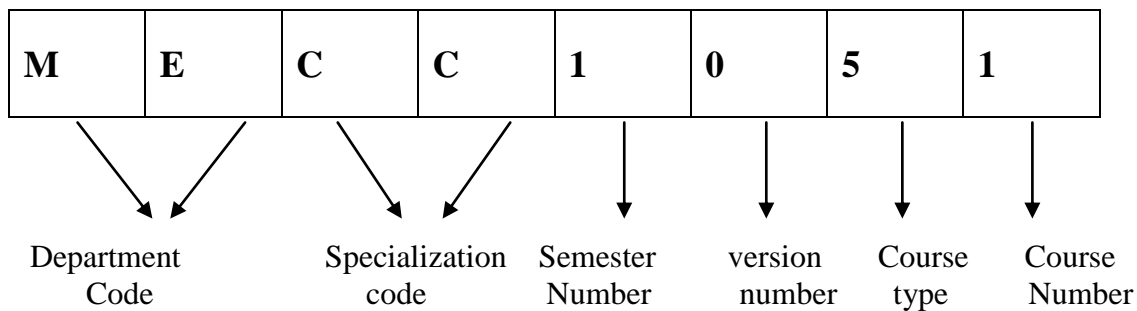
Seventh character represents course type, as per Table No. 4

**Table 4: Course type description**

SEVENTH CHARACTER	DESCRIPTION
0	Theory course
5	Lab course

Eighth character represents course number as described in Figure 1 below. However, few courses are given distinct codes.

For example, in **MECC 1051** course, the course is offered by Mechanical Engineering Department (**ME**) in CAD/CAM specialization offered in the first semester (**1**), the course syllabus version number (**0**), the course is of lab type (**5**) and the course number is (**1**), as given in figure.2 below.



**Figure 1: Course Code Description**

## 6.2 Scheme of Instruction for 1<sup>st</sup> and 2<sup>nd</sup> Years

- The scheme of instruction and exact syllabi of all postgraduate programmes are given separately.

## 6.3 Contact Hours and Credits

The Course Credits are broadly fixed based on the following norms:

- Lectures – One Lecture period per week is assigned one credit.
- Tutorials - Two tutorial periods per week are assigned one credit.
- Practical – 2 periods per week is assigned one credit
- Seminar/Mini Project shall have 2 credits.
- Major project shall have 24 credits.
- However, some courses are prescribed with fixed number of credits depending on the subject complexity and importance.

## 6.4 Theory / Tutorial Classes

Each course is prescribed with fixed number of lecture periods per week. During lecture periods, the course instructor shall deal with the concepts of the course. For certain courses, tutorial periods are prescribed, to give exercises to the students and to closely monitor their learning ability.

## 6.5 Laboratory Courses

A minimum prescribed number of experiments have to be performed by the students, who shall complete these in all respects and get each experiment evaluated by teacher concerned and certified by the Head of the Department concerned at the end of the semester.

## 6.6 Programme Credits

Each specialization of M.Tech programme is designed to have a total of 80 credits, and the student shall have to complete the courses and earn credits as per the requirements for the award of degree.

## 7. MEDIUM OF INSTRUCTION

The medium of instruction and examination is English.

## 8. SYLLABUS

As approved by the concerned BOS and the Academic Council.

## **9. ELIGIBILITY REQUIREMENT FOR APPEARING SEMESTER END EXAMINATION AND CONDONATION**

- a) Regular course of study means a minimum average attendance of 75% in all the courses computed by totaling the number of periods of lectures, tutorials, practical courses and project work as the case may be, held in every course as the denominator and the total number of periods attended by the student in all the courses put together as the numerator.
- b) Condonation of shortage in attendance may be recommended by respective Heads of Departments on genuine medical grounds, provided the student puts in at least 65% attendance in each subject and provided the Principal is satisfied with the genuineness of the reasons and the conduct of the student.
- c) Students, having shortage of attendance, shall pay Rs.20/-per every period of attendance shortage subject to a minimum of Rs.500/-.
- d) Minimum of 50% aggregate marks must be secured by the candidates in the internal examinations conducted for theory, practice and lab courses, to be eligible to write semester end examinations. However, if the student is eligible for promotion based on the attendance, in case necessary, a shortage of internal marks up to a maximum of 10% may be condoned by the Principal based on the recommendations of the Heads of the Departments.
- e) Students having shortage of internal marks up to a maximum of 10% shall have to pay Rs.1000/- towards condonation fee for shortage of internal marks.
- f) A student, who does not satisfy the attendance and/or internal marks requirement, shall have to repeat that semester.
- f) Eligible candidates who failed to register for all papers for the semester-end examinations shall not be permitted to continue the subsequent semester and has to repeat the semester for which he/she has not registered for semester end examinations.

## **10. EXAMINATIONS AND SCHEME OF EVALUATION**

### **10.1 Internal Examinations:**

#### **10.1.1 Theory Courses**

Each course is evaluated for **40** marks (a+b)

- a) The internal evaluation shall be made based on the two midterm examinations each for **20** marks will be conducted in every theory course in a semester. The midterm marks shall be awarded giving a weightage of  $2/3^{\text{rd}}$  in the examination in which the student scores more marks and  $1/3^{\text{rd}}$  for the examination in which the student scores less marks. Each midterm examination shall be conducted for duration of 90 minutes with 3 questions to be answered out of 4 questions.
- b) The remaining 20 marks are awarded through continuous evaluation of assignments / mini project in each subject as notified by the teacher at the beginning of the semester.

Students shall be informed regarding the comprehensive assignment/project during first week of semester and they have to submit completed assignment on or before 12<sup>th</sup> week of semester.

### 10.1.2 Laboratory Courses: 25 marks

- For Laboratory courses there shall be continuous evaluation during the semester for 25 internal marks. The distribution of internal marks are given below:

**Table 5: Distribution of Marks**

Sl.No.	Criteria	Marks
1	Day to Day work	10
2	Record	05
3	Internal Examination	10

### 10.1.3 Seminar/Mini project: 75 marks

The distribution of internal marks for the seminar/mini project is given below.

**Table 6: Distribution of Marks**

Sl.No.	Criteria	Marks
1	Report	45
2	Seminar & Viva-viva	30

### 10.1.4 Major Project: (50 marks each in 3<sup>rd</sup> & 4<sup>th</sup> semesters)

The continuous internal evaluation for 50 marks allocated for the project work in each semester of 3<sup>rd</sup> & 4<sup>th</sup> shall be on the basis of two seminars by each student on the topic of his/her project evaluated by project review committee & day to day assessment by the supervisor in each semester. The project review committee consists of Head of Department, respective internal guide and three senior faculty members of the department. The distribution of marks is as follows.

**Table 7: Continuous internal assessment in each semester**

Sl.No.	Criteria	Marks
1	Two seminars	15+15
2	Day to day assessment	20

## 10.2 Semester End Examinations

### 10.2.1 Theory Courses: 60 marks

- The Semester end examinations shall be conducted for 3 hours duration at the end of the semester. The question paper shall be given in the following pattern :
- There shall be two questions from each unit with internal choice. Each question carries 15 marks. Each course shall consist of four units of syllabus.

### **10.2.2 Lab Courses: 50 marks**

35 marks are allotted for experiments/job works & 10 marks are allotted for viva-voce examination and 5 marks for record.

### **10.2.3 Seminar/Mini project: 50 marks**

There shall be a seminar presentation. For Seminar/Mini Project, a student under the supervision of a faculty member, 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 consists of Head of the Department, supervisor and two other senior faculty members of the department. For Seminar/Mini Project the evaluation is done for 50 marks internally. A candidate has to secure a minimum of 50% to be declared successful.

### **10.3 Major Project:**

The work on the project shall be initiated in the beginning of the second year and the duration of the project is two semesters. Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the Project Review Committee.

- a) A Project Review Committee (PRC) shall be constituted with Head of the Department as chair person, two senior faculty members of the concerned department.
- b) The candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the Project Review Committee for its approval before the second semester end examinations. After obtaining the approval of the Committee the student can initiate the Project work after the second semester end examinations.
- c) If a candidate wishes to change his supervisor or topic of the project he can do so with approval of the PRC. However, the Project Review Committee (PRC) shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.
- d) After approval of the topic in Project Review Committee, the candidate shall be required to submit status report in four stages. The first one in the mid of 3rd semester, second one in the end of 3rd semester, third one in the mid of 4th semester and the final report in the form of draft copy of thesis for the approval of PRC to the Head of the Department and shall make an oral presentation before the PRC.
- e) Due weightage will be given to the papers published from the thesis submitted in the order of International Journal, National Journal, International conference and National conference while evaluating the thesis.
- f) Three copies of the Project Thesis certified by the supervisor shall be submitted to the College.

- g) The thesis shall be adjudicated by one external examiner selected by the Principal. For this, Head of the Department shall submit a panel of five examiners, who are eminent in the field.
- h) The viva-voce examination shall be conducted by a board consisting of the supervisor, Head of the Department and the external examiner. Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination. If any candidate gets less than 50% marks in the viva-voce examination, he/she shall revise and resubmit the project work and reappear for viva-voce examination when next conducted.

In a special case, if any candidate does not submit his/her thesis due to ill health or any other reason permitted by the head of the institution, he/she will be given another chance to attend for the viva-voce examination conducted separately at a later date, if the expenditure for conducting the viva-voce is completely borne by the candidate.

## **11. CONDITIONS FOR PASS AND AWARD OF CREDITS FOR A COURSE**

### **11.1 Conditions for Pass and award of Grades & Credits:**

- a) A candidate shall be declared to have passed in individual Theory/Drawing course if he/she secures a minimum of 50% aggregate marks (Internal & semester end examination marks put together), subject to a minimum of 40% marks in semester end examination.
- b) A candidate shall be declared to have passed in individual lab/project course if he/she secures a minimum of 50% aggregate marks (Internal & semester end examination marks put together), subject to a minimum of 50% marks in semester end examination.
- c) If a candidate secures minimum of 40% marks in Theory Courses in the semester end examination and 40% - 49% of the total marks in the semester end examination and internal evaluation taken together in some theory courses and secures an overall aggregate of 50% in all theory courses of that semester he/she declared to be passed in the theory courses of that semester.
- d) The student has to pass the failed course by appearing the examination when offered next, as per the requirement for award of the degree.
- e) On passing a course of a programme, the student shall earn assigned credits in that Course.

## 11.2 Method of Awarding Letter Grades and Grade Points for a Course.

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

**Table 8: Grading System for individual subjects/labs**

Theory/Drawing	Lab/Project	Grade Points	Letter Grade
85-100%	85-100%	10	Ex
75-84%	75-84%	9	A+
70-74%	70-74%	8	A
65-69%	65-69%	7	B+
60-64%	60-64%	6	B
50-59%	55-59%	5	C
40-49%	50-54%	4	D
< 40%	< 50%	0	F (Fail)

## 11.3 Calculation of Semester Grade Points Average (SGPA)\* and award of division for the program

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

$$SGPA = \frac{\sum(CR * GP)}{\sum CR} \quad (\text{for all courses passed in semester})$$

Where CR= Credits of a course

GP = Grade points awarded for a course

\*SGPA is calculated for the candidates who passed all the courses in that semester.

## 11.4 Calculation of Cumulative Grade Point Average (CGPA) for Entire Programme.

The CGPA is calculated as below:

$$CGPA = \frac{\sum(CR * GP)}{\sum CR} \quad (\text{for entire programme})$$

Where CR= Credits of a course

GP = Grade points awarded for a course

**Table 9: Award of Divisions**

CGPA	DIVISION
$\geq 8$	First Class with distinction
$\geq 6 - < 8$	First Class
$\geq 5 - < 6$	Second Class
$\geq 4 - < 5$	Pass Class
$< 4$	Fail

### **11.5 Transitory Regulations**

A candidate, who is detained or discontinued in the semester, on readmission shall be required to pass all the courses in the curriculum prescribed for such batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed in such courses, in the earlier semester(s) as approved by Board of Studies and ratified by Academic Council.

### **11.6 Consolidated Grade Card**

A consolidated grade card containing credits & grades obtained by the candidates will be issued after completion of the two year M.Tech Programme.

## **12. REVALUATION**

- As per the notification issued by the Chief Controller of Examinations, the students can submit the applications for revaluation, along with the fee receipt for revaluation of his/her answer script(s) of theory course(s), if he/she is not satisfied with marks obtained.
- The Controller of Examinations shall arrange for revaluation of those answer script(s).
- A new external examiner, other than the first examiner, shall reevaluate the answer script(s).
- Better marks of the two will be taken into consideration.

## **13. READMISSION CRITERIA**

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

## **14. BREAK IN STUDY**

Student, who discontinues the studies for what so ever may be the reason, can get readmission into appropriate semester of M.Tech programme after break-in study only with the prior permission of the Principal of the College provided such candidate shall follow the transitory regulations applicable to such batch in which he/she joins. An administrative fee of Rs. 2000/- per each year of break in study in addition to the prescribed tuition and special fee has to be paid by the candidate to condone his/her break in study.

## **15. ELIGIBILITY FOR AWARD OF M.TECH. DEGREE**

The M.Tech., Degree shall be conferred on a candidate who has satisfied the following requirement. A student should register himself for 80 Credits, and should obtain all the 80 credits in order to become eligible for the award of M.Tech Degree.

## 16. CONDUCT AND DISCIPLINE

- Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the students of our Institution.
- As per the order of Honorable Supreme Court of India, ragging in any form is considered a criminal offence and is banned. Any form of ragging will be severely dealt with.
- The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures with regard to ragging.
  - i. Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.
  - ii. Willful damage or distribution of alcoholic drinks or any kind of narcotics to fellow students / citizens.
- Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.
- Mutilation or unauthorized possession of library books.
- Noisy and unseemly behavior, disturbing studies of fellow students.
- Hacking computer systems (such as entering into other person's areas without prior permission, manipulation and/or damage of computer hardware and software or any other cyber crime etc.
- Students are not allowed to use cell phones in the campus.
- Plagiarism of any nature is prohibited.
- Any other act of gross indiscipline as decided by the college from time to time.
- Commensurate with the gravity of offense, the punishment may be reprimand, fine, expulsion from the institute / hostel, debarment from a examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.
- For an offence committed in (i) a hostel (ii) a department or in a class room and (iii) elsewhere, the Chief Warden, the Head of the Department and the Principal, respectively, shall have the authority to reprimand or impose fine.
- Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Principal for taking appropriate action.
- Un authorized collection of money in any form is strictly prohibited.
- Detained and Break-in-Study candidates are allowed into the campus for academic purposes only with permission from Authorities.
- Misconduct committed by a student outside the college campus but having the effect of damaging, undermining & tarnishing the image & reputation of the institution will make the student concerned liable for disciplinary action commensurate with the nature & gravity of such misconduct.
- The Disciplinary Action Committee constituted by the Principal, shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.
- "Grievance appeal Committee" (General) constituted by the Principal shall deal with all grievances pertaining to the academic / administrative /disciplinary matters.
- All the students must abide by the code and conduct rules of the college.

## **17. MALPRACTICES**

- The Principal shall refer the cases of malpractices in internal assessment tests and Semester-End Examinations, to a Malpractice Enquiry Committee, constituted by him/her for the purpose. Such committee shall follow the approved scales of punishment. The Principal shall take necessary action, against the erring students basing on the recommendations of the committee.
- Any action on the part of candidate at an examination 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. The involvement of the Staff, who are in charge of conducting examinations, valuing examination papers and preparing/keeping records of documents relating 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 recommended for award of appropriate punishment after thorough enquiry.

## **18. OTHER MATTERS**

18.1 The physically challenged candidates who have availed additional examination time during their B.Tech/PGCET examinations will be given additional examination time on production of relevant proof/documents.

18.2 Students who are suffering from contagious diseases are not allowed to appear either internal or semester end examinations.

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

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

## **19. AMENDMENTS TO REGULATIONS**

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

**V.R. SIDDHARTHA ENGINEERING COLLEGE :: VIJAYAWADA - 520007**  
**(AUTONOMOUS)**  
**FOUR SEMESTER M.TECH. DEGREE COURSE**  
**POWER SYSTEMS ENGINEERING**

**CURRICULUM & DETAILED SYLLABI**

S.No	Course Code	Subject	Periods/week		Internal marks	End Semester Examination		Credits
			L	P		Duration	Marks	
<b>First Semester</b>								
1.	EEPS1001	Operations Research	4	--	40	3	60	4
2.	EEPS1002	Modern Control Theory	4	--	40	3	60	4
3.	EEPS1003	Solid State Power Converters	4	--	40	3	60	4
4.	EEPS1004	Computer Methods in Power Systems	4	--	40	3	60	4
5.	EEPS1005	High Voltage Engineering	4	--	40	3	60	4
6.	EEPS1006	<b>Elective-I</b>	4	--	40	3	60	4
	EEPS1006/1	HVDC Transmission						
	EEPS1006/2	Power Quality						
	EEPS1006/3	Microprocessors & Microcontrollers						
	EEPS1006/4	Advanced Digital Signal Processing						
7.	EEPS1051	Power Systems Lab	--	3	25	3	50	2
8.	EEPS1052	Simulation Lab – I	--	3	25	3	50	2
		<b>TOTAL</b>	24	6	290	--	460	28
<b>Second Semester</b>								
1.	EEPS2001	Flexible AC Transmission Systems	4	--	40	3	60	4
2.	EEPS2002	Power System Stability	4	--	40	3	60	4
3.	EEPS2003	Power System Operation and Control	4	--	40	3	60	4
4.	EEPS2004	Advanced Power System Protection	4	--	40	3	60	4
5	EEPS2005	<b>Elective-II</b>	4	--	40	3	60	4
	EEPS2005/1	Electrical Distribution Systems						
	EEPS2005/2	Digital Control Systems						
	EEPS2005/3	Demand Side Energy Management						
	EEPS2005/4	PLC Controllers and its Applications						
6.	EEPS2006	<b>Elective-III</b>	4	--	40	3	60	4
	EEPS2006/1	AI Techniques						
	EEPS2006/2	EHVAC Transmission						
	EEPS2006/3	Deregulated Power System Planning						
	EEPS2006/4	Power System Reliability						
7.	EEPS2051	Simulation Lab – II	--	3	25	3	50	2
8.	EEPS2052	Seminar	--	3	75	--	--	2
		<b>TOTAL</b>	24	6	340	--	410	28
<b>Third Semester</b>								
1.	EEPS3051	Project Seminar	--	--	50	--	--	
		<b>TOTAL</b>	--	--	50	--	--	
<b>Fourth Semester</b>								
1.	EEPS4051	Project Presentation	--	--	50	--	200	24
		<b>TOTAL</b>	--	--	50	--	200	80

**UNIT I**

**LINEAR PROGRAMMING:** Definition and Scope of Operations Research, Mathematical formulation of the problem, graphical method, Simplex method, artificial basis technique, Degeneracy, alternative optima, unbounded solution, infeasible solution.  
Duality theorem – Dual simplex method – Sensitivity analysis - effect of changes in cost coefficients

**UNIT II**

**TRANSPORTATION PROBLEM:** Introduction to the problem, LP formulation of a transportation problem. Basic feasible solution by Vogel's approximation method, least cost method. Finding optimal solution by MODI method, degeneracy, unbalanced transportation matrix, Assignment problem – Formulation – Hungarian method

**UNIT III**

**Non linear programming:** Kuhn-Tucker conditions. Single variable optimization problem – Unimodal function – Fibonacci search method, Multivariable optimization problem – Univariate method

**DYNAMIC PROGRAMMING:** Characteristics of D.P. model, solution of optimal sub-division problem, Bellman's principle of optimality

**UNIT IV**

**PROJECT PLANNING THROUGH NETWORKS:** Arrow (Network) Diagram representation. Rules for constructing an arrow diagram, PERT and CPM, Critical path calculations, earliest start and latest completion times, Determination of critical path, determination of floats, Probability considerations in project.

**Text Books:**

1. Operations Research –H.A. Taha, 6<sup>th</sup> Edition, PHI
2. Operations Research - S.D.Sharma, Galgotia publishers

**Reference Books:**

1. Optimization theory and applications – S.S. Rao 3<sup>rd</sup> Ed., New Age International
2. PERT and CPM principles and applications – L.S.Srinadh
3. Operations Research – Richard Bronson, Govindasami Naadimuthu – TMH, 2/E
4. Operations and Research Algorithms and Applications – RP Sen - PHI

**UNIT – I State Variable Analysis**

The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Nonuniqueness of state model – State diagrams for Continuous-Time State models.

Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties.

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.

Control systems design using state feedback – Pole placement method & Full-order state observer

**UNIT- II Nonlinear Systems**

Introduction – Nonlinear Systems - Types of Nonlinearities – Singular Points – Introduction to linearization of nonlinear systems, Properties of nonlinear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Nonlinear systems through describing functions

**UNIT-III Stability Analysis**

Stability in the sense of Lyapunov, Lyapunov’s stability and instability theorems - Stability analysis of the linear continuous- time invariant systems by Lyapunov second method– Direct method of Lyapunov – Generation of Lyapunov functions – Variable gradient and Krasoviskii’s methods

**UNIT- IV Optimal Control**

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

**Text Books:**

1. Modern Control System Theory by M.Gopal – New Age International -2/E
2. Modern Control Engineering by Ogata.K – Prentice Hall – 2/E
3. Control Systems – Principles and Design – M Gopal TMH, 3/E

**References:**

1. Control System Engineering by IJ Nagrath and M Gopal

\* continuous-time systems only

**Unit I**

**Single Phase AC Voltage Controllers**

Single phase AC voltage controllers with Resistive and Resistive-inductive loads – ac voltage controllers with PWM

**Three Phase AC Voltage Controllers**

Three phase AC voltage controllers – Analysis of controllers with star and delta Connected Resistive, Resistive- - numerical problems.

**Unit II**

**Single Phase Converters.**

Single phase converters – Half controlled and Fully controlled converters – Evaluation of input power factor and harmonic factor – continuous and Discontinuous load current – single phase dual converters – power factor

Improvements – Extinction angle control – symmetrical angle control – PWM – single phase sinusoidal PWM – Applications - Numerical problems.

**Three Phase Converters**

Three phase converters – Half controlled and fully controlled converters – Evaluation of input power factor and harmonic factor – continuous and Discontinuous load current – Numerical problems.

**Unit III**

**D.C. to D.C. Converters**

Analysis of step-down and step-up dc to dc converters with resistive and Resistive-inductive loads – Switched mode regulators – Analysis of Buck Regulators - Boost regulators – buck and boost regulators – Cuk regulators –Condition for continuous inductor current and capacitor voltage-Numerical problems.

**Cycloconverters**

Single phase to single phase cycloconverters – analysis of midpoint and bridge Configurations – single phase to three phase cycloconverters – analysis of Midpoint and bridge configurations – Limitations – Advantages – Applications - numerical problems.

**Unit IV**

**Pulse Width Modulated Inverters (single phase)**

Principle of operation – performance parameters – single phase bridge inverter - evaluation of output voltage and current with resistive, inductive and Capacitive loads – Voltage control of single phase inverters – single PWM –

Multiple PWM – sinusoidal PWM – third harmonic PWM-60 degree PWM-modified PWM – phase displacement Control – Advanced modulation techniques for improved performance – Trapezoidal, staircase, stepped, harmonic injection and delta modulation –

Advantage – application – numerical problems.

**Pulse Width Modulated Inverters (three phase)**

Three phase inverters – analysis of 180 degree condition for output voltage And current with resistive, inductive loads – analysis of 120 degree Conduction – voltage control of three phase inverters – sinusoidal PWM – space vector PWM, Comparison of PWM techniques – harmonic reductions – Current Source Inverter – variable d.c. link inverter – boost inverter – application – numerical problems

**Text books:**

1. Power Electronics – Mohammed H. Rashid – Pearson Education – Third Edition – First Indian reprint 2004.
2. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley & Sons – 2/E

**References**

1. Power Electronics –MD Singh and Khanchandani, TMH, 2/E, 2007
2. Power Electronics –P.S Bhimbra, Khanna publisher

**UNIT-I:**

**Network Matrices and Modeling:** Introduction, linear transformation techniques (bus, branch, loop frame of references), single phase modeling of transmission lines, off-nominal transformer tap representation, phase shift representation. Three phase system analysis - use of Compound admittances. Three-phase models of transmission lines and Transformers

**UNIT-II:**

**Power flow solutions:** Review of power flow equations - GS, NR and FDC methods of solving power flow equations, Comparison of power flow methods

**Three Phase Load Flows:** Formulation of three phase power flow equations, Fast-decoupled three phase algorithm and computer program structure

**UNIT-III:**

**Fault System Studies:** (Generators, transformers, cables & systems): Analysis of three phase faults - admittance matrix equation - impedance matrix equation - fault calculations - analysis of unbalanced faults - admittance matrices - fault calculations - short circuit faults - open circuit faults - program description and typical solutions.

**UNIT-IV:**

**Z<sub>BUS</sub> methods in Contingency Analysis:** Adding and removing multiple lines (current injection methods), piece wise solution of interconnected systems, analysis of single and multiple contingencies, Contingency analysis by DC Model, System reduction for contingency and fault studies.

**TEXT BOOKS:**

1. J.Arrilaga and C.P.Arnold: Computer modeling of electric power systems, John Wiley & Sons, N.Y. 1983.
2. Stagg G.Ward, El-Abiad: Computer methods in power system analysis. McGraw Hill, ISE, 1968.
3. J.J.Grainger, W.D.Stevenson JR, Power system analysis, TMH, Delhi 2007.

**REFERENCES:**

1. Nagarath & Kothari Modern power system analysis 3<sup>rd</sup> Edition, TMH.
2. Nagsarkar & Sukhija, Power system analysis, Oxford press, New Delhi, 2007

**UNIT I:**

**Conduction and Breakdown in Gases:**

Ionization process, Townsend's current growth equation, current growth in the secondary processes, Townsend's criterion for breakdown, streamer theory of breakdown in gases, Paschen law, breakdown in non uniform fields and corona discharge.

**Generation of High Voltage and Currents:**

Generation of high D.C., alternating voltages, impulse voltages, generation of impulse currents, tripping and control of impulse generators

**UNIT II:**

**Measurement of high voltage and currents:**

Measurement of high dc voltages, Measurement of high ac and impulse voltages, Measurement of high dc, ac and impulse currents. Cathode Ray Oscilloscope for impulse voltage and current measurements.

**UNIT III:**

**Testing of Materials and Apparatus**

Measurement of D.C. resistivity, measurement of dielectric constant and loss factor, partial discharge measurements, testing of insulators, bushing, circuits breakers, transformers and surge diverters.

Over Voltage Phenomenon Insulation Coordination:

Causes of over voltage, lighting phenomenon, switching over voltages and power frequency over voltages in power systems,

**UNIT IV:**

**Insulation Coordination:**

Principle of insulation coordination on high voltage and extra high voltage power systems.

Gas insulated substations:

Advantages of Gas Insulated Substations, Comparison of Gas Insulated substations and Air Insulated Substations, Design and Layout of Gas Insulated Substations, Description of Various components in GIS.

**TEXT BOOKS:**

1. High Voltage Engineering by M.S.Naidu and V.Kamaraju – TMH.
2. High Voltage Engineering fundamentals by Kuffel and Zungel, Elsevier Publications
3. Switchgear By BHEL, TMH

**REFERENCES:**

1. Fundamentals of Gaseous Ionization and plasma Electronics by Essam Nasser – Wiley - Inter Science.
2. High Voltage Technology by ALSTOM
3. Gaseous Dielectrics by Arora, TMH

**UNIT I:**

H.V.D.C. Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration.

Static Power Converters: 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 transformers.

**UNIT II:**

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., DC power flow control.

**UNIT III:**

Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation.

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

**UNIT IV:**

Transient over voltages in HVDC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults

Component Models for the Analysis of AC/DC Systems; Modelling of DC Network, Modelling of AC Networks, Modelling of DC Links, Solution of DC Load Flow.

**TEXT BOOKS:**

1. HVDC transmission by Adamson and Hingorani.
2. H.V.D.C.Transmission by J.Arillaga : Peter Peregrinus ltd., London UK 1983.
3. H.V.D.C Power transmission systems : Technology and system interactions by K.R.Padiyar, New Age International (P) Ltd.

**REFERENCE BOOKS:**

1. Direct current Transmission, by . E.W. Kimbark , Wiley Inter Science – NewYork.
2. EHV-AC & HVDC transmission Engg. & Practice” by S.Rao, Khanna Publishers.

## EEPS1006/2 POWER QUALITY

### **Unit I**

Power and Voltage Quality : General, classes of Power Quality Problems, Power quality terms, Power frequency variations, the power quality evaluation procedure.

Voltage Quality : Transients, long and short duration Voltage variations, Voltage imbalance, waveform distortion, Voltage Flicker.

**Unit II : Voltage sags and Interruptions** : Sources of sags and Interruptions. Estimating Voltage sag performance.

Fundamental Principles of Protection. Solutions at the end-user level. Evaluating Ride-through Alternatives. Motor-Starting Sags.

**Unit III : Fundamentals of Harmonics** : Harmonic distortion. Voltage versus Current distortion. Harmonic indexes. Harmonic sources from commercial loads. Harmonic sources from industrial loads. Locating Harmonic sources. System response characteristics. Effects of Harmonic Distortion.

**Distributed Generation and Power Quality** : Resurgence of DG. DG Technologies. Interface to the Utility System. Power Quality Issues. Operating Conflicts. DG on distribution Networks . Siting DG distributed Generation, Interconnection standards.

### **Unit IV :**

**Wiring and Grounding** : Resources, Definitions, Reasons for Grounding, Typical wiring and grounding problems, Solution to wiring and grounding problems.

**Power Quality Monitoring** : Monitoring Consideration. Historical Perspective of power quality measurement equipment. Assessment of Power Quality.

Text Book:

Electrical Power Systems Quality: Roger C. Dugan, MF McGranaghan, Surya Santoso and HW Beaty, TMH, 2/E

Reference:

1. Electrical Power Systems Quality : By ROGER C.DUGAN, Electrotek Concepts Inc. 2/E

## EEPS1006/3 MICROPROCESSORS & MICROCONTROLLERS

### **Unit I**

Register Organization of 8086, Architecture, Signal description of 8086, Physical memory Organization, addressing modes of 8086.

8086/8088 instruction set and assembler directives, machine language instruction formats.

### **Unit II**

General Bus Operation, minimum mode 8086 system and timings, maximum mode 8086 system mode and timings

Fundamental I/O considerations, Programmed I/O, Interrupt I/O, Block transfers and DMA.

**Unit III** : Introduction to stack, stack structure of 8086/8088, Interrupts and Interrupt service routine, interrupt cycle of 8086/8088.

Interfacing ROM, RAM and I/O ports to Micro Computer System, PPI (Programmable Peripheral Interface), 8255 modes of operation, Interfacing A to D converters, Interfacing D to A converters, Interfacing Principles and stepper motor interfacing.

**Unit IV** Programmable Interval timer 8254, Programmable Interrupt Controller 8259A, Key Board or Display Controller 8279, Programmable Communication Interface 8251 USART.

Introduction to 8051/31 Microcontroller, PIN diagram, architecture, Different modes of Operation of timer/counters, addressing modes of 8051 and instruction set.

### **Reference Books:**

1. Microprocessors and Interfacing : Programming and Hardware by Douglas V. Hall, 2<sup>nd</sup> edition, TMH, New Delhi, 1999.
2. Micro Computer Systems : The 8086/8088 family by YU-CHENG LIU, GLENN A. GIBSON, 2<sup>nd</sup> edition, PHI India, 2000.
3. The 8051 Microcontrollers : Architecture, Programming & Applications by Kenneth J Ayala, 2/E, Penram International Publishing (India).
4. Advanced Microprocessors and Peripherals, Architecture Programming and Interfacing by A.K. Ray & K.M. Bhurchandi, Forth reprint 2004, TMH.
5. The 8051 Microcontroller and Embedded Systems – Mohammad Ali Mazdi, Janice Gillispie Mazidi, Pearson Education (Singapore) Pvt. Ltd., 2003.

## EEPS1006/4 ADVANCED DIGITAL SIGNAL PROCESSING

### UNIT I: Digital Filter Structure

Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

### UNIT II: Digital filter design

Preliminary considerations-Bilinear transformation method of IIR filter design-design of Low pass, highpass, Bandpass, and Band stop- IIR digital filters-Spectral transformations of IIR filters- FIR filter design-based on Windowed Fourier series- design of FIR digital filters with least –mean-Square-error-constrained Least-square design of FIR digital filters

### UNIT III: DSP algorithm implementation

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

Analysis of finite Word length effects

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

### UNIT IV: Power Spectrum Estimation

Estimation of spectra from Finite Duration Observations 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-Walsh methods-Blackman & torchy method.

### Reference Books:

1. Digital signal processing-sanjit K. Mitra-TMH second edition
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint
- 3 Digital Signal Processing principles, algorithms and Applications – John G.Proakis -PHI –3rd edition-2002
- 4 Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
- 5 Theory and Applications of Digital Signal Processing-LourensR. Rebinar&Bernold  
Digital Filter Analysis and Design-Auntonian-TMH

**List of Experiments\***

1. Evaluation of ABCD parameters for transmission line
2. Sequence reactances and fault studies on synchronous machine
3. Surge Impedance Loading limits of transmission line
4. Voltage control by capacitor compensation and tap changing transformers
5. Active and Reactive power control of synchronous machine connected to infinite bus
6. Line and load compensation of power system network
7. Characteristics of electromagnetic relays
8. Implementation of microprocessor based relays
9. Characteristics of static relays
10. Study of 3-phase bridge converter
11. Study of characteristics of Dual converter
12. Study of single-phase inverter
13. Study of PWM controlled 3-phase inverter
14. H.V. testing of insulators
15. High voltage testing of Cables
16. Study of corona phenomenon

**\* Any eight experiments to be completed**

**List of Experiments\***

1. Solution of simultaneous algebraic equations of Electrical network
2. Solution of simultaneous differential equations of a given network
3. Formation of incidence matrices
4. Formation of network matrices by singular or nonsingular transformations
5. Formation of  $Y_{bus}$  by inspection method
6. Formation of  $Z_{bus}$  by step by step algorithm using MATLAB
7. Fault analysis in power system using matrix method
8. Simulation of electric networks using MATLAB
9. Simulation of transmission line using MATLAB
10. Power flow solution using Gauss seidel method
11. Simulation of 1-phase diode bridge rectifier
12. Simulation of 1-phase controlled rectifier
13. Simulation of Single Phase AC voltage Controller
14. Transfer function analysis of given system using Simulink
15. State space analysis of a control system using MATLAB
16. Conversion of the given state system into a suitable diagonal form

**\* Any eight experiments to be completed**

## EEPS2001 FLEXIBLE AC TRANSMISSION SYSTEMS

### UNIT-I

**FACTS Concepts and General system Considerations:** Power Flow in AC system - definitions on FACTS - Basic types of FACTS Controllers. Converters for Static Compensation – Basic concept of voltage sourced converters. Single phase and three phase full wave bridge converters operation.

**Multi level 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 - comparison of current source converters with voltage source converters.

### UNIT-II

**Static Shunt Compensators:** Objectives of shunt compensation, mid point voltage regulation for line segmentation, End of line voltage support to prevent voltage instability, improvement of transient stability, Power oscillation damping. Methods of controllable var generation: variable impedance type static var generators – TCR and TSR, TSC, FC-TCR, TSC-TCR, switching converter type var generators.

**SVC and STATCOM:** The regulation slope, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and comparison between STATCOM and SVC

### UNIT-III

**Static Series Compensation:** Objectives of series compensation - Concept of series capacitive compensation, improvement of voltage stability, transient stability, power oscillation damping, functional requirements. GCSC, TSSC, and TCSC and SSSC - Operation and Control – Internal and External System Control for series Compensators.

**Static Voltage and Phase Angle Regulators:** Objectives of Voltage and Phase angle regulators, TCVR and TCPAR - Operation and Control. Switching Converter based Voltage and Phase angle regulator

### UNIT-IV

**UPFC:** The unified Power Flow Controller – Operation - Comparison with other FACTS devices – Control structure of UPFC- Control of P and Q - Dynamic Performance

**IPFC :** Interline Power flow Controller – Basic operating principles and characteristics control structure of IPFC.

### **TEXT BOOKS:**

1. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, 2000 by N.G. Hingorani & L.Gyugyi
2. FACTS Controllers in power transmission and Distribution, K.R.Padiyar, New Age Int. Publisher, 2007

**UNIT – I**

**Steady state stability:** Steady state power limits of a two machine system and multi machine systems – Analytical and graphical methods of calculating steady state stability limits – analysis of SMIB system with excitation system . Power system stabilizer – characteristics of small signal stability.

**UNIT – II**

**Transient stability:** Review of transient stability – numerical integration methods – Swing Equation and it's Solution by equal area criterion: Sudden change in mechanical input – Sudden loss of one of parallel lines – Short circuit at one end of line – Short circuit away from line ends – Line reclosure. Swing Equation solution by point by point method – modified Euler's method and Gauss Seidel method. Evaluation of transient stability by direct method.

**UNIT – III**

**Voltage stability analysis:** Voltage stability concepts – voltage collapse phenomenon – prevention of voltage collapse. Voltage stability of Single machine connected to infinite bus system – PV curves – QV curves. Effect of compensation – Series, shunt and SVCs.

**UNIT – IV**

Effects on stability due to losses – governor action – inertia – saturation – SCR – saliency – damper windings – methods of grounding. Methods of improving stability: High speed fault clearing, Reduction of transmission system reactance, regulated shunt compensation, Dynamic braking, Reactor switching, Single pole switching, Steam turbine fast valving, Generator tripping, load shedding, High speed excitation systems, HVDC transmission links, SVC.

**TEXT BOOKS:**

1. Prabha Kundur., “ Power system stability and control”, Tata McGraw Hill
2. Kimbark E.W. “ Power system stability and control – Vol I, Elements of stability calculations”, John Wiley & Sons
3. Kimbark E.W. “ Power system stability and control – Vol III, synchronous machines”, John Wiley & Sons

**REFERENCES:**

1. Anderson P.M., and Foud A.,” Power system control and stability” Galgotia publications
2. Taylor C.W. “ Power systems voltage stability”, TMH
3. K.R. Padiyar, “ Power systems Dynamics stability and control”, Interline publishing pvt., ltd., Bangalore.

**UNIT-I**

**Economic dispatch:** Characteristics of thermal, nuclear and hydro-generator units - Economic dispatch problem – Thermal system dispatch with network losses – line loss formula – The Lambda iteration method – first order gradient method – base point and participation factors.

Unit Commitment - Introduction; Constraints-Thermal and Hydro; Solution methods-Priority list and Dynamic programming methods

**UNIT-II**

**Load frequency control:** Definition of control area – single area control – Block diagram representation – steady state analysis – dynamic response – proportional plus integral control of single area block diagrams – AGC multi area system – modeling – static and dynamic response – tie line bias control – Inter connected systems.

**Automatic voltage control:** Importance – Various methods of voltage control – load compensation – line compensation – modeling of AVR loop – components, Excitation system stabilizer- Rate feedback and PID controllers

**UNIT-III**

**Computer control of power systems:** Energy control centre – various levels – SCADA system – computer configuration functions – monitoring – data acquisition and controls – EMS system

**Power System Security:** Introduction, system state classification, security analysis, Modeling for contingency analysis - Contingency selection, Contingency analysis, sensitivity factors, Power system voltage stability-definitions, measures to prevent voltage instability, voltage collapse, methods of improving voltage stability

**UNIT-IV**

**Power system state estimation:** Introduction – Least squares & Weighted least squares state estimation – Nonlinear measurements, Static state estimation of power systems- injection only algorithm & line only algorithm state estimation of AC network. Treatment of bad data – network observability and pseudo measurements, Application of power system state estimation – schematic diagram

**TEXT BOOKS:**

1. Hadi Saadat, "Power System Analysis" TMH
2. IJ Nagrath & DP Kothari Modern power system analysis 3<sup>rd</sup> Edition, TMH

**REFERENCES:**

1. Allen J. Wood and Bruce F. Wollenberg "Power Generation, Operation & Control" 2<sup>nd</sup> edition, John Wiley and Sons.
2. J.J.Grainger, W.D.Stevenson JR, Power system analysis, Tata McGraw Hill, 2007.
3. Abhijit Chakrabarti & Sunita Halder, " Power System Analysis Operation and Control " 2/E, PHI
4. S. Sivanagaraju and G. Sreenivasan, "Power System Operation and Control", Pearson

**Unit I:**

**INTRODUCTION OF STATIC RELAYS:** Basic construction of static relays, Classification of protective schemes, Comparison of Static relays with electromagnetic relays, Amplitude comparator, Phase comparator, Principle of Duality.

**AMPLITUDE AND PHASE COMPARATORS (TWO-INPUT):** Rectifier bridge circulating and opposed Voltage type- Averaging -phase splitting type -Sampling type of amplitude Comparison. Block spike type-Phase splitting type- Transistor integrating type-Rectifier bridge type - Vector product type Phase comparison.

**Unit II:**

**STATIC OVER CURRENT RELAYS:** Instantaneous- Definite time – Inverse time- Directional-IDMT- Very inverse Time-Extremely inverse time over current relays. Time current characteristics of Over current relays-applications

**STATIC DIFFERENTIAL RELAYS:** Differential relay scheme, single-phase static comparator, poly phase differential protection. Differential protection for generator and transformer.

**Unit III :**

**STATIC DISTANCE PROTECTION:** Static Impedance Relay- Static reactance relay- static MHO relay-effect of arc resistance, effect of power surges, effect of line length and source impedance on performance of distance relays- selection of distance relays

**PILOT RELAYING SCHEMES:** Wire pilot protection - circulating current scheme- balanced voltage scheme - transley scheme-half wave comparison scheme- Carrier current protection: phase comparison type-carrier aided distance protection-operational comparison of transfer trip and blocking schemes

**Unit IV :**

**MICROPROCESSOR BASED PROTECTIVE RELAYS:** Introduction-over current relays-Impedance relay-Directional relay-Reactance relay. Distance Relays- Mho relay – Offset Mho relay

**DIGITAL RELAYING ALGORITHMS:** Various transform techniques - Discrete Fourier Transform, Walsh-Hadamard Transform, Haar Transform, microprocessor implementation of digital distance relaying algorithms – Hardware Description – Software Description

**TEXT BOOKS:**

1. Power System Protection : Static Relays With Microprocessor Applications -T.S.M.Rao -Tata McGraw-Hill.
2. Power System Protection & Switch Gear – Badri Ram & DN Viswakarma –McGraw Hill.

**UNIT – I**

**Distribution systems planning:** Planning and forecast techniques - Present and future role of computers in distribution system planning - Load characteristics, Definitions load growth – tariffs - Diversified demand method.

**Distribution Automation:** Introduction – description – benefits – distribution automation components – distribution SCADA – distribution management system – functions of DMS.

**UNIT – II**

**Distribution transformers:** Types - Regulation and Efficiency - Use of monograms for obtaining efficiency - distribution factors – KW KVA Method of determining regulation.

**Design of subtransmission lines and distribution substations:** Introduction – sub transmission systems - distribution substation – Substation bus schemes - description and comparison of switching schemes – substation location and rating - Application of network flow techniques in rural distribution networks to determine optimum location of sub-station.

**UNIT – III**

**Design considerations on primary systems:** Introduction - types of feeders - voltage levels - Radial type feeders - feeders with uniformly distributed load and non-uniformly distributed loads.

**Design considerations of secondary systems:** Introduction - secondary voltage levels - Secondary banking - existing systems improvement.

**Distribution system Protection:** Basic definitions - over current protection devices - fuses, automatic circuit reclosures, automatic line sectionalizers - objectives of distribution system protection - coordination of protective devices - Fuse to Fuse co-ordination, Fuse to circuit breaker coordination, Reclosure to circuit breaker co-ordination.

**UNIT-IV**

**Voltage drop and power loss calculations:** Three phase primary lines - non 3 phase primary lines - 4 wire multi grounded primary lines - copper loss - Distribution feeder costs - loss reduction and voltage improvement in rural distribution networks.

**Applications of Capacitors to distribution systems:** Effect of series and shunt capacitors - Power factor correction - economic justification for capacitors - a computerized method to determine the economic power factor - Procedure to determine the best and optimum capacitor location

**Distribution System Voltage Regulation:** Basic definitions - Quality of service - voltage control - line drop compensation.

**TEXT BOOKS:**

1. *Turan Gonen* “Electric Power Distribution system Engineering”, MGH.
2. *Dr. V. Kamaraju* “Electrical distribution systems”, Right Publishers .

**REFERENCE BOOK:**

1. *A.S. Pabla* “Electric Power Distribution” TMH, 4<sup>th</sup> Ed., 1997.

## 2005/2 DIGITAL CONTROL SYSTEMS

**Unit I:** Discrete data and digital Control Systems – basic elements, advantages and disadvantages, examples, - Impulse sampling and data hold – transfer functions of Zero order hold and First order hold.

Reconstructing original signals from sampled signals – sampling theorem, ideal low pass filter, frequency response characteristics of the Zero order hold.

The Z-transform, Z transforms of some elementary functions, Important properties and theorems of the Z-transform, The inverse Z-transform, S-transform method for solving difference equations, the pulse transfer function, realization of digital controllers.

**Unit II:** Mapping between the s-plane and the z-plane, the Jury stability test, stability analysis by use of the bilinear transformation and Routh stability criterion. Liapunov stability analysis of discrete time systems.

Transient response specifications, steady state error analysis. Design based on frequency response method, Analytical design method.

**Unit III:** Concept of the state space method, State space representations of discrete time systems, solving discrete time state space equations. Discretisation of continuous time state space equations.

Controllability, Observability, Principle of Duality, Design via pole placement necessary and sufficient condition. Ackerman's formula, Dead Beat response.

**Unit IV:** State observers – necessary and sufficient condition for state observation, full order state observer, minimum order state observer.

Microprocessor and DSP control: Microprocessor control of control systems, single-board controllers with custom-designed chips, DMC – 105 board, digital signal processors – TMS 320 DSPs, development system and support tools. Effects of finite word length and quantization on controllability and closed loop pole placement. Effect of quantization – least upper bound on quantization error.

### Reference Books :

1. Discrete-time Control Systems, 2<sup>nd</sup> edition K.OGATA, Pearson Education Asia.
2. Digital Control Systems : 2<sup>nd</sup> edition, B.C.KUO, Oxford University Press

## 2005/3 DEMAND SIDE ENERGY MANAGEMENT

**Unit-I** : Energy Audit : Definitions-Need-concepts-Types of energy audit; Energy index – cost index – pie charts – Sankey diagrams.

Energy Economics: Introduction-Cost benefit risk analysis-Payback period-Straight line depreciation-Sinking fund depreciation—Reducing balance depreciation-Net present value method-Internal rate of return method-Profitability index for benefit cost ratio.

**Unit-II** : Energy Conservation in Electric utilities and Industry: Electrical load management: Energy and load management devices-Conservation strategies; conservation in electric utilities and industry: Introduction-Energy conservation in utilities by improving load factor-Utility voltage regulation-Energy conservation in Industries-Power factor improvement.

Energy-efficient electric motors (EEMs) : Energy efficient motors-construction and technical features-case studies of EEMs with respect to cost effectiveness-performance characteristics; Economics of EEMs and system life cycle-direct savings and payback analysis-efficiency factor or efficiency evaluation factor

**Unit-III**: Electric Lighting: Introduction-Need for an energy management program-Building analysis-Modification of existing systems-Replacement of existing systems-priorities:

Illumination requirement : Task lighting requirements-lighting levels-system modifications-non illumination modifications-lighting for non task areas-reflectances-space geometry ;System elements.

Light sources - characteristics of families of lamps-lamp substitution in existing systems-selection of Higher efficiency lamps for a new system-Luminaries-ballasts-energy conservation in lighting. White light LED and conducting Polymers.

**Unit-IV** : Space Heating ,Ventilation, Air-Conditioning(HVAC) and Water Heating: Introduction-Heating of buildings-Transfer of Heat-Space heating methods-Ventilation and air-conditioning-Insulation-Cooling load-Electric water heating systems-Energy conservation methods.

Co-generation and storage: Combined cycle cogeneration-energy storage: pumped hydro schemes-compressed air energy storage (CAES)-storage batteries-superconducting magnetic energy storage (SMES)

### References:

1. Energy management Hand book by Wayne C. Turner, John Wiley and Sons publications
2. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi
3. Energy efficient electric motors selection and application by John C. Andreas
4. Hand book on Energy Audit and Management by Amit Kumar Tyagi, published by TERI (Tata energy research Institute)
5. Energy management by Paul W. O' Callaghan McGraw hill book company
6. Energy conversion systems by Rakosh Das Begamudre New age international publishers
7. Energy Management – by W.R. Murphy & G. Mckey Butterworths.

## 2005/4 PLC CONTROLLERS AND ITS APPLICATIONS

### Unit I:

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.

### Unit II:

Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers.

### Unit III:

PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications.

### Unit IV:

Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.

Analog PLC operation: Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

### Reference Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth and F.D Hackworth Jr. – Pearson, 2004.

## EEPS2006/1 AI TECHNIQUES

### Unit I

#### Introduction to Neural Networks

Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models. introduction-neural network models-architectures-knowledge representation-learning process-learning tasks.

#### Feed Forward Neural Networks

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

**ANN paradigm**-back propagation-RBF algorithms-Hopfield networks

### Unit II

**genetic algorithms**-introduction-encoding-fitness function-reproduction operators

**genetic modelling**-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

### Unit III

#### Classical and Fuzzy Sets

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

#### Fuzzy Logic System Components

Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

### UNIT IV - Application of AI Techniques

**Neural network applications:** Process identification, Function Approximation, control and Process Monitoring, fault diagnosis and load forecasting.

**Fuzzy logic applications:** Fuzzy logic control and Fuzzy classification specific applications to power systems load frequency control, fault diagnosis.

### TEXT BOOKS:

1. Chennakesava R Alavala "Fuzzy logic and neural networks", New Age International Publishers.
2. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication.
3. Introduction to Artificial Neural Systems - Jacek M. Zurada, Jaico Publishing House, 1997.

### REFERENCES:

1. Neural and Fuzzy Systems: Foundation, Architectures and Applications, - N. Yadaiah and S. Bapi Raju, Pearson Education
2. Neural Engineering by C.Eliasmith and CH.Anderson, PHI

## EEPS2006/2 EHVAC TRANSMISSION

### Unit I

E.H.V. A.C. Transmission , line trends and preliminary aspects ,standard transmission voltages – power handling capacities and line losses – mechanical aspects.

Calculation of line resistance and inductance : resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix.

### Unit II

Line capacitance calculation : capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings.

### Unit III

Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

Corona : Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

### Unit IV

Power Frequency voltage control : Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines

Static reactive compensating systems : Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system.

### Reference Books :

1. Extra High Voltage AC Transmission Engineering – Rakosh Das Begamudre, Wiley Eastern Ltd., New Delhi – 1987.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

## **EEPS2006/3 DEREGULATED POWER SYSTEMS PLANNING**

### **UNIT – I**

#### **INTRODUCTION**

Power industry restructuring - Electricity market models - Electricity market fundamentals for planning purpose

### **UNIT – II**

#### **POWER SYSTEM PLANNING FUNDAMENTALS & RELIABILITY**

Planning criteria - Uncertainties - Planning process - Generation planning - Transmission planning - Least cost planning - Risks and making choices in planning.

Power system reliability - Reliability assessment - Security assessment.

### **UNIT - III**

#### **SHORT TERM LOAD AND PRICE FORECASTING**

Short term load forecasting - Short term market price forecasting - Regression models for load forecasting - Artificial neural networks for load forecasting - Other approaches for forecasting such as data mining approaches; Issues in load and price forecasting.

### **UNIT - IV**

#### **NEW CHALLENGES OF POWER SYSTEM PLANNING IN A DEREGULATED ENVIRONMENT**

Deterministic vs probabilistic approaches - Probabilistic power system reliability assessment - Probabilistic power system security assessment and Probabilistic power system planning.

#### **TEXT BOOKS :**

1. M. Ilic, F. Grliana, L. Fink “Power System Restructuring” Kluwer Academic Publisher.
2. R.L. Sullivan “Power System Planning “ Tata McGraw-Hill

#### **REFERENCES:**

1. E.O. Crousillat, P. Dorfner, P. Alvarado, H.M. Merrill “ Conflicting Objectives and Risk in Power System Planning”(IEEE Trans. Power Systems, Vol. 8, No. 3, pp. 887 – 893 August 1993.
2. B. Zhang & Z.Y. Dong “An Adaptive Neural-wavelet Model for Short Term Load Forecasting “ International Journal of Electric Power Systems Research. Vol. 59 pp. 121-129 2001.
3. T. De la Torre, J.W. Feltes, T. Gomez and H.M. Merrill “Deregulation, Privatization, and Competition: Transmission Planning under Uncertainty” IEEE Trans. Power Systems, Vol. 14, No. 2, pp. 460-465 May 1999.

## EEPS2006/4 POWER SYSTEM RELIABILITY

**UNIT – I Basics of Probability theory & Distribution :** Basic probability theory – rules for combining probabilities of events – Bernoulli's trials – probabilities density and distribution functions – binomial distribution – expected value and standard deviation of binomial distribution.

**Network Modelling and Reliability Analysis :** Analysis of Series, Parallel, Series-Parallel networks – complex networks – decomposition method.

**UNIT – II Reliability functions :** Reliability functions  $f(t)$ ,  $F(t)$ ,  $R(t)$ ,  $h(t)$  and their relationships – exponential distribution – Expected value and standard deviation of exponential distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF.

**Markov Modelling :** Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities. – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabilities using STPM – two component repairable models.

**UNIT – III Frequency & Duration Techniques :** Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one , two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering of merged states.

**Generation System Reliability Analysis :** Reliability model of a generation system– recursive relation for unit addition and removal – load modeling - Merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

**UNIT – IV Composite Systems Reliability Analysis :** Decompositions method – Reliability Indices – Weather Effects on Transmission Lines.

**Distribution System and Reliability Analysis :** Basic Concepts – Evaluation of Basic and performance reliability indices of radial networks.

### Reference Books :

1. Reliability Evaluation of Engg. System – R. Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Evaluation of Power systems – R. Billinton, R.N.Allan, Pitman Advance Publishing Program, New York.
3. An Introduction to Reliability and Maintainability Engineering. Charles E. Ebeling, TATA Mc Graw - Hill – Edition.

**List of Experiments\***

1. Power flow solution by NR method.
2. Power flow solution by FDC.
3. Contingency studies using load flows for generator & line outages.
4. Solution of Economic load dispatch problem.
5. Transient stability study of SMIB.
6. Contingency studies using  $Z_{BUS}$ .
7. Simulation of State Estimator for power flow using WLSE method
8. Simulation of single area load frequency control.
9. Simulation of two area load frequency control.
10. Simulation of power system stabilizer.
11. Simulation of voltage stability problem.
12. Design of LQR state feed back for a given system
13. Design of State feedback controller and observer through Pole assignment.
14. PSPICE Simulation of Three phase full converter using RL &E loads.
15. PSPICE Simulation of Three phase inverter with PWM controller.
16. PSPICE Simulation of resonant pulse commutation circuit.

**\* Any eight experiments to be completed**