ACADEMIC REGULATIONS

Applicable for students admitted into M.Tech. Programme from 2017-18

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

1. 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 qualifying candidates at an Entrance Test conducted by the University or on the basis of GATE/PGECET score, subject to reservations or policies framed by the Government of Andhra Pradesh policies from time to time.

2. 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 PGECET/GATE score.

b) Category-B seats are to be filled by Management as per the norms stipulated by Government of A. P.

3. SPECIALIZATION:

The following specializations are offered at present for the M.Tech. programme.

Sl. No.	**Specialization**
1.	CAD/CAM
2	Machine Design
2.	Digital Electronics and Communication Systems
3.	Embedded Systems
4.	VLSI System Design
5.	Computer Science and Engineering
6.	Electrical Power Engineering
7.	Electrical Power Systems
8	Structural Engineering

and any other specialization as approved by the concerned authorities from time to time.

4. COURSE WORK:

4.1. A Candidate after securing admission must pursue the M. Tech. programme of study for four semesters duration.

4.2. Each semester shall be of 20 weeks duration including all examinations.

4.3. A candidate admitted in to the programme should complete it within a period equal to twice the prescribed duration of the programme from the date of admission.

5. 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 aggregate in all subjects/courses in the semester.

5.2. Condonation of shortage of attendance up to 10% i.e., between 65% and above and less than 75% may be granted by the Institute Academic committee.

5.3. Shortage of attendance below 65% in aggregate shall in no case be condoned.

5.4. Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence.

5.5. A stipulated fee shall be payable towards condonation of shortage of attendance to the institute as per following slab system

1st Slab: Less than 75% attendance but equal to or greater than 70% a normal condonation fee can be collected from the student.

2nd Slab: Less than 70% but equal to or greater than 65%, double the condonation fee can be collected from the student.

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

5.7. A student will not be promoted to the next semester unless he satisfies the attendance requirements of the current semester, as applicable.

5.8. A student detained due to shortage of attendance, will have to repeat that semester when offered next.

6. CREDIT SYSTEM NORMS:

	Period(s)/week	**Credits**
Theory	01	01
Practical	03	02
Seminar	01	01
Project	-	16

TABLE 1

7. EVALUATION:

7.1 Distribution of marks

S. No	Examination	Marks	Examination and Evaluation	Scheme of Evaluation
1.	Theory	60	Semester-end examination (External evaluation)	The question paper shall be of descriptive type with 5 questions with internal choice are to be answered in 3hours duration of the examination.
		40	Mid - Examination of 120 Min. duration (Internal evaluation). 4 descriptive type questions with internal choice are to be answered and evaluated for 30 marks, and the reaming 10 marks are to be allotted for 3-5 assignments to be submitted by the student. The assignment marks are to be awarded based on the completeness of the assignment, correctness of the assignment and in-time submission, evaluated for 10 marks and average of the total assignment marks are rounded to the next integer.	Two mid-exams 30 marks each are to be conducted. Better one to be considered. **Mid-I:** After first spell of instructions (I&II Units). **Mid-II:** After second spell of instructions (III - V Units).

S. No	Examination	Marks	Examination and Evaluation		Scheme of Evaluation
2	Laboratory	60	Semester-end Lab Examination (External evaluation)		**For laboratory courses: 3** hours duration. One External and One Internal examiners.
		40	30	Day to Day evaluation (Internal evaluation)	Performance in laboratory experiments.
			10	Internal evaluation	Practical Tests (one best out of two tests includes viva-voce)
3	Seminar in each of the semesters. 2 hours /week	100	Internal Evaluation 20 Marks for Report 20 Marks for subject content 40 Marks for presentation 20 Marks for Question and Answers		Continuous evaluation during a semester by the Departmental Committee (DC)
4	Project work	Grade A (95%) Grade B (85%)	12 credits	External evaluation	End Project Viva-Voce Examination by Committee as detailed under sect. 9.
			4 credits	Internal evaluation	Continuous evaluation by the DC. as detailed under sect. 9.5

7.2 A candidate shall be deemed to have secured the minimum academic requirement in a subject/practical 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.

7.3 A candidate has to secure a minimum of 50% to be declared successful.

7.4 In case the candidate does not secure the minimum academic requirement in any of the subjects/practical, he has to reappear for the Examination either supplementary or regular in that subject/practical along with the next batch students.

A separate supplementary examinations will be conducted for the I semester students at the end of II semester.

7.5 **Revaluation / Recounting:** Students shall be permitted to request for recounting/ revaluation of the end theory 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 memorandum of marks. If there are no changes, the student shall be intimated the same through a letter or a notice.

8. RE-REGISTRATION FOR IMPROVEMENT OF INTERNAL EVALUATION MARKS(for theory subjects only):

8.1 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.

8.2 The candidate can re-register for the chosen subjects and fulfill the academic requirements. Re-registration shall not be permitted after the commencement of class work for that semester. The candidate can re-register for 1st semester subjects when he is in his 3rd semester and for 2nd semester subjects when he is in his 4th semester else the candidate can re-register after completion of 2 years course work.

8.3 For each subject re-registered, the candidate has to pay a fee equivalent to one third of the semester tuition fee.

8.4 In the event of re-registration, the internal evaluation marks as well as the End Examinations marks secured in the previous attempt(s) for those subjects stand cancelled.

9. EVALUATION OF PROJECT WORK:

Every candidate shall be required to submit thesis/dissertation after taking up a topic approved by the Departmental Committee.

9.1 The Departmental Committee (DC) consisting of HOD, Project supervisor and two internal senior experts shall monitor the progress of the project work. A Project Review Committee (PRC) shall be constituted with Principal as Chair Person, Heads of the departments of the M.Tech Programs and Two other senior faculty members, as members of the PRC. PRC will come into action when the DC is not able to resolve the issues.

9.2 Registration of Project work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses (theory, practical and seminar of I & II semesters).

9.3 After satisfying 9.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the DC for approval. Only after obtaining the approval of DC, the student can initiate the project work.

9.4 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 DC after 36 weeks from the date of registration at the earliest but not later than one calendar year from the date of registration for the project work. Extension of time within the total permissible limit for completing the programme is to be obtained from the Head of the Institution.

9.5 The Internal Evaluation shall be made by the DC to grade, on the basis of two seminars presented by the student on the topic of his project.

9.6 The student must submit status report at least in two different phases during the project work period. These reports must be approved by the DC before submission of the Project Report.

9.7 A candidate shall be allowed to submit the thesis / dissertation only after passing all the prescribed subjects (theory, practical, seminar and project work internal evaluation).

9.8 A candidate has to prepare four copies of the thesis/dissertation certified in the prescribed format by the supervisor and HOD. Out of which three copies shall be submitted in the examination section.

9.9 Viva-voce examination shall be conducted by a board consisting of the supervisor, Head of the department and the examiner. The board shall jointly report candidate's work as.

A Very Good performance
B Moderate Performance
C Failure Performance

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce.

If the report of the viva-voce is failure performance, the candidate will retake the viva-voce examination after three months. If he fails to get a satisfactory report at the second viva-voce examination, he will not be eligible for the award of the degree.

10. CREDIT POINT AVERAGE AND CUMULATIVE CREDIT POINT AVERAGE:

10.1. CREDIT POINT AVERAGE (CPA):

$$\textbf{CPA} = \frac{\sum_i C_i T_i}{10 \sum_i C_i}$$

Where C_i= Credits earned for Course i in any semester/year.

T_i= Total marks obtained for course i in any semester/year.

10.2. CUMULATIVE CREDIT POINT AVERAGE (CCPA):

$$\textbf{CCPA} = \frac{\sum_n \sum_i C_{ni} T_{ni}}{10 \sum_n \sum_i C_{ni}}$$

Where ***n*** refers to the semester in which such courses were credited.

The CCPA is awarded only when a student earns all the credits prescribed for the programme.

10.3. OVERALL PERFORMANCE:

CCPA	Classification of Final Results
7.0 and above	First Class with Distinction
6.0 and above but below 7.0	First Class
5.0 and above but below 6.0	Second Class

11. TRANSCRIPTS:

After successful completion of the entire programme of study, a transcript containing performance of all the academic years will be issued as a final record. Duplicate transcripts will be issued if required, after payment of requisite fee. Partial transcript will also be issued up to any point of study to a student on request.

12. ELIGIBILITY:

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

i. Registered and successfully completed all the components prescribed in the programme of study to which he was admitted.
ii. Successfully acquired all **72 credits** as specified in the curriculum corresponding to the branch of his study within the stipulated time.
iii. No disciplinary action is pending against him.

13. AWARD OF DEGREE:

The Degree will be conferred and awarded by Jawaharlal Nehru Technological University Anantapur, Anantapur on the recommendations of the Principal, AITS (Autonomous) based on the eligibility as mentioned in clause 11.

14. WITHHOLDING OF RESULTS:

If the candidate has any dues to the Institute 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.

15. 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. Whereas, he continues to be in the academic regulations he was first admitted.

16. AMENDMENTS OF REGULATIONS:

The Chairman, Academic Council of Annamacharya Institute of Technology and Sciences, Rajampet (Autonomous) reserves the right to revise, amend, or change the Regulations, Scheme of Examinations and/or Syllabi or any other policy relevant to the needs of the society or industrial requirements etc., without prior notice.

17. GENERAL:

Where the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

18. Any legal issues are to be resolved in Rajampet Jurisdiction.

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Curriculum for the Programmes under Autonomous Scheme								
Regulation	R17							
Department	Department of Electrical And Electronics Engineering							
Programme Code & Name	**P7-Electrical Power Systems & Electrical Power Engineering**							
Semester I								
Subject Code	Course Name	Hours/ Week			Credit	Maximum marks		
		L	T	P	C	Internal	External	Total
	THEORY							
7P6211	**Static & Digital Protection of Power Systems**	4	0	0	4	40	60	100
7P6212	**Modern Power System Analysis**	4	0	0	4	40	60	100
7P6213	**Power system Control & Stability**	4	0	0	4	40	60	100
7P6214	**Reactive Power Compensation & Management**	4	0	0	4	40	60	100
	Elective-I							
7P6215	**Modern Control Theory**	4	0	0	4	40	60	100
7P6216	**Micro Controllers & Applications**							
7P6217	**Electrical Transients In Power Systems**							
	Elective-II							
7P6218	**Energy auditing, conservation & management**	4	0	0	4	40	60	100
7P6219	**Advanced Power Electronics**							
7P621A	**Power System Planning & Reliability**							
7P621B	**SEMINAR-I**	0	0	2	2	40	60	100
7P621C	**Machines and Power system Lab**	0	0	3	2	40	60	100
Total		**24**	**0**	**5**	**28**	**800**		

Curriculum for the Programmes under Autonomous Scheme								
Regulation	R17							
Department	Department of Electrical And Electronics Engineering							
Programme Code & Name	**P7-Electrical Power Systems & Electrical Power Engineering**							
Semester II								
Subject Code	Course Name	Hours/ Week			Credit	Maximum marks		
		L	T	P	C	Internal	External	Total
	THEORY							
7P6221	**EHV AC/DC Transmission**	**4**	0	0	4	40	60	100
7P6222	**FACTS**	**4**	0	0	4	40	60	100
7P6223	**Economics Operation & Control of Power Systems**	**4**	0	0	4	40	60	100
7P6224	**Solar & Energy Storage Systems**	**4**	0	0	4	40	60	100
	Elective-III							
7P6225	**Power System Quality & Assessment**	**4**	0	0	4	40	60	100
7P6226	**AI Techniques In Power Systems**							
7P6227	**Electrical Power Distribution & Automation**							
	Elective-IV							
7P6228	**Restructured power systems**	**4**	0	0	4	40	60	100
7P6229	**Distributed Generation & Micro Grid**							
7P622A	**Modern optimization techniques**							
7P622B	**SEMINAR-II**	**0**	0	2	2	40	60	100
7P622C	**Power system simulation lab**	**0**	0	3	2	40	60	100
Total		**24**	**0**	**5**	**28**	**800**		

Curriculum for the Programmes under Autonomous Scheme					
Regulation	R17				
Department	Department of Electrical And Electronics Engineering				
Programme Code & Name	**P7-Electrical Power Systems & Electrical Power Engineering**				
Semester III & SEMESTER IV					
Subject Code	Course Name	Credits	Maximum marks		
			Internal	External	Total
7P6231	**PROJECT WORK**	16	GRADE (A/B/C)		
TOTAL		**16**	**GRADE**		

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester

STATIC AND DIGITAL PROTECTION OF POWER SYSTEM

PRE-REQUISITES: Switchgear and Protection and Microprocessors and Microcontrollers at UG level.

COURSE OBJECTIVES:

The objective of the course is: To impart knowledge on various aspects of protective relaying for power system components

- To learn about various types of protective relays for power system.
- To acquire an in-depth knowledge on the protection of transmission lines, generators and motors.
- To understand the concept of static protection for power system
- To understand the concept of digital protection and computer relaying for power system

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.

Amplitude & Phase comparators: Circulating current type and opposed voltage type rectifier bridge Amplitude comparators –Direct and Instantaneous Amplitude comparators. Coincidence circuit type block spike phase comparator, techniques to measure the period of coincidence – Integrating type – Rectifier and vector product type phase comparators.

UNIT-II: Static over current relays: Introduction-Instantaneous over current relay – Time over current relays-basic principles-Definite time and Inverse definite time over current relays.

Static Differential Relays: Analysis of static differential relays – static relay schemes –Duo bias transformer differential protection – Harmonic restraint relay.

UNIT-III: Static distance Relays: Static impedance –reactance-MHO and angle impedance relay sampling comparator–realization of reactance and MHO relay using a sampling comparator.

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-IV: 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.

UNIT-V: Protection of Generators and Motors: Types of faults, Stator and rotor protection against various types of faults.

Protection of Transformers: Types of faults, differential protection schemes, harmonic restraint relay, over flux protection, earthing transformer protection.

Bus Zone Protection: Types of Bus-bar faults, differential current protection frame leakage protection.

TEXT BOOKS:

1. T.S.MadhavaRao, “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.

REFERENCE BOOKS:

1.. S.P Patra, S.K Bl,lsu and S. Choudhary, "Power System Protection", Oxford IBH Pub.

2. S. Ravindernath and M. Chander, "Power System Protection and Switchgear", Wiley Eastern Ltd.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
MODERN POWER SYSTEM ANALYSIS

PRE-REQUISITES: **Power system Analysis at UG level**
:

OBJECTIVES

To Introduce different techniques of dealing with sparse matrix for large scale power systems.
To impart in-depth knowledge on different methods of power flow solutions.
To perform optimal power flow solutions in detail
To perform short circuit fault analysis and understand the consequence of different type of faults.
To Illustrate different numeric al integration methods and factors influencing transient stability

UNIT I SOLUTION TECHNIQUE Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays – Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices, Π- representation of off-nominal tap transformers.

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UNIT-II: **POWER FLOW STUDIES** Introduction to load flow analysis, formation of Ybus . Classification of buses, Load flow solution methods – Gauss-Seidal method, Newton Raphson method, Decoupled and fast decoupled load flow, Comparison of load flow methods, DC power flow method.

UNIT-III: SHORT CIRCUIT ANALYSIS: Formation of bus impedance matrix with & without mutual coupling (single phase basis) - Computer method for fault analysis using ZBUS and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase – symmetrical and unsymmetrical faults.

UNIT IV OPTIMAL POWER FLOW Problem statement; Solution of Optimal Power Flow (OPF) – The gradient method, Newton‟s method, Linear Sensitivity Analysis; LP methods – With real power variables only – LP method with AC power flow variables and detailed cost functions; Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs.

UNIT-V: NUMERICAL INTEGRATION METHODS: Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model; Factors influencing transient stability, Numerical stability and implicit Integration methods.

Text Books:

1. Computer Techniques in Power System Analysis- M.A. Pai, Tata Mc-Graw Hill New Delhi.
2. Computer Methods in Power System Analysis- Stagg and El.Abiad, Mc-GrawHill (International Student Edition.)
3. A.J. Wood & W.F. Wollenberg, 'Power Generation, Operation, and Control', 2nd Edn, John Wiley & Sons, New York, 1996

Reference Books:

1. Computer Analysis of Power Systems-J.Arrilinga, C.P.Arnold. Wiely Eastern Ltd.
2. Optimization Techniques-S.S.Rao, Wiely Eastern Ltd, New Delhi

3. Computer Aided Power System operation and Analysis-R.N.Dhar, Tata Mc- Graw Hill New Delhi
4. Modern Power System Engineering, Nagrath and Kothari (Tata McGraw Hill)

5. Electrical Energy System Theory–an introduction- OlleElgerd. TMH Publishing Company, New Delhi
6. Power Generation Operation and Control – Allen Wood, Wiley Publications.

7.W.F.Tinney and W.S.Meyer, "Solution of Large Sparse System by Ordered Triangular Factorization" IEEE Trans. on Automatic Control, Vol : AC-18, pp:333- 346, Aug 1973.

8. K.Zollenkopf, "Bi-Factorization: Basic Computational Algorithm and Programming Techniques ; pp:75-96 ; Book on "Large Sparse Set of Linear Systems" Editor: J.K.Rerd,Academic Press, 1971.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
POWER SYSTEM CONTROL & STABILITY

Pre-requisites: Power system operation and control, Electrical Machines

Corse Objective:

- To analyze the concept of power system stability, response to small disturbances and power system stabilizer
- To gain the knowledge of excitation systems and voltage stability

UNIT-I THE ELEMENTARY MATHEMATICAL MODEL: Definition of Stability, Classification of power system stability, Rotor angle stability, frequency stability, voltage stability, midterm and long term stability, transient and steady state stability, Dynamics of synchronous machine, Development of swing equation, Classical model of one machine connected to an infinite bus – Equal area criteria, Classical model of multi machine system – Problems, Effect of the excitation system on Transient stability.

UNIT-II SYSTEM RESPONSE TO SMALL DISTURBANCES: The unregulated synchronous Machine – Demagnetizing effect of armature reaction –Effect of small changes of speed – modes of oscillation of an unregulated Multi machine system – regulated synchronous machine – voltage regulator with one time lag – Governor with one time lag – Problems. 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

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 systems: rotating rectifier system, Type-3 system: Static with terminal potential and current supplies - Type –4 systems: non – continuous acting - Block diagram representation – state space modeling equations of these types.

UNIT-V VOLTAGE STABILITY: Voltage stability –voltage collapse, voltage security, physical relation indicating dependence of voltage and reactive power flow, Factors affecting voltage instability and collapse – Previous case of voltage collapse incidences, PV curve-QV curve- Control of voltage instability. Voltage Stability analysis-Static & Dynamic Analysis-The Continuation Power Flow Analysis-Prevention of voltage collapse

TEXT BOOKS

1. P.M.Anderson, A.A.Fouad, "Power System Control and Stability", IOWA State University Press, Galgotia Publications, New Delhi, 2003.
2. 'Power system stability and control" by PrabhaKundur,MCGrawhill-Inc, USA, 1994
3. D.P.Kothari and I.J.Nagrath, "Modern Power System Analysis", third edition, TMH Publications, 2003.

REFERENCE BOOKS

1. M.A.Pai, Power System Stability – Analysis by the direct method of Lyapunov.North Holland Publishing Company, Newyork, 1981.

2. K.R. Padiyar, Power System Dynamics (Stability & Control), 2nd Edition B.S.Publications, 2002.

3. Edward Wilson Kimbark, "Power System stability: Synchronous Machines", Dover publications Inc., New York.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
REACTIVE POWER COMPENSATION AND MANAGEMENT

PRE-REQUISITES: Generation of Electrical Power & Transmission of Electrical power at UG level

Course Objectives:

- To identify the necessity of reactive power compensation
- To describe load compensation
- To select various types of reactive power compensation in transmission systems
- To illustrate reactive power coordination system
- To characterize distribution side and utility side reactive power management.

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 AND TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM

Uncompensated line – types of compensation – passive shunt, 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 AND DEMAND SIDE MANAGEMENT

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.

Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.

UNIT-VI: DISTRIBUTION AND USER SIDE REACTIVE POWER MANAGEMENT

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks. KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations.

UNIT-V: REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES

Typical layout of traction systems – 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. Reactive power control in Electric power systems" by T.J.E.Miller, John Wiley and sons, 1982.
2. "Reactive power Management" by D.M.Tagare, Tata McGraw Hill, 2004.

Reference Books:

1. S. Sivanagaru & G. Sreenivasan, Power System Operation and Control, Pearson Publications.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
MODERN CONTROL THEORY
(ELECTIVE)

PRE- REQUISITES: Electrical Circuits, Laplace transforms & Linear Control Systems

Course Objective:

To provide the basic idea of modern control circuits which are using in many industrial applications

UNIT –I MATHEMATICAL PRELIMINARIES: Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity –Non uniqueness of state model – State diagrams for Continuous – Time state models .

UNIT-II STATE VARIABLE ANALYSIS: Linear Continuous time models for Physical systems–Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems –Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form.

UNIT-III: MODAL CONTROL: Controllable and Observable Canonical forms of State model- State feedback controller design through Pole Assignment – State observers: Full order and reduced order.

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

UNIT-V: STABILITY ANALYSIS: Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems -Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method –Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

OPTIMAL CONTROL: Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental theorem of Calculus of variations — Linear Quadratic regulator

TEXT BOOKS:

1. M.Gopal , *Modern Control System Theory* New Age International -1995
2. Ogata.K ,*Modern Control Engineering,* Prentice Hall of India, Fifth edition,2010

REFERENCES:

1. Donald E Kirck *Optimal control Theory*–Dover Publications,2004
2. Astrom.K.J, and Wittenmark.B, "Adaptive control", Addison-Wesley Longman Publishing Co, Second Edition,1994.
3. Brian.D, Anderson.O, John Barratt Moore, "*Optimal Control*" Prentice Hall,1990.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
MICROCONTROLLERS AND APPLICATIONS

PRE-REQUISITES:
Digital logic, Microprocessors and Microcontrollers at UG level

COURSE Objectives:
8051 Microcontroller: Architecture, Programming and Interfacing
PIC Microcontrollers: Architecture, features, programming and Interfacing

UNIT–I: 8051 MICROCONTROLLER
Overview of 8051 microcontrollers. 8051/8052 – architecture and features. Memory – internal / external Program, Data memory and their interfacing. Data memory – Register Bank, Bit addressable space, scratch pad area. Special Function Registers (SFRs). Instruction set – Data transfer, Arithmetic, logical, branch control instructions. Addressing modes. Timers – Mode - 0, 1, 2 and 3 operations, TMOD, TCON. Timer applications – wave generation, Device control operations.

UNIT-II: INTERFACING
Basics of serial communication – RS232, MAX232, Baud rate. Serial port programming - SCON, SMOD, SBUF, PCON. Interrupts – IE, TCON, IP.Applications using interrupts of 8051/8052 – wave generation, Device control operations. Interfacing – ADC, DAC, DC motor and PWM.

UNNIT-III: PIC MICROCONTROLLERS
CISC Vs RISC. Harvard Vs Von Neumann architectures. PIC16F87XA architecture and features. PIC16 Memory organization – program memory, data memory. PIC Register file – General purpose registers and SFRs.Introduction to PIC Assembly Programming, PIC Data Format and Directives.PIC programming tools. Instruction set – data transfer, arithmetic, logical, bit manipulation, branch Instructions. I/O Port Programming. Addressing modes –Immediate, Direct, Register Indirect Addressing Modes. Macros and Modules.

UNIT–IV: SERIAL, INTERRUPT, I/O PORTS AND TIMER PROGRAMMING
I/O ports – Port A, TRISA, Port B, TRISB, Port C TRISC. Timer - 0, 1, 2 modules. Compare mode, capture mode. PIC Serial Port programming, PIC Interrupts, Programming Timer Interrupts, Programming the Serial Communication Interrupts, Port-B - Change Interrupt, Interrupt Priority in the PIC.

UNIT–V: PIC INTERFACING

ADC Characteristics, ADC Programming in the PIC, DAC Interfacing, Sensor Interfacing and Signal Conditioning, Standard and Enhanced CCP Modules,Compare Mode Programming, Capture Mode Programming, PWM Programming,ECCP Programming, Relays and Opto-isolators, Stepper Motor Interfacing, DC Motor Interfacing and PWM, PWM Motor Control with CCP, DC Motor Control with ECCP.

TEXT BOOKS:

1. Muhammad Ali Mazidi, Jancie Gillespie Mazidi, Rolin McKinlay, *The 8051Microcontroller and Embedded Sytems using Assembly and C*, 2nd edition,Pearson Education.
2. John B. Peatman, *Design with PIC Microcontrollers*, Pearson Education,2007.

REFERENCE BOOKS:

1. PIC16F87XA manual.
2. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, *PIC Microcontroller and Embedded Systems using assembly and C for PIC 18*, Pearson Education, 2008.
3. John B. Peatman, *Embedded design with the PIC18F452 Microcontroller*,Printice Hall, 2003.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE& EPS) II Semester
ELECTRICAL TRANSIENTS IN POWER SYSTEMS
(ELECTIVE)

PRE-REQUISITE: Electrical Circuits II & Transmission of Electrical Power .

OBJECTIVE:

- To gain knowledge in the sources and effects of lightning, switching and temporary over voltages.
- Ability to model and estimate the over voltages in power system
- To coordinate the insulation of power system and protective devices

UNIT I TRAVELLING WAVES ON TRANSMISSION LINE & COMPUTATION OF POWER SYSTEM TRANSIENTS: Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behavior of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion – Multi-conductor system and Velocity wave.
Principle of digital computation – Matrix method of solution, Modal analysis, Z transforms, Computation using EMTP – Simulation of switches and non-linear elements.

UNIT II LIGHTNING SURGES: Review of various types of power system transients - effect of transients on power systems -relevance of the study and computation of power system transients - electrification of thunder clouds - lightning current stages - lightning current parameters and their values - stroke to tower and mid span - induced lightning surges.

UNIT III SWITCHING SURGES: Closing and reclosing of lines - load rejection - fault initiation - fault clearing - short line faults - ferro resonance - isolator switching surges - temporary over voltages - surges on an integrated systems - switching - harmonics.

UNIT IV IMPULSE VOLTAGES: Generation of high AC and DC-impulse voltages, currents-measurement using sphere gaps-peak voltmeters-potential dividers and CRO. Initial and Final voltage distribution - Winding oscillation - traveling wave solution - Behavior of the transformer core under surge condition – Rotating machine – Surge in generator and motor.

UNIT V CURRENT CHOPPING PHENOMENON& INSULATION CO-ORDINATION: Current chopping in circuit breakers. Short line fault condition and its relation to circuit breaker duty. Trapped charge effects. Effect of source and source representation in short line fault studies. Control of transients .Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS), insulation level, statistical approach, co-ordination between insulation and protection level –overvoltage protective devices – lightning arresters, substation earthing.

TEXT BOOKS

1. Allan Greenwood, 'Electrical Transients in Power Systems', Willey Inter science, New York, 1971.
2. Klaus Ragaller, 'Surges in High Voltage Networks', Plenum Press, New York, 1980.

REFERENCES

1.W. Diesendorf, 'Over Voltage on High Voltage Systems', Renselaer Bookstore, Troy New York, 1971.

2. H.A. Peterson, 'Transient in Power Systems', Dover Publication, New York, 1963.

3. Rakosh das Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Ltd, 1990

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
ENERGY AUDITING, CONSERVATION & MANAGEMENT
(ELECTIVE)

Prerequisite: Concepts of Power systems

Course Objectives: To know the necessity of conservation of energy
To generalize the methods of energy management
To illustrate the factors to increase the efficiency of electrical equipment
To detect the benefits of carrying out energy audits.

UNIT-I: BASIC PRINCIPLES OF ENERGY AUDIT: Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT-II: ENERGY MANAGEMENT: Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, Qualities and functions, language, Questionnaire - check list for top management

UNIT-III: ENERGY EFFICIENT MOTORS: Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed, variable duty cycle systems, RMS hp-voltage variation-voltage unbalance- over motoring- motor energy audit

UNIT- IV: POWER FACTOR IMPROVEMENT, LIGHTING ENERGY INSTRUMENTS

Power factor – methods of improvement, location of capacitors, pf with nonlinear loads, effect of harmonics on p.f.,p.f motor controllers - Good lighting system design and practice, lighting control, lighting energy audit. Energy Instruments: watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's.

UNIT- V ECONOMIC ASPECTS AND ANALYSIS

Economics Analysis-Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, and life cycle costing analysis - Calculation of simple payback method, net present worth method - Applications of life cycle costing analysis, return on investment.

TEXT BOOKS:

1."Energy management" by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2."Energy management "by Paul o Callaghan, Mc-graw Hill Book company-1st edition, 1998.

REFERENCE BOOKS:

1."Energy efficient electric motors" by John C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995.
2."Energy management hand book" by W.C.Turner, john Wiley and sons.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES (AUTONOMOUS)

M.Tech (EPE & EPS) I Semester

ADVANCED POWER ELECTRONICS

PRE- REQUISITES:Electrical Circuits,Electronic Devices and Circuits & Power Electronics

.

Course Objective:

To give the basic idea of modern power electronic converters which are using in many industrial applications.

UNIT-I HIGH-POWER SEMICONDUCTOR DEVICES

Introduction, High-Power Switching Devices, Diodes, Silicon-Controlled Rectifier (SCR), Gate Turn-Off (GTO) Thyristor, Gate-Commutated Thyristor (GCT), Insulated Gate Bipolar Transistor (IGBT), Other Switching Devices, Operation of Series-Connected Devices, Main Causes of Voltage Unbalance ,Voltage Equalization for GCTs,

UNIT-II CASCADED H-BRIDGE MULTILEVEL INVERTERS

Introduction, Sinusoidal PWM ,Modulation Scheme ,Harmonic Content, Over modulation,Third Harmonic Injection PWM, Space Vector Modulation , Switching States , Space Vectors, Dwell Time Calculation, Modulation Index , Switching Sequence, Spectrum Analysis, Even-Order Harmonic Elimination, Discontinuous Space Vector Modulation.

Introduction, H-Bridge Inverter, Bipolar Pulse-Width Modulation, Unipolar Pulse-Width Modulation.

UNIT-III DIODE-CLAMPED MULTILEVEL INVERTERS Three-Level Inverter , Converter Configuration, Switching State ,Commutation, Space Vector Modulation, Stationary Space Vectors , Dwell Time Calculation, Relationship Between *V_ref*Location and Dwell Times, Switching Sequence Design, Inverter Output Waveforms and Harmonic Content , Even-Order Harmonic Elimination, Neutral-Point Voltage Control, Causes of Neutral-Point Voltage Deviation , Effect of Motoring and Regenerative Operation, Feedback Control of Neutral-Point Voltage

UNIT-IV DC-DC SWITCH-MODE CONVERTERS& SWITCHING DC POWER SUPPLIES Control of dc-dc converter,Buck converter, boost converter, buck-boost converter, cuk dc-dc converter, full-bridge dc-dc converter, dc-dc converter comparison.Introduction, linear power supplies, overview of switching power supplies, dc-dc converters with electrical isolation, control of switch mode dc power supplies, power supply protection, and electrical isolation in the feedback loop, designing to meet the power supply specifications.

UNIT-V RESONANT CONVERTERS& POWER CONDITIONERS AND UNINTERRUPTIBLE POWER SUPPLIES Classification of resonant converters, basic resonant circuit concepts, load-resonant converters, resonant-switch converters, zero-voltage-switching, resonant-dc-link inverters with zero-voltage switching's, high frequency-link integral-half cycle converters.Power line disturbances, Introduction to Power Quality, power Conditioners, uninterruptible power supplies, Applications.

TEXT BOOKS:

1.Power electronics circuits, Devices and applications — M.H. Rashid PHI –I edition –1995.

2."Power Electronics converters, Applications and Design" Ned Mohan, Tore M. Undeland and William P. Robbins, A John Wiley & Sons, Inc., Publication 3rd Edition.

REFERENCES:

1). Switch-Mode Power Converters: Design and Analysis By Keng C. Wu.

2). Pulse-Width Modulated DC-DC Power Converters By Marian K. Kazimierczuk.

3). Fundamentals of Power Electronics Robert W. Erickson, Dragan Maksimovic

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
POWER SYSTEM PLANNING AND RELIABILITY

PRE- REQUISITES:Concepts of Power Systems & Probability

.

Course Objective:

To give the basic idea of modern power electronic converters which are using in many industrial applications

Unit 1: Load Forecasting : Introduction, Factors affecting Load Forecasting, Load Research, Load Growth Characteristics, Classification of Load and Its Characteristics, Load Forecasting Methods - (i) Extrapolation (ii) Co-Relation Techniques, Energy Forecasting, Peak Load Forecasting, Reactive Load Forecasting, Non-Weather sensitive load Forecasting, Weather sensitive load Forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting, Objectives & Factors affecting to System Planning , Short Term Planning, Medium Term Planning, Long Term Planning.

Unit 2: **Probability theory** : Introduction to probability, Probability distributions : Random variables, density and distribution functions. Mathematical expectation. Binominal distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution. Normal Gaussian, Gamma and Beta distribution. Correlation and regression

Unit 3: Reliability : Reliability, Failure, Concepts of Probability, Evaluation Techniques (i) Markov Process (ii) Recursive Technique, Stochastic Prediction of Frequency and Duration of Long & Short Interruption,Adequacy of Reliability, Reliability Cost

Unit 4: Generation & Transmission Planning and Reliability : Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Interconnected System, Factors affecting interconnection under Emergency Assistance. Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability

Unit 5: **Distribution Planning and Reliability** : Radial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices. Parallel & Meshed Networks - Introduction, Basic Evaluation Techniques, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Weather Effects, Breaker Failure.

Text Books:

1. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication.
2. Power System Planning - R.L. Sullivan, Tata McGraw Hill Publishing Company Ltd.
3. Probability and Statistic for Engineers, Miler & Freund's, Pearson Education, Richard Johnson. Reference

Books:

1. Modern Power System Planning – X. Wang & J.R. McDonald, McGraw Hill Book Company
2. Electrical Power Distribution Engineering - T. Gönen, McGraw Hill Book Company
3. Generation of Electrical Energy – B.R. Gupta, S. Chand Publications
4. Electrical Power Distribution A.S. Pabla, Tata McGraw Hill Publishing Company Ltd.
5. Electricity Economics & Planning – T.W.Berrie, Peter Peregrinus Ltd., London
6. Reliability modeling in Electric Power System -Endrenyi, J., „ " John Wiley, 1980

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) I Semester
POWER SYSTEMS LAB

Any Ten Experiments:

1. Measurement of Earth Resistance.
2. Determination of Transmission line parameters, Surge Impedance Loading, Regulation, efficiency and Ferranti effect

3. Grid Synchronization of solar PV Inverter
4. Characteristics of Over Voltage Relay (Electromagnetic & (Microprocessor)
5. Partial discharge measurement of dielectrics
6. Characteristics of Percentage Biased Differential Relay (Electromagnetic Type).
7. Equivalent Circuit of three winding transformer.
8. Location of Fault using Cable Fault Locator
9. Fault Analysis-I
   A. LG Fault
   B. LL Fault
10. Fault Analysis-II

    A.LLG Fault

    B.LLLG Fault

10. Power Angle Characteristics of Salient pole Synchronous machine.
11. Determination of Sub transient Reactance of Salient pole Synchronous Machine.
12. String efficiency of Insulators.
13. Determination of Sequence Impedances of Synchronous Machine.
14. Measurement of harmonics using Energy analyzer.
15. Characteristics of IDMT Over Current Relay (Electromagnetic Type).
16. Characteristics of Negative Phase Sequence relay (Static Type).
17. Determination of Sequence Impedances of Three Phase Transformer

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) II Semester
EHVAC/HVDC TRANSMISSION

PRE- REQUISITES:Concepts of Electrical Circuits & Power Systems

Course Objective:

The main idea of introducing the course" **EHVAC/DC TRANSMISSION**" to M.Tech (EPE & EPE & EPS) streams is to give the basic idea of modern power transmission circuits which are using at present stage to give more efficiency

Unit – I : E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters, 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 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 in un energised lines – measurements of field and voltage gradients for three phase single and double circuit lines – unenergised 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 – staticVAR compensation. 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.

Unit-IV : H.V.DC Transmission : General consideration , Power Handling Capabilities of HVDC lines , Basic Conversion principles , static converter configuration. Static Power Converters: 3 pulse, 6 pulse & 12 pulse converters, converter station and terminal equipment communication process, Rectifier and inverter operation, equivalent circuit for converter- special futures of converter transformers.

Unit-V: Harmonics in HVDC systems, harmonicas elimination, AC & DC filter Control of HVDC converter and systems: constant current, constant extinction angle and constant ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Interaction between HVAC & DC systems –voltage interaction, harmonic instability problems and DC power modulation.

TEXT BOOKS:

1. Extra High Voltage AC Transmission Engineering – Rokosh Das Begamudre, Wiley EASTERN LTD., NEW DELHI – 1987.
2.K.R.Padiyar: High Voltage Direct current Transmission, Wiley Eastern Ltd

REFERENCE BOOKS:

1. EHV Transmission line reference Books – Edison Electric Institution (GEC 1968).
2.E.W.Kimbark: Direct current Transmission, Wiley inter Science- New york.
3.J.Arillaga: H.V.D.C.Tranmission peter peregrilnus ltd., London UK 1983
4.E.Uhlman: Power Transmission by Direct Current Springer Verlag,Berrlin

ANAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) II Semester

FLEXIBLE A.C. TRANSMISSION SYSTEMS

PRE- REQUISITES: Power Electrronics

OBJECTIVES

1. To emphasis the need for FACTS controllers.
2. To learn the characteristics, applications and modeling of series and shunt FACTS controllers.
3. To analyze the interaction of different FACTS controller and perform control coordination

UNIT-I: FACTS CONCEPTS: Loading capability limits - dynamic stability considerations - importance of controllable parameters - basic types of FACTS controllers - benefits from FACTS controllers.

UNIT-II: VOLTAGE SOURCE CONVERTERS: Three phase full wave bridge converters - transformer connections for 12 pulse 24 and 48 pulse operation - three level voltage source converter - pulse width modulation converter - basic concept of voltage source and current source converters - comparison of CSC and VSC.

UNIT-III: STATIC SHUNT COMPENSATION: Objectives of shunt compensation - mid-point regulation - voltage instability prevention - improvement of transient stability - power oscillation damping - methods of controllable VAR generation - variable impedance type VAR generators - switching converter type VAR generators - hybrid VAR generators.

UNIT-IV: SVC AND STATCOM: The regulation slope - transfer function and dynamic performance - transient stability Enhancement - power oscillation damping - operating point control and summary of Compensator control.

UNIT-V: STATIC SERIES COMPENSATORS

Concept of series capacitive compensation - improvement of transient stability - power oscillation damping - GTO thyristor controlled series capacitor (GCSC) - Thyristor Switched Series Capacitor (TSSC), and Thyristor Controlled Series Capacitor (TCSC), control schemes for GCSC, TSSC and TCSC.

TEXT BOOKS:

1. "Understanding FACTS Devices" N. G. Hingorani and L. Guygi. IEEE Press Publications
2."FACTS Controllers in Power Transmission and Distribution" New Age Int.Publishers,2007.

REFERENCES:

1.Zhang ,Xiao-ping ,Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control" , Springer 2012.

2.Yong-Hua Song ,Allan Johns, "Flexible AC Transmission Systems " ,IET ,1999.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) II Semester
ECONOMIC OPERATION & CONTROL OF POWER SYSTEMS

PRE- REQUISITES: PSOC, PSA, GEP & SCT

COURSE OBJECTIVES:

1. To learn the concepts of unit-commitment and load scheduling.
2. To learn Automatic control of power output of generators to maintain the scheduled frequency
3. To know the single area and two area load frequency control methods
4. To understand the modeling concepts of governor.

UNIT-I: Economic operation and Unit Commitment: Load forecasting – unit commitment – economic dispatch problem of thermal units – gradient method – newton's method – base point and participation factor method – optimal unit commitment, constraints in unit commitment – unit commitment solution methods – priority list methods, dynamic programming solution – forward DP approach.

UNIT-II: Hydrothermal co-ordination: Short-term hydrothermal scheduling problem – gradient approach – hydro units in series – pumped storage hydro plants – hydro scheduling using dynamic programming and linear programming.

UNIT-III: Need for frequency and voltage control – Plant and system level control – modeling of LFC of single area system – static and dynamic analysis – LFC of two area system – static and dynamic analysis – tie line bias control.
Automatic generation control – features – implementation

UNIT-IV: Interchange of power & energy – economic interchange between interconnected utilities – inter utility energy evaluation – interchange evaluation with unit commitment – multiple utility interchange transactions – other types of interchange – power pools – transmission effects and issues limitations – wheeling.

UNIT-V: Power system security – Contingency analysis – linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation – security constrained optimal power flow – maximum likelihood weighted least squares equation – orthogonal decomposition estimation method – algorithm.

TEXT BOOKS:

1. Allen J.Wood and Wollenberg B.F., 'Power Generation Operation and control', John Wiley & Sons, Second Edition.
2. Nagrath, I.J. and Kothari D.P., 'Modern Power System Analysis', TMH,N.Delhi,1980

REFERENCES:

1. D.P.Kothari&J.S.Dhillon, Power System Optimization, PHI, 2004

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)
M.Tech (EPE & EPS) II Semester
SOLAR AND ENERGY STORAGE SYSTEMS

PRE- REQUISITES : Renewable Energy sources

OBJECTIVES

- To Study about solar modules and PV system design and their applications
- To Deal with grid connected PV systems
- To discuss about different energy storage systems

UNIT I INTRODUCTION

Characteristics of sunlight – semiconductors and P-N junctions-structure and working of solar cell –behavior of solar cells – cell properties – PV cell interconnection-solar energy collectors and its performance.

UNIT II STAND ALONE PV SYSTEMS

Solar modules – storage systems – power conditioning and regulation – protection – stand alone PV systems design – sizing.

UNIT III GRID CONNECTED PV SYSTEMS

PV systems in buildings – design issues for central power stations – safety – Economic aspect – Efficiency and performance – International PV programs

UNIT IV ENERGY STORAGE SYSTEMS

Necessity of storage of solar energy-Impact of intermittent generation – Battery energy storage – solar thermal energy storage-chemical energy storage – pumped hydroelectric energy storage-heat storage in underground water, heat storage in the ground.

UNIT V APPLICATIONS

Water pumping – battery chargers – solar car – direct-drive applications –solar thermal applications-heating,cooling,desalination,drying,cooking.

REFERENCES:

1. Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa,1994.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, Applied Photovoltaics, 2007,Earthscan, UK.
3. Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook , CRC Press, 2011.
4. Solar & Wind Energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990
5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill,1987.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)

M.Tech (EPE & EPS) II Semester

POWER SYSTEM QUALITY AND ASSESSMENT

(ELECTIVE)

PRE- REQUISITES: Power quality & Power Systems

Expected Outcome :Upon successful completion of this course, students will be able to identify the power quality problems, causes and suggest suitable mitigating techniques

UNIT I INTRODUCTION: Power quality-voltage quality-overview of power quality phenomena-classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, electromagnetic compatibility (EMC) standards and recommended practices.

UNIT II POWER ASSESSMENT UNDER WAVEFORM DISTORTION & WAVEFORM PROCESSING TECHNIQUES: Introduction, single phase definitions, three phase definitions, illustrative examples.
Fundamental frequency characterization, Fourier analysis, Fast Fourier Transform, Window functions, Efficiency of Fast Fourier Transform (FFT) algorithms, alternative transforms, wavelet transform, Hartely transform, Automation of disturbance recognition.

UNIT III POWER QUALITY MONITORING: Introduction, transducers, Current Transformer (CT), Potential Transformer (PT), power quality instrumentation, Harmonic monitoring, event recording, flicker monitoring, assessment of voltage and current unbalance, examples of application

UNIT IV HARMONIC DISTORTION AND MITIGATION: Introduction, direct harmonic analysis, incorporation of harmonic voltage sources, derivation of network harmonic impedances, solution by direct injection, Representation of individual power system components, implementation of harmonic analysis, post processing and display of results, Harmonic resonance, Impedance Scan Analysis-Active Power Factor Corrected Single Phase Front End, introduction to three Phase APFC and Control Techniques,

UNIT V GROUNDING: Grounding and wiring–introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems

BOOKS RECOMMENDED:

1. Heydt G.T., *Electric Power Quality*, Stars in a Circle Publishers, 1994.

2. Bollen Math H., *Understanding Power Quality Problems*.

3. Arrillaga J., *Power System Quality Assessment*, John Wiley, 2000.

4. Arrillaga J., Smith B.C., Watson N.R. and Wood A.R., *Power System Harmonic Analysis*, John Wiley, 1997.

5. Santoso Surya, Beaty H. Wayne, Dugan Roger C., McGranaghan Mark F., *Electrical Power System Quality*, McGraw Hills, 2002.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)

M.Tech (EPE & EPS) II Semester

AI TECHNIQUES TO POWER SYSTEMS

(ELECTIVE)

PRE- REQUISITES: Power Systems

Course Objectives: To locate soft commanding methodologies, such as artificial neural networks, Fuzzy• logic and genetic Algorithms. To observe the concepts of feed forward neural networks and about feedback neural• networks. To practice the concept of fuzziness involved in various systems and comprehensive• knowledge of fuzzy logic control and to design the fuzzy control To analyze genetic algorithm, genetic operations and genetic mutations•

UNIT-I INTRODUCTION TO NEURAL NETWORKS

Introduction, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Spiking Neuron Model, McCulloch-Pitts Model, Historical Developments, Characteristics of ANN, Potential Applications of ANN. Neuron Activation Functions, ANN Architectures, Activation and Synaptic Dynamic Model, Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

UNIT-II FEED FORWARD NETWORKS

Introduction, Perceptron Models, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations and Applications. ADALINE, MADALINE, Back Propagation Network, BP Learning Rule, Input Layer, Hidden Layer and output Layer computations, Radial Basis Function.

ANN Based Short Term Load Forecasting, Load Flow Studies, Contingency Analysis.

UNIT-III INTROUDUCTION TO FUZZY SETS

Introduction to Classical Sets, Fuzzy sets: Operations, Properties, Membership, Uncertainty, Fuzzy Relations, Cardinalities and Membership Functions.

UNIT-IV FUZZY LOGIC SYSTEMS & ITS APPLICATION

Fuzzification, Membership Value Assignment, Development of Rule Base and Fuzzy Inference System, Defuzzification, Defuzzificatio nmethods.Fuzzy Logic Based Unit Commitment Problem, Power System Stabilizer.

UNIT-V INTRODUCTION TO GENETIC ALGORITHMS & ITS APPLICATIONS

Introduction, Basic operators and Terminologies in GA, Traditional Vs Genetic Algorithm, Encoding, Fitness Function, Reproduction,Crossover, Mutation Operators. Genetic Algorithms Based Economic Load Dispatch.

TEXT BOOK:

1. Introduction to Artificial Neural Systems- JacekM.Zurada, Jaico Publishing House, 1997.
2. "Principles of Soft Computing Techniques" by S.N. Sivanandam and S.N.Deepa, WILEY-INDIA Edition

REFERENCE BOOKS:

1. Neural and Fuzzy Systems: Foundation, Architectures and Applications, - N. Yadaiah and S. BapiRaju, Pearson Education
2. Neural Netwroks – James A Freeman and Davis Skapura, Pearson, 2002
3. Neural Netwroks and Fuzzy Logic System by BrokKosko, PHI Publications.
4. Neural Netwroks, Fuzylogic ,Gnenetic algorithms: synthesis and applications by Rajasekharan and Rai- PHI Publication.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET

(AN AUTONOMOUS INSTITUTION)

M.Tech (EPE & EPS) II Semester

ELECTRICAL POWER DISTRIBUTION AUTOMATION

(ELECTIVE)

Course Pre-requisites: Generation of Electrical Power and Transmission of Electrical Power

Course Objectives:

- To learn the basics of Distribution system, different types of loads and their characteristics and to understand the concept of DC distribution of power in terms of voltage drop and power loss.
- To understand the concepts of AC distribution of power in terms of load voltage drop and power loss, need of protection of Distribution systems and protecting devices.
- To gain the concept of Distribution Automation System (DAS), SCADA and its functions.
- To analyze the concept Distribution Management Systems(DMS), its functions and functionalities.
- To learn the importance of Energy management and its classification, fault – definition, location, isolation and system restoration with flow charts.

UNIT–I: GENERAL CONCEPTS OF DISTRIBUTION SYSTEMS: Introduction to distribution systems, Load modeling and characteristics. Basic Definitions: Connected load, Maximum demand, Load factor, Demand Factor, Plant capacity factor, Utilization factor, Coincidence factor, Contribution factor and Loss factor. Relationship between Load factor and Loss factor. Classification of loads and their characteristics.Design consideration in distribution system, Factors affecting distribution system losses, Methods of reducing the distribution system losses, Classification of Distribution Systems, Requirements and Design features of Distribution Systems, DC Distributor fed at one end and both ends with equal and unequal voltages for both concentrated and uniform loading, Numerical Problems.

UNIT – II A.C. DISTRIBUTION SYSTEMS: Design Considerations of Distribution Feeders: Radial and loop types of primary feeders, voltage levels, feeder loading. Voltage Drop Calculations in A.C. Distributors for the following cases: Power Factors referred to receiving end voltage and with respect to respective load voltages, Numerical Problems. Secondary Distribution System, Objectives of Distribution System Protection, Types of Common Fault sand Procedure for Fault Calculations. Protective Devices: Principle of operations, Coordination of Protective Devices, General coordination procedure.

UNIT-III: DISTRIBUTION AUTOMATION SYSTEMS: Introduction: Need of Distribution Automation, Distribution Automation System (DAS), Basic architectures and implementation strategies for DA, Functions of DAS, Benefits of DA. SCADA System ,Functions of SCADA, SCADA applied to DA.

UNIT–IV: DISTRIBUTION MANAGEMENT SYSTEMS: Distribution Management Systems(DMS), Distribution Management Functions, Focus of DM: Real time control, Outage Management, Decision Support Applications, Database Structures And Interfaces. Functionalities of DAS.

UNIT – V DISTRIBUTION AUTOMATION AND CONTROL FUNCTIONS: Introduction, Energy Management, Classification of Energy Management, Demand Side Management (DSM), Objectives of DSM, StEPE & EPS used in DSM, Benefits of DSM, Voltage/Var control, Fault – Definition, Fault Detection, Fault isolation, Restoration Function, Reconfiguration of Distribution Systems, Power Quality.

TEXT BOOKS:

1. "Electric Power Distribution system, Engineering" – by TuranGonen, McGraw-hill BookCompany.

2."Control and Automation of Electrical Power Distribution Systems" by James NorthcotoGreen,Robert Wilson, CRC Press, Taylor and Francis.

REFERENCES:

1. "Electric Power Distribution Automation" by Dr. M. K. Khedkar and Dr. G. M. Dhole,University Science Press.

2. "Electrical Power Distribution Systems" by V. Kamaraju, Right Publishers.

3. "Electrical Power Distribution & Automation" by S. Sivanagaraju, Educational & TechnicalPublishers.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
(AN AUTONOMOUS INSTITUTION)

M.Tech (EPE & EPS) II Semester

(4P622A) RESTRUCTURED POWER SYSTEM
(ELECTIVE-IV)

Pre-requisite : Power system Analysis, Power system Operation & Control

Course Outcome:

To enable the students to understand the process and operation of restructured power system

Course Objectives

1. To introduce the restructuring of power industry and market models.
2. To impart knowledge on fundamental concepts of congestion management.
3. To Illustrate about various power sectors in India
4. To analyze the concepts of locational marginal pricing and financial transmission rights.

UNIT I: Key Issues in Electric Utilities: Introduction – Restructuring models – Independent System Operator (ISO) – Power Exchange - Market operations – Market Power , Different types of market Power – Mitigation of Market Power - Examples. Introduction – Standard cost – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion. Structure of OASIS - Posting of Information – Transfer capability on OASIS.

UNIT II: Available Transfer Capability (ATC)& Electricity Pricing: Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow.Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

UNIT III: Power System Operation in Competitive Environment: Introduction – Operational Planning Activities of ISO- The ISO in Pool Markets – The ISO in Bilateral Markets – Operational Planning Activities of a GENCO.

UNIT IV: Ancillary Services Management & REFORMS IN INDIAN POWER SECTOR: Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers. Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

UNIT V: Transmission Pricing: Introduction Transmission Cost Allocation Methods : Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

TEXT BOOKS

1. **Operation of Restructured Power System**, Kankar Bhattacharya, Math H.J. Boller and JaapE.DaalderKulwer Academic Publishers, 2001.
2. **Restructured Electrical Power Systems**, Mohammad Shahidehpour and Muwaffaqalomoush, Marcel Dekker, Inc., 2001.

REFERENCES:

1. **Power System Restructuring and Deregulation**, Loi Lei Lai, John Wiley & Sons Ltd.England.
2. Sally Hunt, “Making competition work in electricity”, John Willey and Sons Inc. 2002.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
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M.Tech (EPE & EPS) II Semester
DISTRIBUTED GENERATION AND MICROGRID

Pre-Requsites: Power System Analysis and Distribution Systems
Course Objectives: To understand the planning and operational issues related to Distributed Generation and Micro- grids.

UNIT–I Introduction: Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

UNIT – II Distributed Generations (DG):
Concept of Distributed generations, topologies, selection of sources, regulatory standards/ framework ,standard for interconnecting distributed resources to electrical power system IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

UNIT – III Impact of Grid Integration:
Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT – IV Micro-grids:
Concept and definition of Micro-grid, Micro-grid drivers and benefits, review of sources of Micro-grids, typical structure and configuration of a Micro-grid, AC and DC Micro-grids, Power Electronics interfaces in DC and AC Micro-grids, communication infrastructure, modes of operation and control of Micro-grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques.

UNIT-V Power Quality Issues In Micro-grids:
Power quality issues in Micro-grids modeling and Stability analysis of Micro-grid, regulatory standards, Micro-grid economics, Introduction to smart Micro-grids.

Reference Books:

1. AmirnaserYezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
2. DorinNeacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, “Solar Photo Voltaics”, PHI learning Pvt. Ltd., New Delhi, 2009.
4. J.F. Manwell, “Wind Energy Explained, theory design and applications,” J.G. McGowan Wiley publication, 2002.
5. D. D. Hall and R. P. Grover, “Biomass Regenerable Energy”, John Wiley, New York, 1987.
6. John Twidell and Tony Weir, “Renewable Energy Resources” Tyalor and Francis Publications, 2005.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
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M.Tech (EPE & EPS) II Semester
MODERN OPTIMIZATION TECHNIQUES IN POWER SYSTEMS

Pre-requisite: Concepts of Power systems

Course Objectives:

1. To have knowledge on optimization techniques applied to power systems.
2. To understand the different evolutionary computation techniques and multi objective
3. Optimization and their applications in power systems.

UNIT I - FUNDAMENTALS OF OPTIMIZATION Definition-Classification of optimization problems-Unconstrained and Constrained optimization-Optimality conditions-Classical Optimization techniques (Linear and non linear programming, Quadratic programming, Mixed integer programming)-Intelligent Search methods (Optimization neural network, Evolutionary algorithms, Tabu search, Particle swarm optimization, Application of fuzzy set theory).

UNIT II - EVOLUTIONARY COMPUTATION TECHNIQUES Evolution in nature-Fundamentals of Evolutionary algorithms-Working Principles of Genetic Algorithm-Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation-Issues in GA implementation- GA based Economic Dispatch solution-Fuzzy Economic Dispatch including losses- Tabu search algorithm for unit commitment problem-GA for unit commitment-GA based Optimal power flow- GA based state estimation.

UNIT III - PARTICLE SWARM OPTIMIZATION Fundamental principle-Velocity Updating-Advanced operators-Parameter selection- Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial PSO-Implementation issues Convergence issues- PSO based OPF problem and unit commitment-PSO for reactive power and voltage control-PSO for power system reliability and security.

UNIT IV - ADVANCED OPTIMIZATION METHODS Simulated annealing algorithm-Tabu search algorithm-SA and TS for unit commitment-Ant colony optimization- Bacteria Foraging optimization.

UNIT V - MULTI OBJECTIVE OPTIMIZATION Concept of pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function-Economic Emission dispatch using MOGA-Multiobjective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO) –Multiobjective OPF problem.

REFERENCES

1. D.P.Kothari and J.S.Dhillon, “Power System Optimization”, 2nd Edition, PHI learning private limited, 2010.
2. Kalyanmoy Deb, “Multi objective optimization using Evolutionary Algorithms”, John Wiley and Sons, 2008.
3. Kalyanmoy Deb, “Optimization for Engineering Design”,Prentice hall of India first edition,1988.
4. Carlos A.Coello Coello, Gary B.Lamont, David A.Van Veldhuizen, “Evolutionary Algorithms for solving Multi Objective Problems”, 2nd Edition, Springer, 2007.
5. SolimanAbdel Hady,Abdel Aal Hassan Mantawy, “Modern optimization techniques with applications in Electric Power Systems”, Springer,2012.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
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M.Tech (EPE& EPS) II Semester
ELECTRICAL SYSTEMS SIMULATION LAB

PRE-REQUISITES:

Power system, Power electronics, Control Systems and Electrical Machines at UG level Economic operation and control of power system at PG level

COURSE DESCRIPTION:

Modelling, simulation and analysis of multi area power system, load flows, load frequency control, power system stability, power quality problems and power electronic converters

Conduct any TEN experiments from the following:

(the Experiments are performed using the prescribed software's such as Matlab,Pscad,Pspice., etc.)

1. Formation of Bus admittance matrix with and without off-nominal ratios of transformer of a power system network.
2. Formation of Bus Impedance matrix with and without mutual coupling of a power system network.
3. Load flow analysis using a) Gauss Seidal Method.
   b) Newton Raphson Method.
   c) Fast Decoupled Method.
4. Short Circuit Analysis.
5. Modeling & Performance of long transmission line.
6. Simulation of Compensation Techniques of Transmission Line.
7. Transient Stability Analysis Using swing equation by RK -method
8. Step response of two area system with integral control and estimation of tie line power deviation & Frequency deviation
9. Single Phase Full Converter with RLE Load
10. Closed Loop Speed Control of Separately Excited D.C Motor.
11. Sinusoidal Pulse Width Modulation.
12. Generation System Reliability Analysis
13. Distribution System Reliability Analysis.
14. Economic Load Dispatch using MATLAB.
15. Simulation of Power Quality problems (like Sag/Swell ,Interruptions,Transients,harmonics, flickers etc)