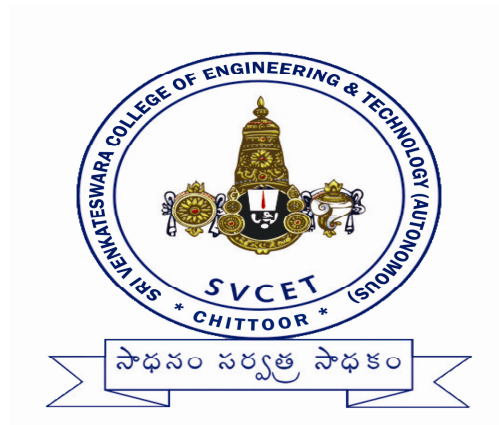


ACADEMIC REGULATIONS (R-15) COURSE STRUCTURE & DETAILED SYLLABI

M. Tech Regular Two Year Degree Courses

(For the Batches Admitted From 2015-2016)

ELECTRICAL POWER SYSTEMS (EPS)



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

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SRI VENKATESWARA COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS)

(AFFILIATED TO JNTUA, ANANTAPURAMU)

ACADEMIC REGULATIONS

M.TECH REGULAR 2 YEAR DEGREE PROGRAMME

(FOR THE BATCHES ADMITTED FROM THE ACADEMIC YEAR 2015-16)

The Jawaharlal Nehru Technological University Anantapur shall confer M.Tech Post Graduate degree to candidates who are admitted to the Master of Technology Programs and fulfill all the requirements for the award of the degree.

1.0 ELIGIBILITY FOR ADMISSIONS:

Admission to the above programme shall be made subject to the eligibility, qualifications and specialization prescribed by the competent authority for each programme, from time to time. Admissions shall be made either on the basis of merit rank obtained by the qualified candidates at an Entrance Test conducted by the University or on the basis of GATE/PGECET score, subject to reservations and policies prescribed by the Government from time to time.

2.0 ADMISSION PROCEDURE:

As per the existing stipulations of AP State Council for Higher Education (APSCHE), Government of Andhra Pradesh, admissions are made into the first year as follows:

- a) Category –A seats are to be filled by Convenor through GATE/PGECET score.
- b) Category-B seats are to be filled by Management as per the norms stipulated by Government of A.P.

3.0 Specializations:

Sl. No	Department	Specializations
1.	CE	Structural Engg.
2.	EEE	Power Electronics & Electrical Drives
3.	EEE	Electrical Power Systems
4.	ME	CAD/CAM
5.	ME	Machine Design
6.	ECE	VLSI System Design

7.	ECE	Digital Electronics and Communication System
8.	ECE	Embedded systems
9.	CSE	Computer Science & Engg.
10.	CSE	Computer Science
11.	IT	Software Engg.

4.0 COURSE WORK:

- 4.1. A Candidate after securing admission must pursue the M.Tech course of study for Four Semesters duration.
- 4.2. Each semester shall have a minimum of 16 instructional weeks.
- 4.3. A candidate admitted to a programme should complete it within a period equal to twice the prescribed duration of the programme from the date of admission.

5.0 ATTENDANCE:

- 5.1. A candidate shall be deemed to have eligibility to write end semester examinations if he has put in at least 75% of attendance on cumulative basis of all subjects/courses in the semester.
- 5.2. Condonation of shortage of attendance up to 10% i.e., from 65% and above and less than 75% may be given by the college on the recommendation of the Principal.
- 5.3. Condonation of shortage of attendance shall be granted only on medical grounds and on representation by the candidate with supporting evidence.
- 5.4. If the candidate does not satisfy the attendance requirement he is detained for want of attendance and shall reregister for that semester. He shall not be promoted to the next semester.

6.0 EVALUATION:

The performance of the candidate in each semester shall be evaluated subject wise, with a maximum of 100 marks for Theory and 100 marks for practical's, on the basis of Internal Evaluation and End Semester Examination.

- 6.1. For the theory subjects 60% of the marks will be for the External End Examination. While 40% of the marks will be for Internal Evaluation, based on the average of the marks secured in the two Mid Term-Examinations held, one in the middle of the Semester (first two units) and another immediately after the completion of instruction (last three units) with four questions to be answered out of five in 2 hours, evaluated for 40 marks. For semester end examination (external paper

setting & external evaluation) five questions shall be given for a maximum of 60 marks with one question from each unit with internal choice i.e. either or type. All questions carry equal marks.

- 6.2. For practical subjects, 60 marks shall be for the End Semester Examinations and 40 marks will be for internal evaluation based on the day to day performance (25 marks) and practical test at the end of the semester (15 marks).
- 6.3. Seminar is a continuous assessment process. For Seminar there will be an internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful. The assessment will be made by a board consisting of HOD and two internal experts.
- 6.4. For comprehensive viva voce there will be an internal evaluation of 100 marks. A candidate has to secure a minimum of 50% to be declared successful. The assessment will be made by a board consisting of HOD and two internal experts.
- 6.5. **A candidate shall be deemed to have secured the minimum academic requirement in a** subject if he secures a minimum of 40% of marks in the End Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.
- 6.6. In case the candidate does not secure the minimum academic requirement in any of the subjects (as specified in 6.5) he has to reappear for the Semester Examination either supplementary or regular in that subject, or repeat the subject when next offered or do any other specified subject as may be required.

6.7. **Revaluation / Recounting:**

Students shall be permitted for request for recounting/revaluation of the Semester-End examination answer scripts within a stipulated period after payment of prescribed fee. After recounting or revaluation, records are updated with changes if any and the student will be issued a revised grade sheet. If there are no changes, the same will be intimated to the students.

6.8 **Supplementary Examination:**

In addition to the regular Semester- End examinations conducted, the College may also schedule and conduct supplementary examinations for all the subjects of other semesters when feasible for the benefit of students. Such of the candidates writing supplementary examinations may have to write more than one examination per day.

7.0 **RE-REGISTRATION:**

Following are the conditions to avail the benefit of improvement of internal evaluation marks

- 7.1. The candidate should have completed the course work and obtained examinations results for I & II semesters.

- 7.2. He should have passed all the subjects for which the Internal evaluation marks secured are more than or equal to 50%.
- 7.3. Out of the subjects the candidate has failed in the examination due to Internal evaluation marks secured being less than 50%, the candidate shall be given one chance for each Theory subject and for a maximum of **three** Theory subjects for Improvement of Internal evaluation marks.
- 7.4. The candidate has to re-register for the chosen subjects and fulfill the academic requirements.
- 7.5. For each subject, the candidate has to pay a fee equivalent to one third of the semester tuition fee and the along with the requisition to the Principal of the college.
- 7.6. In the event of availing the Improvement of Internal evaluation marks, the internal evaluation marks as well as the End Examinations marks secured in the previous attempt(s) for the reregistered subjects stand cancelled.

8.0 EVALUATION OF PROJECT WORK:

Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the college/ institute.

- 8.1. Registration of Project work: A candidate is permitted to register for the project work after satisfying the attendance requirement of I & II Semesters.
- 8.2. An Internal Departmental Committee (I.D.C) consisting of HOD, Supervisor and one internal senior teacher shall monitor the progress of the project work.
- 8.3. The work on the project shall be initiated in the penultimate semester and continued in the final semester. The duration of the project is for two semesters. The candidate can submit Project thesis with the approval of I.D.C. after 36 weeks from the date of registration at the earliest. Extension of time within the total permissible limit for completing the programme is to be obtained from the Head of the Institution.
- 8.4. The student must submit status report at least in three different phases during the project work period. These reports must be approved by the I.D.C before submission of the Project Report and award internal assessment marks for 120.
- 8.5. A candidate shall be allowed to submit the Thesis / Dissertation only after passing in all the prescribed subjects (both theory and practical) and then take viva voce examination of the project. The viva voce examination may be conducted once in two months for all the candidates who have submitted thesis during that period.
- 8.6. Three copies of the Thesis / Dissertation certified in the prescribed form by the supervisor and HOD shall be presented to the H.OD. One copy is to be forwarded to the Controller Of Examinations and one copy to be sent to the examiner.
- 8.7. The Dept shall submit a panel of three experts for a maximum of 5 students at a time. However, the Thesis / Dissertation will be adjudicated by one examiner nominated by the Chief Controller Of Examinations.

- 8.8. If the report of the examiner is favorable viva-voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the thesis / dissertation. The board shall jointly award the marks for 180.
- 8.9. A candidate shall be deemed to have secured the minimum academic requirement in the project work if he secures a minimum of 50% marks in the end viva-voce examination and a minimum aggregate of 50% of the total marks in the end viva-voce examination and the internal project report taken together. If he fails to get the minimum academic requirement he has to appear for the viva-voce examination again to get the minimum marks. If he fails to get the minimum marks at the second viva-voce examination he will not be eligible for the award of the degree, unless the candidate is asked to revise and resubmit. If the candidate fails to secure minimum marks again, the project shall be summarily rejected.

9.0 Grades, Grade point Average, Cumulative Grade point Average:

9.1. Grade System: After all the components and sub-components of any subject (including laboratory subjects) are evaluated, the final total marks obtained will be converted to letter grades on a "10 point scale" described below.

% of marks obtained	Grade	Grade Points(GP)
90 to 100	A+	10
80 to 89	A	9
70 to 79	B	8
60 to 69	C	7
50 to 59	D	6
Less than 50 in sum of Int. and Ext. (or) Less than 40 in Ext.	F	0
Not Appeared	N	0

9.2. GPA: Grade Point Average (GPA) will be calculated as given below on a "10 Point scale" as an Index of the student's performance at the end of each semester:

$$\text{GPA} = \frac{\sum(CXGP)}{\sum C}$$

Where C denotes the credits assigned to the subjects undertaken in that semester and GP denotes the grade points earned by the student in the respective subjects

9.3. CGPA: At the end of every semester, a Cumulative Grade Point Average (CGPA) on a 10 Point scale is computed considering all the subjects passed up to that point as an index of overall Performance up to that Point as given below:

$$\text{CGPA} = \frac{\sum(CXGP)}{\sum C}$$

Where C denotes the credits assigned to subjects undertaken upto the end of the current semester and GP denotes the grade points earned by the student in the respective courses.

9.4. Grade sheet: A grade sheet (Marks Memorandum) will be issued to each student Indicating his performance in all subjects registered in that semester indicating the GPA and CGPA. GPA and CGPA will be rounded off to the second place of decimal.

9.5 Transcripts: After successful completion of the entire Program of study, a transcript containing performance of all semesters will be issued as a final record. Duplicate transcripts will also be issued, if required, after payment of requisite fee.

10.0 Award of Degree: The Degree will be conferred and awarded by Jawaharlal Nehru Technological University Anantapur, Anantapur on the recommendation of The Principal of SVCET (Autonomous).

10.1 Eligibility: A student shall be eligible for the award of M.Tech. Degree if he fulfills all the following conditions:

- Registered and successfully completed all the components prescribed in the program of study for which he is admitted.
- Successfully acquired the minimum required credits as specified in the curriculum corresponding to the specialization of study within the stipulated time.
- Obtained CGPA greater than or equal to 6.0 (Minimum requirement for declaring as passed.)

10.2 Award of Class: Declaration of Class is based on CGPA.

Cumulative Grade Point Average	Class
≥7.75	First Class with Distinction
≥6.75 and <7.75	First Class
≥6.0 and <6.75	Second Class

11.0 WITH – HOLDING OF RESULTS: If the candidate has not paid dues to the university or If any case of in-discipline is pending against him, the result of the candidate shall be withheld and he will not be allowed / promoted into the next higher semester. The issue of degree is liable to be withheld in such cases.

12.0 TRANSITORY REGULATIONS:

Candidates who have discontinued or have been detained for want of attendance or who have failed after having undergone the course in earlier regulations and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent subjects as and when subjects are offered, subject to 6.5 and 4.3 sections. Whereas they continue to be in the academic regulations of the batch they join later.

13.0 GENERAL:

- i. The academic regulations should be read as a whole for purpose of any interpretation.
- ii. Disciplinary action for Malpractice/improper conduct in examinations is appended.
- iii. Where the words "he", "him", "his", occur in the regulations, they include "she", "her", "hers".
- iv. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.
- v. The college may change or amend the academic regulations or syllabi at any time and the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the college.

Identification of Courses

M. Tech

Each course shall be uniquely identified by an alphanumeric code of width 7 characters as given below.

No. of digits	Description
First two digits	Year of regulations Ex:15
Next one letter	Type of program: A: B. Tech B: M. Tech C: M.B.A D: M.C.A
Next two letters	Code of program: ST: Structural Engineering, P.E: Power Electronics & Electric Drives, PS: Electrical Power Systems, CM: CAD/CAM, MD: Machine Design, VL: VLSI, DE: DECS, EM: Embedded Systems, CS: Computer Science and Engineering, CO: Computer Science, SE: Software Engineering,
Last two digits	Indicate serial numbers: ≥ 01

Ex:

15BST01

15BPE01

15BPS01

15BCM01

15BMD01

15BVL01

15BDE01

15BEM01

15BCS01

15BCO01

15BSE01

RULES FOR DISCIPLINARY ACTION FOR MALPRACTICE / 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 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 candidate 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/year. The Hall Ticket of the candidate is to be cancelled.

3.	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 to appear for the remaining examinations of the subjects of that Semester/year.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, 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 for the remaining examinations of the subjects of that Semester/year. 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.	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 for the remaining examinations of the subjects of that Semester/year. 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.
6.	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 for the remaining examinations of the subjects of that Semester/year. The candidate is also debarred and forfeits of seat.
7.	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 examinations of the remaining subjects of that semester/year. 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.

8.	<p>Refuses to obey the orders of the Chief Superintendent / Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, 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 or any of his relations, or indulges in any other act of misconduct or mischief which result 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.</p>	<p>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/year. 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.</p>
9.	<p>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 clause 6 to 8.</p>	<p>Student of the colleges 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/year. The candidate is also debarred and forfeits the seat.</p> <p>Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.</p>

10.	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 the performance in that subject.
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/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Examination committee for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.



SCHEME OF INSTRUCTIONS M.TECH (EPS) REGULAR TWO-YEAR DEGREE COURSES

I M.Tech, I Semester (EPS)

S.No	Course Code	Subject	Hours/ week			Credits	Scheme of Examination (Maximum Marks)		
			L	T	P		Internal	External	Total
1	15BPS01	Operation and Control of Inter-Connected Power Systems	3	1	-	4	40	60	100
2	15BPS02	Power System Control & Stability	3	1	-	4	40	60	100
3	15BPS03	Reactive Power Compensation and Management	3	1	-	4	40	60	100
4	15BPS04	Advanced Computer Methods in Power Systems	3	1	-	4	40	60	100
5		Elective - I	3	1	-	4	40	60	100
	15BPS05	Power System Deregulation							
	15BPS06	EHVAC Transmission							
	15BPS07	Optimization Techniques in Power Systems							
6		Elective - II	3	1	-	4	40	60	100
	15BPS08	Modeling and Analysis of HVDC Transmission Systems							
	15BPS09	State Estimation and its Applications							
	15BPE08	PIC Controllers and their applications							
7	15BPS10	Advanced Machines & Power Systems Lab	-	-	3	2	40	60	100
8	15BPS11	Power Systems Simulation Lab-I	-	-	3	2	40	60	100
9	15BPS12	Seminar – I	-	-	-	2	50	-	50
		Total	18	6	6	30	370	480	850



SCHEME OF INSTRUCTIONS M.TECH (EPS) REGULAR TWO-YEAR DEGREE COURSES

I M.Tech, II Semester (EPS)

S.No	Course Code	Subject	Hours/ week			Credits	Scheme of Examination (Maximum Marks)		
			L	T	P		Internal	External	Total
1	15BPS13	Distribution System Planning & Automation	3	1	-	4	40	60	100
2	15BPS14	Advanced Power System Protection	3	1	-	4	40	60	100
3	15BPS15	FACTS and Custom Power Devices	3	1	-	4	40	60	100
4	15BPS16	Real Time Control of Power Systems	3	1	-	4	40	60	100
5		Elective - III							
	15BPE21	Optimal Control Theory	3	1	-	4	40	60	100
	15BPS17	Power System Transients							
	15BPS18	Substation Engineering and Automation							
6		Elective - IV							
	15BPE17	Power Electronic Applications in Power Systems	3	1	-	4	40	60	100
	15BPS19	Intelligent Control of Power Systems							
	15BPS20	Smart Electric Grid Technology							
7	15BPS21	Power Systems Protection Lab	-	-	3	2	40	60	100
8	15BPS22	Power Systems Simulation Lab - II	-	-	3	2	40	60	100
9	15BPS23	Seminar - II	-	-	-	2	50	-	50
10	15BPS24	Comprehensive Viva - Voce	-	-	-	2	100	-	100
		Total	18	6	6	32	470	480	950

II M.Tech, III & IV Semester

S.No	Course Code	Subject	Hours/ week			Credits	Scheme of Examination (Maximum Marks)		
			L	T	P		Internal	External	Total
1	15BPS25	Project Work	-	-	-	12	120	180	300

SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I M.Tech, I Semester (EPS)

L T P C
3 1 - 4

15BPS01 OPERATION AND CONTROL OF INTER-CONNECTED POWER SYSTEMS

Objectives:

1. To Study economic dispatch and Unit commitment solution and hydrothermal scheduling problem by various methods.
2. To understand the load frequency control and economic dispatch control with different control techniques.
3. To know the concept of Economic interchange between interconnected utilities and power pools.
4. To understand the formulation of AC power flow, DC power flow and Orthogonal Decomposition estimation methods.

Outcomes:

After completion of this course the student will be able to:

1. Apply the concepts of economic dispatch and solve unit commitment problems with various constraints using conventional optimization techniques.
2. Solve AGC problems using heuristic techniques.
3. Acquire the knowledge in interchange of power & energy and power pools.
4. Analyze the formulation of AC & DC power flows and Orthogonal Decomposition estimation methods.

UNIT - I

ECONOMIC OPERATION & UNIT COMMITMENT: Introduction - Load forecasting - Economic dispatch problem - Gradient method - Newton's method - Unit Commitment - Optimal Unit Commitment - Constraints in unit commitment - Unit commitment Solution methods - Priority-List method - Dynamic Programming solution.

UNIT - II

HYDROTHERMAL CO-ORDINATION: Short-term hydrothermal scheduling problem - Short-term hydro-scheduling using Gradient approach - Hydro units in series - pumped storage hydro plants - Dynamic programming solution to hydrothermal scheduling problem - Hydro scheduling using Linear programming.

UNIT - III

AUTOMATIC GENERATION CONTROL (AGC): Review of Load Frequency Control and Economic Dispatch Control using the three modes of control viz. Flat frequency - Tie-line control and Tie-line bias control - AGC Features - Static and Dynamic response of Uncontrolled and Control two-area system.

UNIT - IV

INTERCHANGE OF POWER & ENERGY: Economic interchange between interconnected utilities - Interutility energy evaluation - Interchange evaluation with Unit commitment - Power Pools - Transmission effects and Issues: Limitations - Wheeling.

UNIT - V

POWER FLOW METHODS & ALGORITHMS: Formulation of AC Power Flow – Solution methods: Gauss Siedal, Newton Rapson and Decoupled Power flow methods – DC Power flow method - Maximum likelihood weighted least squares equation - Orthogonal Decomposition estimation method - Orthogonal Decomposition Algorithm.

Text Books:

1. Allen J.Wood and Wollen berg B.F: *Power Generation Operation and control*, 2nd Edition, John Wiley & Sons.
2. Nagrath, I.J. and Kothari D.P: *Modern Power System Analysis*, 3rd Edition, Tata McGraw-Hill, New Delhi.
3. O.I. Elgerd: "*Electric Energy System Theory - an Introduction*", Tata McGraw Hill, New Delhi, 2002.

References:

1. Kothari D.P. & J.S. Dhillon: *Power System Optimization*, Printice Hall of India, 2004
2. Chakrabarthy A., S.Halder: *Power System Analysis: Operation & Control*, PHI, 2006.
R.N.Dhar: *Computer Aided Power Systems Operation and Analysis*, Tata McGraw Hill, 1982.

I M.Tech, I Semester (EPS)

L T P C
3 1 - 4

15BPS02 POWER SYSTEM CONTROL AND STABILITY

Objectives:

1. To familiarize with Classical model of one machine connected to an infinite bus.
2. To know the state space model of one machine system connected to infinite bus and the supplementary stabilizing signals.
3. To Understand the Excitation system response to regulated power system.
4. To analyze the Lyapunov's stability theorems of non-linear systems using energy concept.

Outcomes:

After completion of this course the student will be able to:

1. Apply mathematical models of power system for dynamic studies.
2. Analyze the performance of single and multi-machine systems.
3. Design stabilizers for the power systems.
4. Apply Lyapunov's stability theorem and Zubov's & Popov's methods to analyze voltage stability in power system.

UNIT I

THE ELEMENTARY MATHEMATICAL MODEL& SYSTEM RESPONSE TO SMALL DISTURBANCES: A Classical model of one machine connected to an infinite bus – Classical model of multi machine system –Problems – Effect of the excitation system on Transient stability. The unregulated synchronous Machine – Effect of small changes of speed – modes of oscillation of an unregulated Multimachine system – regulated synchronous machine – voltage regulator with one time lag – Governor with one time lag – Problems.

UNIT II

DYNAMIC STABILITY: Concept of Dynamic stability – state space model of one machine system connected to infinite bus – effect of excitation on Dynamic stability – examination of dynamic stability by Routh's criterion.

UNIT III

POWER SYSTEM STABILIZERS: Introduction to supplementary stabilizing signals- Block diagram of the linear system- Approximate model of the complete exciter – generator system – Lead compensation – Stability aspect using Eigen value approach.

UNIT IV

EXCITATION SYSTEMS: Excitation system response – Non-continuously regulated systems – continuously regulated systems – Excitation system compensation – state space description of the excitation system- simplified linear model – effect of excitation on generator power limits. Type –2 system, rotating rectifier system, Type-3 system, Static with terminal potential and current supplies - Type –4 system: non – continuous acting - Block diagram representation – state space modeling equations of these types.

UNIT V

INTRODUCTION TO VOLTAGE STABILITY: What is voltage stability –Factors affecting voltage instability and collapse – Comparison of Angle and voltage stability – Analysis of voltage instability and collapse – Integrated analysis of voltage and Angle stability – Control of voltage instability.

Text Books:

1. P.M.Anderson, A.A.Fouad: "*Power System Control and Stability*", IOWA State University Press, Galgotia Publications, Vol-I, 1st Edition.
2. K.R.Padiyar: *Power System Dynamics (Stability & Control)*, 2nd Edition B.S.Publications, 2002.

References:

1. P.Kundur: *Power System stability and Control*, TMH Publications.
2. M.A.Pai, *Power System stability- Analysis by the direct method of lypunov*, N H – publications company

**SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

I M.Tech, I Semester (EPS)

**L T P C
3 1 - 4**

15BPS03 REACTIVE POWER COMPENSATION AND MANAGEMENT

Objectives:

1. To understand the objectives of load compensation and phase balancing of un-symmetrical loads.
2. To study the types of compensation techniques for steady state, reactive power compensation and concept of reactive power coordination.
3. To obtain the knowledge on reactive power & demand side management on distribution side.
4. To study the reactive power management on user side and electric traction systems.

Outcomes:

After completion of this course the student will be able to:

1. Analyze the load compensation in transmission systems.
2. Apply the reactive power planning and coordination.
3. Analyze the demand side management techniques.
4. Apply the electric traction concepts to electrical problems.

UNIT I

LOAD COMPENSATION: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

UNIT II

STEADY – STATE & TRANSIENT REACTIVE POWER COMPENSATIONS IN TRANSMISSION SYSTEMS: Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples, Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation, compensation using synchronous condensers – examples.

UNIT III

REACTIVE POWER COORDINATION: Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

UNIT-IV

DEMAND SIDE MANAGEMENT & REACTIVE POWER MANAGEMENT IN DISTRIBUTION SIDE: Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels - System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

UNIT V

REACTIVE POWER MANAGEMENT-USER SIDE & ELECTRICAL TRACTION SYSTEMS: KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations- Reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace.

Text Books:

1. T.J.E.Miller: *Reactive power control in Electric power systems*, John Wiley and sons, 1982.
2. Jyothi Prakash, *Demand Side Management*, TMH McGraw Hill.

References:

1. D.M.Tagare: *Reactive power Management*, Tata McGraw Hill,2004.

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15BPS04 ADVANCED COMPUTER METHODS IN POWER SYSTEMS

Objectives:

1. *To understand the formation of various network matrices by direct and singular transformation methods know the three phase network elements and Algorithm for formation of three phase bus impedance matrix.*
2. *To know various numerical methods applicable for power flow solutions.*
3. *To understand the concept of per unit system and evaluates solutions for Various LG, LL, LLG faults with and without Fault Impedance.*
4. *To study Load flow solutions using AI techniques such as ANN, FLC, NFC, GA and PSO.*

Outcomes:

After completion of this course the student will be able to:

1. *Apply the formation of Y_{Bus} Matrix and Z_{Bus} Matrix and their application in power systems.*
2. *Apply the Modifications in Bus Impedance Matrix for changes in the network solutions.*
3. *Analyze the solutions for load flow equations using different numerical methods.*
4. *Analyze the Short Circuit Current and MVA Calculations and understanding the power flow analysis with artificial intelligence techniques.*

UNIT-I

INCIDENCE AND NETWORK MATRICES: Graph Theory: Definitions, Incidence Matrices (A' , A , K , B , B' , C and C') – Primitive network – Formation of network matrices by Singular transformations - Formation of Y_{Bus} Matrix: Formation of Bus Admittance Matrix by Direct and Singular Transformation Methods – Numerical Problems - Formation of Z_{Bus} Matrix: Partial network – Algorithm for formation of Bus Impedance Matrix – Addition of a Branch, Addition of a Link and Modification of Bus Impedance Matrix for changes in the network (Derivations and Numerical Problems).

UNIT-II

THREE PHASE NETWORKS: Introduction – Three phase network elements – Algorithm for formation of three phase bus impedance matrix - Addition of a Branch, Addition of a Link and Modification of Bus Impedance Matrix for changes in the network (Derivations and Numerical Problems).

UNIT-III

POWER FLOW ANALYSIS: Gauss Seidel Method: Static load flow equations – Load flow solutions using Gauss Seidel Method with and without P-V buses, Algorithm and Flowchart - Numerical problems (Max. 4-Buses) - Determination of Bus Voltages - Injected Active and Reactive Powers - Line Flows/Losses - Newton Raphson Method: Load Flow Solution with and without PV Buses - Algorithm and Flow diagram - Sparsity techniques and applications - Decoupled and Fast Decoupled load flow methods – Flow diagram.

UNIT-IV

SHORT CIRCUIT ANALYSIS: Per unit System: Representation of Per Unit system – Per unit equivalent reactance network of a three phase Power System - Numerical Problems - Symmetrical Component Theory: Symmetrical Component Transformation, Positive, Negative and Zero sequence components - Voltages, Currents and Impedance representations - Sequence Networks: Positive, Negative and Zero sequence Networks - Numerical Problems - Symmetrical fault Analysis: Short Circuit Current and MVA Calculations - Fault levels - Numerical Problems - Unsymmetrical Fault Analysis: LG, LL, LLG faults with and without fault impedance - Numerical Problems.

UNIT-V

POWER FLOW ANALYSIS WITH ARTIFICIAL INTELLIGENCE TECHNIQUES:

Load flow solutions using Artificial intelligence techniques: ANN, FLC, NFC, GA and PSO.

TEXT BOOKS:

1. Stagg El – Abiad & Stags: *Computer Methods in Power Systems*, Mc Graw-hill.
2. Nagrath.I.J & Kothari.D.P: *Modern Power system Analysis*, 3rd edition, Tata McGraw-Hill Publishing Company.
3. K. Warwick, Arthur Ekwue, Raj Aggarwal: *Artificial Intelligence Techniques in Power Systems*, Institution of Electrical Engineers.

REFERENCE BOOKS:

1. L.P. Singh: *Advanced methods in power system analysis and dynamics*, Wiley Eastern.
2. Hadi Saadat: *Power system Analysis*, TMH, 2002.
3. Grainger and Stevenson: *Power System Analysis*, Tata McGraw Hill.
4. Pai.M.A: *Computer Techniques in Power System Analysis*, Second Edition, TMH.
5. Gupta.B.R: *Power System Analysis and Design*, S. Chand & Co, 2010.

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**15BPS05 POWER SYSTEM DEREGULATION
(ELECTIVE-I)**

Objectives:

1. *To introduce competitive market generation, Electricity demand and operation reliability assessment.*
2. *To know the distribution utilities and deregulation market for billing and planning .*
3. *To understand ancillary services and market regulation, power pool and renewable generation.*
4. *To know the transmission open access for operation and congestion management.*

Outcomes:

After completion of this course the student will be able to:

1. *Analyze the role of existing power industry, reconfiguration and operation reliability..*
2. *Analyze various types of market regulation and deregulation utilities.*
3. *To acquire knowledge in deregulation utilities and distribution of market.*
4. *To emphasize transmission open access and restructured PX and ISO system*

UNIT I

ENERGY GENERATION UNDER NEW ENVIRONMENT: Introduction-Competitive Market for Generation and advantages-The role of existing power industry: Reconfiguration and trends in conventional electricity generation-Electricity demand and operation reliability: Power plant and Reliability assessment.

UNIT II

DISTRIBUTED GENERATION AND RENEWABLE GENERATION: Market regulation-The power pool-Ancillary Services-Technical issues-Connection and use of system charges-Bio mass-Fuel cell-Wind-photo voltaic-solar.

UNIT III

DEREGULATION OF UTILITIES: Inroductiuon-Tradtional central utility model-Reform motivations-Separation of ownership and operations-competition and direct access in electricity market.

UNIT IV

DISTRIBUTION OF DEREGULATION MARKET: The development of competition: Responsibilities-key issues-use of system billing-customer service and billing-Maintaining distribution planning: Regulatory incentives-Technical issues and planning

UNIT V

TRANSMISSION OPEN ACCESS: Introduction-Components of Restructured systems-PX and ISO function and responsibilities-open transmission system operation and congestion management.

TEXT BOOKS:

1. Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & sons.
2. J. Wood and B. F. Wollenberg: Power generation, operation and control.
3. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder: Operation of restructured power systems.

REFERENCE BOOKS:

1. M. Shahidehpour, H. Yamin: Market operations in electric power systems.
2. S. Kirschen and G. Strbac: Fundamentals of power system economics.
3. N. S. Rau: Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry.

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**15BPS06 EHVAC TRANSMISSION
(ELECTIVE-I)**

Objectives:

1. To provide an in-depth understanding of different aspects of EHVAC transmission systems design and analysis.
2. To impart knowledge on effect of electrostatic fields and voltage gradients of transmission lines.
3. To understand the compensation techniques in a EHVAC transmission line.
4. To study the concept of generation of audible noise and corona , limitation of Radio Interference.

Outcomes:

After completion of the course the student will be able to:

1. Design commercial EHVAC transmission system.
2. Apply the concepts of electrostatic fields and voltage gradients in EHVAC transmission.
3. Apply compensation methods to control over voltages in EHV lines.
4. Understand the corona effects & losses, audible noise and Radio Interference.

UNIT I

E.H.V.A.C. TRANSMISSION: Trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters.

E.H.V.A.C Transmission Conductors: Bundle conductor systems inductance and capacitance of E.H.V. lines – positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

UNIT II

ELECTROSTATIC FIELD AND VOLTAGE GRADIENTS: calculations of electrostatic field of AC lines – effect of high electrostatic field on biological organisms and human beings surface voltage gradients and maximum gradients of actual transmission lines – voltage gradients on sub conductor.

Electrostatic Induction: Unenergised lines – measurements of field and voltage gradients for three phase single and double circuit lines.

UNIT III

POWER FREQUENCY VOLTAGE CONTROL AND OVER VOLTAGES IN EHV LINES: No load voltage – charging currents at power frequency - voltage control – shunt and series compensation – static VAR compensation.

UNIT IV

CORONA IN E.H.V. LINES: Corona loss formulae attenuation of traveling waves due to Corona – Audio noise due to Corona, its generation, characteristic and limits.

Measurements Of Audio Noise Radio Interference: Due to Corona RF properties of radio noise – frequency spectrum of RI fields – Measurements of RI and RIV.

UNIT V

DESIGN OF EHV LINES: Based on steady state and transient limits. EHV cables and their characteristics.

Text Books:

1. Rokosh Das Begamudre: *Extra High Voltage AC Transmission Engineering*, Wiley Eastern Ltd., New Delhi – 1987.

References:

1. EHV Transmission line reference Books - Edison Electric Institution (GEC 1968).

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**15BPS07 OPTIMIZATION TECHNIQUES IN POWER SYSTEMS
(ELECTIVE-I)**

Objectives:

1. *To know the classical optimization techniques for solving linear programming problem & unconstrained and constrained optimization techniques for solving Non-linear programming problem.*
2. *To understand the concept of sub optimization and multi stage decision problem.*
3. *To understand the fundamentals of Genetic Algorithm and solution of unconstrained and constrained optimization methods using GA.*
4. *To Familiarize Various Applications of Optimization Techniques in Power System*

Outcomes:

After completion of this course the student will be able to:

1. *Apply linear programming methods for and various optimization techniques solving the non-linear problems.*
2. *Apply principle of optimality and application of dynamic programming in solving non linear problems.*
3. *Analyze the Similarities and Differences between Gas and Traditional Methods.*
4. *Apply optimization techniques for the solution of optimal power flow problems.*

UNIT –I

INTRODUCTION TO OPTIMIZATION: Classical optimization techniques Linear programming; standard form, geometry of LPP, Simplex method of solving LPP, Revised simplex method, duality, decomposition principle, and transportation problem.

UNIT-II

NON LINEAR PROBLEM (NLP): One dimensional method, Elimination methods, Interpolation methods, unconstrained optimization techniques-Direct search and Descent methods, constrained optimization techniques, direct and indirect methods.

UNIT-III

DYNAMIC PROGRAMMING: Multi stage decision process, concept of sub optimization and principle of optimality, conversion of final value problem in to an initial value problem CPM and PERT.

UNIT-IV

INTRODUCTION TO GENETIC ALGORITHM & COMPUTATION USING GENETIC ALGORITHM: Introduction to genetic algorithm, working principle, coding of variables, fitness function, GA operators, similarities and differences between GAs and traditional methods, unconstrained and constrained optimization using genetic algorithm, real coded Gas, advanced Gas, global optimization using GA.

UNIT-V

APPLICATIONS TO POWER SYSTEM: Economic load dispatch in thermal and hydro-thermal system using GA and classical optimization techniques, unit commitment problem, Reactive power optimization, optimal power flow, LPP and NLP techniques to optimal power flow problems.

Text Books:

1. S.S .Rao: *Optimization theory and applications*, Wiley –Eastern Limited
2. D.E.Gold berg, Addison: *Genetic algorithm in search optimization and machine learning*, Wesley Publication, 1989.

References:

1. Polak: *Computational methods in optimization*, Academic Press.
2. Kalyanmoy Deb: *Optimization engineering design: Algorithms and examples*, PHI publications.
3. L.P. Singh: *Advanced power system analysis and dynamics*, Wiley Eastern limited.
4. David G. Luenberger: *Introduction to linear and non linear programming*, Wesley publishing company.

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**15BPS08 MODELLING AND ANALYSIS OF HVDC TRANSMISSION SYSTEMS
(ELECTIVE-II)**

Objectives:

1. *To study the analysis of HVDC converters, modeling and power flow analysis in AC/DC systems.*
2. *To study transient, dynamic stability and power modulation in MTDC system.*
3. *To study harmonics, torsional interactions and modeling of HVDC system digital dynamic simulation.*
4. *To study DC systems and transient simulation of DC and AC systems.*

Outcomes:

After completion of this course the student will be able to:

1. *Apply the key technology and system compensation in modern HVDC design.*
2. *Develop modeling and analysis of HVDC design.*
3. *Analyze of harmonics and basic of protection for HVDC system.*
4. *Develop dynamic and transient simulation of HVDC systems.*

UNIT I

ANALYSIS OF HVDC CONVERTERS: Pulse number – choice of converter configuration – simplified analysis of Graetz circuit – converter bridge characteristics – HVDC system control – Principles of DC link control – converter control characteristics – system control hierarchy – firing angle control – current and extinction angle control – starting and stopping of DC link power control.

UNIT II

COMPONENTS AND POWER FLOW ANALYSIS IN AC/DC SYSTEMS: General – converter model – converter control – modeling of DC network – modeling of AC Networks. Modeling of DC links – solution of DC load flows –per unit system for DC qualities – solution of AC/DC power flow.

UNIT III

TRANSIENT & DYNAMIC STABILITY: Introduction - Converter model – Converter control models – DC network models – solution methodology – Direct methods for stability Evaluation - Power modulation - Power modulation for damping low frequency oscillations – Basic principles – practical consideration in the application of power modulation controllers – Gamma or reactive power modulation – power modulation in MTDC system – voltage stability in AC/DC system.

UNIT IV

HARMONIC AND TORSIONAL INTERACTIONS: Harmonic Interactions – Torsion Interactions – Torsional interactions with in HVDC systems – counter measures to torsion interactions with DC systems, simulation of HVDC systems: System simulation – philosophy & Tools – HVDC system simulation – modeling of HVDC systems Digital dynamic simulation.

UNIT V

DIGITAL DYNAMIC SIMULATION OF CONVERTERS AND DC SYSTEMS: Valve model, Gate pulse generation – generation of control voltage – transformer model – converter model – transient simulation of DC and AC systems.

Text Books:

1. KR. Padiyar: "*HVDC power transmission systems – technology & system interaction*" WE limited 1990.

References:

1. S.Kamakshaiah, V.Kamaraju: "*HVDC Transmission*", TMH, 2011.
2. Kimbark.E.W: *Direct Current Transmission*, John Wiley & Sons.

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**15BPS09 STATE ESTIMATION & ITS APPLICATIONS
(ELECTIVE-II)**

Objectives:

1. To know introductory aspects of state estimation in power systems.
2. To Detect and identify bad measurements and study the power system security and contingency.
3. To study different Solutions for the optimum power flow operation.
4. To derive software for state estimation.

Outcomes:

After completion of this course the student will be able to:

1. Analyze the state estimation of AC Network in power system.
2. Analyze the application of power systems state estimation.
3. Apply various linear programming methods in power system.
4. Design an algorithm for state estimation.

UNIT-I

INTRODUCTION TO STATE ESTIMATION IN POWER SYSTEMS: Power system state estimation-Maximum likelihood concepts –Matrix formulation-Example of weighted least squares state Estimation. State Estimation of Ac Network: Development of method- Typical results of state estimation on AC network-State estimation by orthogonal decomposition-Algorithm.

UNIT-II

ADVANCED TOPICS IN STATE ESTIMATION: Detection and identification of bad measurements- Estimation of quantities not being measured- Network Observability and pseudo -measurements –application of power systems state estimation.

UNIT-III

POWER SYSTEM SECURITY AND CONTINGENCY ANALYSIS: Introduction-System state classification Factors affecting power system security-Contingency Analysis-Detection of network problems – An overview of security analysis-Linear sensitivity factors, AC power flow methods-Contingency selection – Concentric relaxation- Bounding-Power system voltage stability.

UNIT-IV

OPTIMUM POWER FLOW: Introduction-Solution of the optimum power flow-The Gradient method-Newton’s method-Linear sensitivity analysis- Sensitivity coefficients of an AC network model, Linear programming methods-Real Power variables only-AC power flow variables and detailed cost functions – Security constrained optimal power flow-Interior point algorithm.

UNIT-V

COMPUTER CONTROL OF POWER SYSTEMS: Evolution time scale of system control, online control, software for state estimation.

Text Books:

1. Allen J.Wood and B.F. Woolenderg: Power generation, Operation and control, 2nd Edition, Wiley India pvt.Ltd. 2006.
2. John J. Grainger and William D Stevenson: Power system analysis, 1st McGraw Hill ISE, 2003.
3. Special issue on computer control of power systems, IEEE Proc, July 1974.

References:

1. A. Monticelli: *State Estimation in Electric Power Systems: A Generalized Approach*, Kluwer academic Publisher.
2. DP Kothari and IJ Nagrath : *Modern power system analysis*, 3rd edition Tata McGraw Hill 2006

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**15BPE08 PIC CONTROLLERS & THEIR APPLICATIONS
(ELECTIVE – II)
(Common to PE& ED and EPS)**

Objectives:

1. To understand the review of basic models of 8-bit microcontrollers like MCS-51 and Atmel.
2. To know in detail the PIC microcontrollers.
3. To understand interface some of the peripheral devices with the microcontroller.
4. To study some Industrial applications of PIC Controllers.

Outcomes:

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

1. Distinguish between CISC and RISC processors
2. Design the concept of PIC Controllers and Flash microcontrollers
3. Implement the concept of connecting PIC controllers with various interfacing devices for several applications.
4. Utilize the knowledge of PIC controllers for various Industrial applications related with Electrical Engineering.

UNIT I

INTRODUCTION TO MICROCONTROLLERS: 8-bit & 16-bit microcontrollers – CISC and RISC processors – Harvard and Van Neumann architecture –MCS-51 Architecture –MCS-51 Instruction Set-Simple Programs-ATMEL Microcontroller(89CXX and 89C20XX)-Architectural Overview of ATMEL 89C51 and ATMEL 89C2051-PIN Description of 89C51and 89C2051

UNIT II

PIC CONTROLLERS: Overview and Features – PIC 16C6X/7X – FSR (File Selection Register) [Indirect Data memory Address Pointer]- PIC Reset actions – PIC Oscillator connections - PIC Memory organization - PIC 16C6X/7X Instructions - Addressing modes – I/O Ports – Interrupts in PIC 16C61/71 – PIC 16C61/71 Timers

UNIT III

PIC 16F8XX FLASH MICRO CONTROLLERS: Introduction - PIN diagram of 16F8XX –STATUS register – OPTION-REG register – Power control register – PIC 16F8XX Program memory – PIC 16F8XX Data memory, Data EEPROM and Flash program EEPROM - Interrupts in 16F877 – I/O Ports – Timers.

UNIT IV

INTERFACING AND MICROCONTROLLER APPLICATIONS: Introduction – Light Emitting Diodes (LEDs), Push buttons, Relays and Latch Connections - Key board interfacing – Interfacing 7-segment Displays – LCD Interfacing – ADC and DAC interfacing with 89C51 microcontrollers

UNIT V

INDUSTRIAL APPLICATIONS: Introduction – Measurement Applications – Sensing Robot Arm position – Linear Variable Differential Transformer (LVDT) – RPM meter – Digital Thermometer – Load cell. Automation and Control applications – Digital PID Controllers – Power controlling devices – Stepper motor drive

Text Books:

1. Ajay V Deshmukh: *Microcontrollers – Theory and Applications*, Mc Graw Hills.

References:

1. Kenneth J Aayala: *8051 Microcontrollers Architecture, Programing and Applications*, 2nd edition, Thomson Publishing
2. Prof C.R. Sarma: *Microprocessor and Microcontrollers*.
3. John B Peatman: *Design with PIC Microcontrollers*, Pearson Education Inc.

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15BPS10 ADVANCED MACHINES AND POWER SYSTEMS LAB

Objectives:

1. *To paraphrase the operational characteristics of synchronous machine.*
2. *To categorize losses in induction motor.*
3. *To analyze various faults in power system.*
4. *To understand the power flow in inter-connected system.*

Outcomes:

After completion of this course students will be able to

1. *Apply the synchronous machine characteristics for power system analysis.*
2. *Analyze the effect of fault during abnormal condition.*
3. *Analyze the no load losses of poly phase induction motor.*
4. *Analyze the performance of salient pole type synchronous machine.*

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted as compulsory experiments

1. Equivalent Circuit of a Three Winding Transformer
2. Separation of No-Load Losses in Three-Phase Squirrel Cage Induction Motor.
3. Determination of Sub transient Reactance of Salient Pole Synchronous Machine
4. Determination of Sequence Impedances of Cylindrical Rotor Synchronous Machine
5. Power Angle Characteristics of Salient Pole Synchronous Machine.
6. Parallel operation of 3- Φ transformer
7. Fault Analysis – I
 - (I) LG Fault
 - (II) LL Fault
8. Fault Analysis – II
 - (I) LLG Fault
 - (II) LLLG Fault
9. Sequence impedance of a 3- Φ Transformer
10. Solar/Wind/hybrid 1- Φ / 3- Φ generation trainers
11. Electrical power transmission line power simulator
12. SCADA based electrical power transmission line power simulator

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15BPS11 POWER SYSTEMS SIMULATION LAB - I

Objectives:

1. To understand the formation of bus admittance & impedance matrices for a power system network.
2. To study the different load flow algorithms.
3. To investigate the response of a two area power system for tie line deviations.
4. To design power system networks and study fault analysis.

Outcomes:

After Completion of this course students will be able to:

1. Design in formation of admittance and impedance matrices in MATLAB.
2. Apply the load flow solutions in power system analysis.
3. Analyze the transient stability problems in power systems using MATLAB.
4. Design the simulation diagrams in MATLAB/SIMULINK.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted as compulsory experiments

1. Formation of Z-Bus and Y-Bus
2. Load flow solution by Gauss Seidel method
3. Load flow solution by Newton Raphson method
4. Load flow solution by Fast Decoupled method
5. Simulation of Single Area power system
6. Simulation of Two Area power system
7. Simulation of Automatic Generation Control
8. Economic Dispatch Problem (EDP) in power systems
9. Characteristics of Equal area criterion
10. Swing equation by point by point method
11. Stability Analysis: single machine connected to an infinite bus system
12. Modeling and Computation of Transmission line parameters
13. Study of load frequency control problem of Controlled and Uncontrolled Cases
14. Short circuit analysis by symmetrical and unsymmetrical fault analysis

Software Tools: **MATLAB and SIMULINK**

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15BPS12 SEMINAR - I

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15BPS13 DISTRIBUTION SYSTEM PLANNING & AUTOMATION

Objectives:

1. *To know overview of system planning and fault studies.*
2. *To understand the concept of load forecasting and different types of forecasting.*
3. *To study sub transmission system and distribution transformers.*
4. *To understand grounding system and planning of distribution system automation.*

Outcomes:

After completion of this course the student will be able to:

1. *Design the distribution system planning in power system.*
2. *Analyze the load forecasting and regulate the model.*
3. *Gain the knowledge of sub transmission system and distribution transformers.*
4. *Design planning of system earthing and planning of distribution system automation.*

UNIT-I

SYSTEM PLANNING : Planning process- Planning criteria and Standards- System development-Dispersed generation-Distribution system Economics and Finance-Mapping-Enterprise Resource Planning(ERP)-Modelling-System calculations- Introductory Methods-Load flow- Automated Planning- Fault studies- Effect of Abnormal Loads- Line circuits-Urban distribution-Out sourcing.

UNIT-II

LOAD FORECASTING: Load characteristics -Load forecasting-Definitions of Basic concepts in statistics-Regression analysis-Correlation theory- Analysis of Time series- Factors in power system loading-Unloading the system. Forecast of system peak -Strategic fore casting-Spatial load fore casting- Technological fore casting- Sources of Error: Regulating the model.

UNIT-III

SUB TRANSMISSION SYSTEMS AND TARIFFS: Sub transmission lines-distribution substations-Bus schemes Substation location and rating- Primary systems -Voltage drop and power loss calculations, Different types of tariffs.

UNIT-IV

DISTRIBUTION TRANSFORMERS AND GROUNDING SYSTEM: Three phase and single phase transformers-Connections, Dry type and self protected type transformers-Regulation and efficiency, Grounding system- Earth and safety- Nature of an earth electrode system-Earth conductor sizes-Design of Earthing Electrodes-System Earthing-Earth Testing

UNIT-V

DISTRIBUTION SYSTEM AUTOMATION: Distribution automation-Project planning - Definitions-Communication-Sensors-supervisory Control and Data Acquisition (SCADA)- Consumer information service(CIS)-Geographical Information system (GIS)-Automatic meter reading (AMR).

Text Books:

1. Turan Gonen: *Electric power distribution system Engineering*, 2nd edition, BS publications,2007.
2. Pabla A.S: *Electric power distribution systems*, 4th Edition, TMH,2006

References:

1. J.N.Green, R.Wilson: *Control and Automation of Electrical Power Distribution Systems*, Taylor and Francis Group.
2. Dr.M.K.Khedkar, Dr.G.M.Dhole: *A Textbook of Electrical Power Distribution Automation*, Lakshmi Publication.

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15BPS14 ADVANCED POWER SYSTEM PROTECTION

Objectives:

1. *To know construction of static relays and the operation of amplitude and phase comparators*
2. *To understand the concepts of Static over current, static differential and static distance relays.*
3. *To understand multiinput comparators and concept of power swings on the distance relays.*
4. *To know the operation of microprocessor based protective relays.*

Outcomes:

After Completion of this course students will be able to:

1. *Analyze the operation of static relays and the advantages of static relay over electromagnetic relay.*
2. *Apply rectifier bridge comparators, instantaneous comparators, phase comparators in power system protection.*
3. *Use the concepts of static differential and distance relay in power system protection and multi input comparators.*
4. *Analyze the concept of power swings on distance relay in power system protection and to identify the microprocessor based protective relays and their operation.*

UNIT I

STATIC RELAYS: Advantages of static relays- Basic construction of static relays – Level detectors – Replica impedance-mixing circuits-general equation for two input phase and amplitude comparators –Duality between amplitude and phase comparator.

UNIT II

AMPLITUDE COMPARATORS: Circulating current type and opposed voltage type rectifier bridge comparators –Direct and Instantaneous comparators.
phase comparators, coincidence circuit type block spike phase comparator, techniques to measure the period of coincidence – Integrating type– Rectifier and vector product type phase comparators.
Multi –Input Comparators - Conic section characteristics – Three input amplitude comparator – Hybrid comparator – switched distance schemes –Polyphase distance schemes-Phase fault scheme –Three phase scheme – combined and ground fault scheme.

UNIT III

STATIC OVER CURRENT AND DIFFERENTIAL RELAYS: Introduction-Instantaneous over current relay – Time over current relays-basic principles-Definite time and Inverse definite time over current relays - Analysis of static differential relays – static relay schemes –Duo bias transformer differential protection – Harmonic restraint relay. Static distance Relays: Static impedance –reactance-MHO and angle impedance relay sampling comparator–realization of reactance and MHO relay using a sampling comparator

UNIT IV

POWER SWINGS: Effect of power swings on the performance of Distance relays- Power swing analysis – Principle of out of step tripping and blocking relays – effect of line length and source impedance on distance relays.

UNIT V

MICROPROCESSOR BASED PROTECTIVE RELAYS: Over current relays – impedance relays – directional relay – reactance relay (Block diagram and flow chart approach only) - Generalized mathematical expression for distance relays - measurement of resistance and reactance – MHO and offset MHO relays –Realization of MHO characteristics – Realization of offset MHO characteristics (Block diagram and flow chart approach only) Basic principle of Digital computer relaying.

Text Books:

1. T.S.Madhava Rao, "Power system Protection static relay", Tata McGraw Hill Publishing company limited , second edition,1989
2. Badri Ram and D.N.Vishwakarma, " Power system Protection and Switchgear ", Tata McGraw Hill Publication company limited First Edition -1995

References:

1. Y.G. Pythankar- Advanced Power System Protection

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15BPS15 FACTS AND CUSTOM POWER DEVICES

Objectives:

1. To acquire knowledge on FACTS concepts and application of custom power devices.
2. To understand different types of controllers using FACTS devices and multilevel inverters.
3. To understand Custom power devices to instigate harmonics, voltage sag, voltage swell etc.
4. To learn the reactive power compensation by using different types of FACTS controllers.

Outcomes:

After completion of this course the student will be able to:

1. Analyze the power flow in AC system and types of FACTS controllers.
2. analyze the multi-level inverters like cascade type multi-level inverters and current control inverters.
3. Apply shunt, series and shunt-series type compensation, custom power devices, D-STATCOM, DVR and UPQC.
4. Acquire knowledge in Power quality issues which is related to power distribution systems for improving power quality.

UNIT I

FACTS CONCEPT AND GENERAL SYSTEM CONSIDERATION: Transmission Interconnection – Flow of Power in an AC System – Power flow and dynamic stability considerations – Relative importance of controllable parameters – Basic types of FACTS controllers – Brief description and definitions of FACTS Controllers – Check list of Possible benefits from FACTS Technology.

UNIT II

CONVERTERS FOR STATIC COMPENSATION: Three phase converters and standard modulation strategies (Programmed Harmonic Elimination and SPWM) - GTO Inverters - Multi-Pulse Converters and Interface Magnetics - Transformer Connections for 12, 24 and 48 pulse operation.

Multi-level inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) - Multi-level inverters of Cascade Type and their modulation - Current Control of Inverters.

UNIT III

STATIC SHUNT AND SERIES COMPENSATORS: Static Shunt Compensators - SVC and STATCOM - operation and control of TSC, TCR, STATCOM - Compensator Control - Comparison between SVC and STATCOM - STATCOM for transient and dynamic stability enhancement - Static Series Compensation- GCSC, TSSC, TCSC and SSSC - operation and control - external system control for series compensators - SSR and its damping - static voltage and phase angle regulators - TCVR and TCPAR - operation and control.

UNIT IV

UPFC AND IPFC: The Unified Power Flow Controller - operation, comparison with other FACTS devices - control of P and Q - dynamic performance - Special Purpose FACTS Controllers - Interline Power Flow Controller - operation and control.

UNIT V

POWER QUALITY AND INTRODUCTION TO CUSTOM POWER DEVICES: Power Quality issues related to distribution systems-Custom power devices – Distribution STATCOM – Dynamic Voltage restorer – Unified Power Quality Conditioner Application of D-STATCOM, DVR and UPQC for improving power quality in distribution systems.

Text Books:

1. N.G. Hingorani & L. Gyugyi: *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*.
2. K. R. Padiyar: *FACTS Controllers in Power Transmission and Distribution*, NewAge International Publishers.

References:

1. T.J.E Miller: *Reactive Power Control in Electric Systems*, John Wiley & Sons.
2. Ned Mohan: *Power Electronics*, John Wiley and Sons.
3. Dr Ashok S & Suresh K S Kumar: "*FACTS Controllers and applications*", course book for STTP, 2003.

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15BPS16 REAL TIME CONTROL OF POWER SYSTEMS

Objectives:

1. *To know about different types of state estimations and bad data detections.*
2. *To understand the security analysis and monitoring, Contingency Analysis using iterative linear power flow methods.*
3. *To gain the knowledge of real time control of power systems and software requirements.*
4. *To understand different artificial intelligence techniques in power systems.*

Outcomes:

After completion of this course the student will be able to:

1. *Apply the concepts of state estimation and bad data detection in power system.*
2. *Analyze the security and contingency analysis.*
3. *Design of real time control of power systems and SCADA implementation.*
4. *Apply different types of intelligence techniques in power systems.*

UNIT-I

STATE ESTIMATION & BAD DATA OBSERVABILITY: Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements - Bad data detection, identification and elimination.

UNIT-II

SECURITY AND CONTINGENCY EVALUATION: Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

UNIT-III

COMPUTER CONTROL OF POWER SYSTEMS: Need for real time and computer control of power systems - operating states of a power system.

UNIT-IV

SCADA: Supervisory Control And Data Acquisition (SCADA) systems – SCADA systems implementation considerations - energy control centers - software requirements for implementing the above functions.

UNIT-V

APPLICATION OF AI AND ANN IN POWER SYSTEM: Basic concepts and definitions - algorithms for load flow - short term load forecasting - fault diagnosis and state estimation.

Text Books:

1. John J.Grainger and William D.Stevenson, Jr.: *Power System Analysis*, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg: *Power Generation operation and control*, John Wiley & Sons, 1984
3. R.N.Dhar: *Computer Aided Power Systems Operation and Analysis*, Tata McGraw Hill, 1982.

References :

1. L.P.Singh: *Advanced Power System Analysis and Dynamics*, Wiley Eastern Ltd.
2. Prabha Kundur: *Power System Stability and Control*, McGraw Hill, 1994
3. P.D.Wasserman: *Neural Computing : Theory and Practice*, Van Nostrand Reinhold, New York.

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**15BPE21 OPTIMAL CONTROL THEORY
(ELECTIVE-III)
(Common to PE& ED and EPS)**

Objectives:

1. To define the optimal control problems, Mathematical model of a process including physical constraints and know the introductory aspects of optimal control theory.
2. To Know the fundamental concept of calculus of variation and usefulness of Euler's equation for fixed end and free end point problems.
3. To study the usefulness of Hamaltonian function and Pontryagin's minimum principle to solve optimal control problem using variational approach.
4. To understand the concept of Dynamic programming and know the computational procedure for solving optimal control problems.

Outcomes:

After completion of this course the student will be able to:

1. Select the performance measure and for typical different control problem apply principle of controllability and observability in solving linear system.
2. Apply Euler's equation for solving optimal control problems having functional of single function and functional involving several independent functions.
3. Solve several optimal control problems using Hamaltonian function and Pontryagin's minimum principle.
4. Apply Dynamic programming to solve nonlinear problems.

UNIT I

INTRODUCTION: The Mathematical Model of a Process, Physical Constraints. The Performance Measure , the Optimal Control Problem , Forms of the Optimal Control, State Variable Representation of System – System Classification and Output Equations , Solution of State Equation – Linear Systems, Typical Control Problems, Selection of Performance Measure , Controllability and Observability.

UNIT II

THE CALCULUS OF VARIATIONS – I: Fundamental Concepts, Maxima and Minima of Functions, Fundamental Theorem of Calculus of Variations. Functional of Single Function, The Simplest Variation Problem- Euler's Equation, Fixed End Point Problem- Free End Point Problem.

UNIT III

THE CALCULUS OF VARIATIONS – II: Functional Involving Several Independent Functions – Problem with Fixed End Points – Problems with Free End Points, Constrained Extrema- Constrained Minimization of Function and Functional.

UNIT IV

VARIATIONAL APPROACH TO OPTIMAL CONTROL PROBLEMS: Necessary Conditions for Optimal Control Hamaltonian Function- Boundary Conditions in Optimal Control Problems – Linear Regulator Problems – Matrix Riccati Equation – Linear Tracking Problem.

PONTRYAGIN'S MINIMUM PRINCIPLE: State un Equality Constraints – Minimum Time Problem- Minimum Control Effort Problem- Minimum Fuel Problem – Minimum Energy Problem.

UNIT V

DYNAMIC PROGRAMMING: The Optimal Control Law, The principal of Optimality, Dynamic Programming applied to Routing Problems, An Optimal Control Systems-A recurrence Relation of Dynamic Programming – Computational Procedure for Solving Optimal Control Problems – Discrete Linear Regulator Problems, Hamilton – Jacobian- Bellman Equation- Continuous Linear Regulator Problems.

NUMERICAL DETERMINATION OF OPTIMAL TRAJECTORIES: Two-Point Boundary-Value Problem- Method of Steepest Descent –Steepest Descent Algorithm.

Text Books:

1. Donald E. Krik: *Optimal Control Theory*, Library of Congress Cataloging in Publication Data.
2. M.Gopal: *Modern Control Systems Theory*, New age International Publishers, 5th Edition, 1984

References:

1. A.P.Sage: *Optimal System Control*, Pearson Education Canada, 1977.
2. Ogata: *Modern Control Systems Theory*, Prentice Hall, 2010.

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**15BPS17 POWER SYSTEM TRANSIENTS
(ELECTIVE-III)**

Objectives:

1. To analyze the electrical transients in power systems.
2. To impart the concepts of traveling waves and propagation.
3. To discuss issues related to insulation coordination, grounding and limiting of surge effects.
4. To develop the techniques related to transition points in transmission lines and cables.

Outcomes:

After completion of this course the student will be able to:

1. Analyze the electrical transients in power systems.
2. To design protective systems against over voltage.
3. Design protective systems in substations.
4. Develop the techniques related to transition points in transmission lines and cables.

UNIT I

INTRODUCTION TO TRANSIENTS: Travelling waves on transmission lines – Wave Equation – surge impedance and wave velocity – Specification of Travelling waves - Reflection and Refraction of waves – Typical cases of line terminations – Forked line – Reactive termination - Successive reflections – Bewley Lattice Diagrams – Attenuation and Distortion.

UNIT II

OVERVOLTAGES-I: Lightning, Physical phenomena of lightning – Interaction between lightning and power system – Factors contributing to line design – Switching: Short line or kilometric fault

UNIT III

OVER VOLTAGES-II: Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault – Very Fast Transient Overvoltage (VFTO).

UNIT IV

PROTECTION OF TRANSMISSION LINES & SUBSTATIONS AGAINST SURGES: Transmission line insulation and performance – Ground wires – Protective angle – Tower footing resistance – Driven rods – Counterpoise – Protector tube - Protection Of Substation Against Surges: Substation protection – surge diverters – Selection of arrester rating – Location of arresters – Influence of additional lines – Effect of short length of cable – Surge capacitor, surge reactor and surge absorber – Shielding substation with ground wires – Protection of rotating machines.

UNIT V

INSULATION CO-ORDINATION: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS), insulation level, statistical approach. Insulation Coordination: co-ordination between insulation and protection level – overvoltage protective devices – lightning arresters, substation earthing.

Text Books:

1. Gupta.B.R, *Power System Analysis and Design*, S.Chand Publications 2004
2. Thapar.B, Gupta.B.R and Khera.L.K, "*Power System Transients and High Voltage Principles*", Mohindra Capital Publishers
3. Allan Greenwood, *Electrical Transients in Power System*, Wiley & Sons Inc. New York, 1991.

References :

1. Klaus Ragaller, *Surges in High Voltage Networks*, Plenum Press, New York, 1980.
2. Rakosh Das Begamudre, *Extra High Voltage AC Transmission*
3. *Engineering*, (Second edition) Newage International (P) Ltd., New Delhi, 1990.
4. Naidu M S and Kamaraju V, *High Voltage Engineering*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
5. Indulkr, *Transients in Power Systems*, PHI Publications.

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**15BPS18 SUBSTATION ENGINEERING & AUTOMATION
(ELECTIVE-III)**

Objectives:

1. To know types of sub-transmission systems and understand the design of substation construction.
2. To discuss the classification of substations and study the Basic elements of SCADA implementation in substation automation.
3. To know the Substation grounding and understand.
4. To understand the substation fire protection and communications.

Outcomes:

After completion of this course the student will be able to:

1. Sketch the layout and design of substation.
2. Implementation SCADA for substation monitoring.
3. Designing lightning and grounding of substations.
4. Apply the protective schemes in substation.

UNIT-I

INTRODUCTION TO SUB-TRANSMISSION SYSTEM AND SUBSTATION: Introduction to sub transmission systems-types-radial type sub transmission system, Ring-main type, Grid or network, design criteria and standard- operation criterion - standards of-Designing substation construction and commissioning process selection of substation, location of site for the substations

UNIT-II

CLASSIFICATION OF SUBSTATIONS: Classification of substation, Air-insulated substation (AIS), Gas-Insulated substations, Distribution substation, feeder system-primary systems-secondary systems

UNIT-III

SUBSTATION AUTOMATION & SCADA IMPLEMENTATION: High voltage power electronic substations, interface between automation and substation, substation integration and automation, Basic elements of SCADA implementation in substation state monitoring

UNIT-IV

SUBSTATION GROUNDING: Substation grounding and design criteria, lightning, grounding techniques for substations.

UNIT-V: PROTECTION OF SUBSTATIONS: Substation fire protection and communications, Key diagrams of substation

TEXT BOOKS:

1. Electric power substations engineering , John.D.Mc Donald ,3rd edition ,CRC Press Taylor and Francis Group
2. Substation structure design guide, Leon Kempner, ACE publications

REFERENCE BOOKS:

1. Electric power distribution, AS pabla, 5th edition Tata Mc Graw Hill education Pvt. Ltd

15BPE17 POWER ELECTRONIC APPLICATIONS IN POWER SYSTEMS

(Common to PE&ED and EPS)

(ELECTIVE-IV)

Objectives:

1. *To acquire requisite knowledge on basic concepts of voltage regulation and power factor correction and stability aspects of Transmission lines.*
2. *To understand the different methods of employing commutation .*
3. *To analyze harmonic control, power factor improvement in different types of converters and to know working principles of various voltage regulators.*
4. *To gain adequate knowledge on switched mode power supply and to analyze HVDC converters and its control characteristics.*

Outcomes:

After completion of this course student will be able to:

1. *Analyze the Transmission lines with Unsymmetrical loads with and without compensation.*
2. *Apply the compensation techniques in the analysis of transmission lines.*
3. *Apply the compensation techniques in varied and harmonics can be controlled by using different types of Converters.*
4. *Design Switched mode power supplies, the thyristor converter used in HVDC Transmission including its control characteristics.*

UNIT-I

LOAD COMPENSATION IN POWER SYSTEMS AND UNCOMPENSATED TRANSMISSION LINES:

Introduction – Voltage Regulation – Power Factor Correction – Phase Balancing and power Factor Correction of Unsymmetrical Loads - Uncompensated electrical parameters - Transmission line equation-Solution of transmission line wave equation - Surge impedance and natural loading – Uncompensated on open circuit-voltage and current profile - Uncompensated under load conditions- stability consideration-effect of generator reactance.

UNIT-II

STATIC COMPENSATION CONTROL AND COMMUTATION METHODS FOR CONTROLLED CONVERTERS:

Shunt – Series Compensation, Compensation by Sectioning – Property of Static Compensation – Thyristor Controlled Reactor (TCR) – Thyristor Switched Capacitor – Saturated Reactor Compensators. Methods of employing natural commutation – Methods of employing forced commutation and implementation of forced commutation.

UNIT-III

HARMONICS CONTROL & POWER FACTOR IMPROVEMENT AND VOLTAGE REGULATORS:

Reactive Power Variation for Fully Controlled Converter – Half Controlled Converter – Fully Controlled Converter with controlled freewheeling. Introduction to voltage regulators – Manually Controlled voltage regulator (Conventional methods) - Static tap changer using Thyristors – Different control schemes.

UNIT-IV

SWITCHED MODE POWER SUPPLY (SMPS): Introduction to Switched Mode Power Supply (SMPS) – Switched mode DC power supply – Fly back converter- Forward converter-Push pull Converter-Resonant DC power supply- Switched mode AC Power supply-Resonant AC Power supply-Bidirectional power Supply.

UNIT-V

HIGH VOLTAGE DC TRANSMISSION: Analysis of HVDC Converters: Pulse number – Choice of converter configuration – Simplified analysis of Graetz circuit – Converter bridge characteristics. Converted and HVDC system control : Principles of DC link control – Converter control characteristics – System control hierarchy – firing control – current and extinction angle control – starting and stopping of DC link power control.

Text Books:

1. Miller.T.J.E, *Reactive Power Control in Electric Systems*, Wiley-Interscience, New York, 1982.
2. G.K.Dubey, *Thyristorised power controllers*, New Age International Publishers, 1st Edition.
3. KR. Padiyar: *HVDC power transmission systems – Technology & system interaction*, published by WE limited, 1990.

References:

1. P.C.Sen, *Power Electronics*, Tata Mc Graw Hill, 2008.
2. M.H.Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education India, 3rd Edition.
3. Dr.P.S.Bimbhra, *Power Electronics*, Khanna Publishers, 3rd Edition, 2003.

15BPS19 INTELLIGENT CONTROL OF POWER SYSTEMS

(ELECTIVE-IV)

Objectives:

1. *To develop the artificial neural networks models*
2. *To know the concept of genetic algorithms using MATLAB*
3. *To study the operation and reasoning of fuzzy logic system*
4. *To develop the neural network ,fuzzy logic controller based power system solutions*

Outcomes:

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

1. *Apply the concept of about ANN models.*
2. *Design the genetic algorithms using MATLAB.*
3. *Emphasize the fuzzy logic controller using MATLAB.*
4. *Analyze the application of artificial neural network and fuzzy logic controller in power systems.*

UNIT I

INTRODUCTION: Approaches to intelligent control - Architecture for intelligent control - Symbolic reasoning system – rule based systems - AI approach - Knowledge representation - Expert systems.

UNIT II

ARTIFICIAL NEURAL NETWORKS: Concept of Artificial Neural Networks and its basic mathematical model – McCulloch Pitts neuron model - simple perceptron - Adeline and Madeline - Feed-forward Multilayer Perceptron - Learning and Training the neural network - Principal - Component analysis and wavelet transformations - Design of logic using all algorithms - Neural Network based controller with any application.

UNIT III

GENETIC ALGORITHM: Concept of Genetic algorithm and detail algorithmic steps - Genetic operators - Solution of typical control problems using genetic algorithm-Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems -Case studies: Speed control of Induction motor using MATLAB - Neural Network toolbox - simple feed-forward network programs.

UNIT IV

FUZZY LOGIC SYSTEM: Introduction to crisp sets and fuzzy sets - basic fuzzy set operation and approximate reasoning - Introduction to fuzzy logic modeling and control – Fuzzification inferencing Defuzzification - Fuzzy knowledge and rule bases - Fuzzy modeling and control schemes for nonlinear systems - Self-organizing fuzzy logic control - Implementation of fuzzy logic controller using MATLAB fuzzy-logic toolbox -Stability analysis of fuzzy control systems.

UNIT V

APPLICATION OF AI IN POWER SYSTEMS: Power flow analysis using fuzzy logic- Load forecasting using neural networks- Economic dispatch using genetic algorithm

Text Books:

1. S.N.Sivanandam, S.Sumathi and S.N.Deepa:"*Introduction to Neural Networks using MATLAB 6.0*", Mc Graw Hill Publishing companies Limited, 3rd Edition 2008.
2. Computational intelligence Applications to power systems, Yong-uasong, Allan Johns & Raj Agarwal, Science Press Kluwer Academic Publishers
3. Loi LEI Lai, Intelligence System Application in Power Engineering, Wiley, July 1998

References:

1. Simopn S.Haykin:"*Neural Networks: A Comprehensive Foundation*", Macmillan, 1994.
2. S.Rajasekaran, G.A.Vijayalakshmi Pai:"*Neural Networks, Fuzzy Logic & Genetic Algorithms: Synthesis & Applications*", PHI, 3rd Edition 2007.
3. Artificial Intelligence Techniques in Power Systems by K. Warwick, Arthur Ekwue, Raj Agarwal, Institution of Electrical Engineers

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**15BPS20 SMART ELECTRIC GRID TECHNOLOGY
(ELECTIVE-IV)**

Objectives:

1. To know the evaluation of the electric grid, the smart grid concept and distributed Energy Resources.
2. To Introduce various smart grid technologies like smart meters, smart substation etc.
3. To understand the concept of micro grid control, applications of micro grid and power quality issues.
4. To Introduce the Applications of Information Technology & Communication Technology for Smart Grid Operation and Control.

Outcomes:

After completion of this course the student will be able to:

1. Analyze the Difference between conventional grid & smart grid.
2. Design various Smart Substations and their Automation and also the protection & control of micro grid.
3. Emphasize the power quality conditioners for smart grid, web based power quality monitoring and power quality audit.
4. Desing AMI, HAN, NAN, WAN, Bluetooth, Zig-Bee, GPRS, Wi-Fi, CLOUD Computing and BPL.

UNIT-I

INTRODUCTION TO SMART GRID & DISTRIBUTED ENERGY RESOURCES: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid, CDM opportunities in Smart Grid, Distributed Energy Resources: Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.

UNIT-II

SMART GRID TECHNOLOGIES: Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers, Smart Substations, Substation Automation, Feeder Automation, Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT-III

MICRO GRIDS: Concept of micro grid, need & applications of micro grid, formation of micro grid, issues of interconnection, protection & control of micro grid.

UNIT-IV

POWER QUALITY MANAGEMENT IN SMART GRID: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT-V

INFORMATION TECHNOLOGY& COMMUNICATION TECHNOLOGY FOR SMART GRID: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN),Bluetooth, Zig-Bee, GPRS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL), IP based protocols.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press JanakaEkanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama," Smart Grid: Technology and Applications", Wiley

References:

1. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell
2. Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc. (ISBN: 978-1-59749-570-7)
3. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities"

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15BPS21 POWER SYSTEMS PROTECTION LAB

Objectives:

1. *To analyze the performance of relays.*
2. *To study the performance of electro mechanical type relay.*
3. *To study the performance of micro controller based type relay.*
4. *To analyze the protection of transformer, generator through microcontroller based type relay/electro mechanical type relays*

Outcomes:

After Completion of this course students will be able to:

1. *Gain the knowledge in characteristic of various relays.*
2. *Acquire the knowledge of protection of transformer*
3. *Acquire the knowledge of protection of generator*

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted as compulsory experiments

1. Characteristics of Static Negative Sequence Relay
2. Determination of dielectric strength of oil and air.
3. Micro controller based earth fault relay.
4. Differential Protection of Transformer.
5. Electro mechanical type 3- Φ over current relay
6. Directional over current relay
7. Electro mechanical type over voltage relay
8. Electro mechanical type under voltage relay
9. Performance of Buchholz Relay.
10. Micro controller directional over current relay
11. Micro controller based 3- Φ differential relay
12. Electro mechanical type generator protection system
13. Micro controller based under/over voltage relay

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15BPS22 POWER SYSTEMS SIMULATION LAB - II

Objectives:

1. To analyze different types of faults, determination of voltage distribution and string efficiency.
2. To estimate tie-line power deviation and characteristics of relays.
3. To obtain reactive power compensation at different points.
4. To design parameters of wind energy farm.

Outcomes:

After Completion of this course students will be able to:

1. Analyze power system faults and obtain voltage distribution etc.
2. Analyze the tie-line power deviation and characteristics of relays.
3. Acquire reactive power compensation at different points.
4. Design parameters of wind energy farm in MATLAB/SIMULINK.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted as compulsory experiments

1. Fault analysis of 3- \emptyset alternator –LG, LL, LLG, LLLG faults.
2. Determination of voltage distribution and string efficiency in series connected insulator.
3. Step response of two area system with integral control of estimation of tie line power deviation.
4. Characteristics of over current relay, directional relay and non directional relay
5. Analysis of short circuit, over current and over voltage faults in over head transmission line.
6. Harmonic analysis and filter design in transmission line.
7. Power flow analysis using fuzzy logic.
8. Load forecasting using neural networks.
9. System dynamic transient stability and fault analysis in transmission line.
10. Determination of reactive power compensation using super conducting fault current limiter located at different points.
11. Design parameters of wind energy farm.
12. Step response of two area system with integral control of estimation of tie line frequency deviation.
13. Economic dispatch using genetic algorithm.

Software Tools: **SKM**

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15BPS23 SEMINAR - II

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15BPS24 COMPREHENSIVE VIVA-VOCE

**SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

II M.Tech, III & IV Semester (EPS)

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15BPS25 PROJECT WORK