ACHARYA NAGARJUNA UNIVERSITY

NAGARJUNA NAGAR, GUNTUR – 522 510
ANDHRAPRADESH, INDIA

CHOICE BASED CREDIT SYSTEM
Regulations, Scheme of Instruction, Examination and Detailed Syllabi
for
Power Systems Engineering

2-Year M.Tech Degree Course
In Electrical & Electronics Engineering
(Semester System)

w.e.f. : 2015-2016

ACHARYA NAGARJUNA UNIVERSITY :: NAGARJUNA NAGAR

REVISED REGULATIONS FOR
TWO - YEAR M.TECH. DEGREE COURSE
(CHOICE BASED CREDIT SYSTEM)

(With effect from the batch of students admitted during the academic year 2015-2016)

1.0 ELIGIBILITY FOR ADMISSION

1.1 The candidates, both non-sponsored and sponsored, for Admission into M.Tech programme shall have one of the following qualifications.

S.No.	Programme	Qualifications
1.	Chemical Engineering	Bachelor Degree in Chemical Engineering / Chemical Technology / Biotechnology or its equivalent Degree recognized by Acharya Nagarjuna University
2.	Civil Engineering	Bachelor Degree in Civil Engineering or its equivalent Degree recognized by Acharya Nagarjuna University
3.	Computer Science & Engineering	B.Tech / B.E Computer Science and Engineering / Information Technology / M.C.A / M.Sc., Computers / M.Sc., Electronics / M.Sc., Mathematics or its equivalent Degree recognized by Acharya Nagarjuna University.
4.	Electrical and Electronics Engineering	Bachelor Degree in Electrical & Electronics Engineering / Electrical Engineering / Electrical Power Engineering / AMIE (Electrical Engineering) or its equivalent Degree recognized by Acharya Nagarjuna University.
5.	Electronics and Communication Engineering	Bachelor Degree in Electronics & Communication / Electronic & Instrumentation Engineering / AMIE or its equivalent Degree recognized by Acharya Nagarjuna University.
6.	Mechanical Engineering	Bachelor Degree in Mechanical Engineering or its equivalent Degree recognized by Acharya Nagarjuna University.

1.2 Admission of Non-sponsored category students: Admission of non-sponsored category students is made on the basis of GATE/PGECET rank. When GATE/PGECET qualified candidates are not available, admission will be on the basis of merit in the qualifying examination. Students with or without GATE/PGECET rank should have obtained a minimum of 50% marks in the qualifying examination to become eligible for admission.

Reservation of seats to the candidates belonging to Scheduled Castes and Scheduled Tribes is as prescribed by the State Govt./University from time to time. If suitable candidates are not available to fill all the seats reserved for S.T category, they shall be filled by students S.C. Category and vice-versa.

If suitable candidates are not available for reserved seats, they shall be filled by the general category candidates.

1.3 Admission of Sponsored Category students: Sponsored category students should have at least 50% marks in the qualifying examination to become eligible for admission to the Post Graduate Programme. Preference will be given to those candidates who are GATE/PGECET qualified.

The candidates must have a minimum of two years of full time work experience in a registered firm / company/ industry / educational and research institutions / any government department or government autonomous organizations in the relevant field in which the admission is being sought.

A letter from the employer must be furnished stating that the candidate is being sponsored to get admission. The employer should also indicate that the candidate will not be withdrawn midway till the completion of course. The rule of reservation shall not apply to the admission of sponsored category students.

1.4 The total number of full time candidates admitted into a course with or without GATE/PGECET rank should not exceed the sanctioned strength.

2.0 MEDIUM OF INSTRUCTION, DURATION AND STRUCTURE

2.1. The medium of instruction shall be in English.

2.2. The minimum and maximum period for completion of the P.G. Programme is 4 Semesters for full time students.

2.3. Each Semester shall normally spread over sixteen weeks.

(a) The Programme may consist of
   i. Core Courses
   ii. Elective Courses
   iii. Seminars
   iv. Internship
   v. Project Work

(b) The structure of the Programme comprises of two semesters of course work consisting of 6 Core subjects + 6 Elective subjects and 3 Lab courses + 1 Mini Project / Seminar (or) 2 Lab courses + 2 Seminars / Mini Project, followed by two semesters of Project work. In summer break, the student should undergo internship for four weeks duration. The student should present a seminar on the project work done at the end of the third semester. At the end of fourth semester the students should submit Project Thesis.

(c) Core subjects are fixed in each semester and a student must opt them without any choice. Whereas electives can be chosen by a student from the list of electives given (minimum 18 and maximum 24) according to his choice.

2.4. Project work shall be carried out under the Supervision of a Faculty Member in the concerned department.

2.5. A candidate may, however, in certain cases, be permitted to work on his Project/Dissertation at the place of employment, any recognized Institution/R&D Organization/Industry with the approval of the Head of the Department concerned and Head of the Organization. In such cases, the Project Work shall be jointly supervised by a member of the faculty and a person from the Organization holding a minimum of P.G. Degree in the concerned area of specialization.

2.6. Five copies of the Project Report certified by the Supervisor(s) and the Head of the Department concerned shall be submitted within one Calendar Year after completion of the second semester.

2.7. The student is eligible for the submission of M.Tech. Project Report at the end of fourth semester if he/she passed all the course work in the first & second semesters.

2.8. In a special case, if any candidate unable submit his/her Project Report at the end of fourth semester due to ill health or any other reason permitted by the head of the institution, he/she will be allowed submit at a later date and the viva-voce examination will be conducted, if clause 2.7 is satisfied.

3.0. ATTENDANCE

3.1 The candidate shall put up a minimum of 75% attendance in each subject.

3.2. Condonation of shortage in attendance up to 10% in any subject may be condoned by the University on the recommendations of the Principal of the concerned College for reasons of ill health and the application is submitted at the time of actual illness and is supported by a certificate from the authorized Medical Officer approved by the Principal.

3.3. If the candidate does not satisfy the attendance requirement in any subject he or she shall not be permitted to appear for the University examination in that subject and has to repeat that subject when next offered or study any other specified subject as may be required. In case of repetition the new internal marks will be taken into amount.

3.4. Failure in securing minimum prescribed attendance in any subject of previous Semester (s) is no bar for enrollment to the next semester.

4.0. EVALUATION

4.1 The performance of the candidate in each semester shall be evaluated subject wise. The maximum marks for each subject, seminar etc, will be as prescribed in the curriculum. The Internal Evaluation for Theory subjects shall be based on two mid-term examinations and two assignments. In every theory subject, out of 40 sessional marks, 30 marks are allotted to mid-term examination and 10 marks for assignments. The best of the performances in the two midterm examinations, one held in the middle of the semester and another held immediately after the completion of the instruction, will be considered. The internal evaluation for practical subjects is based on the day-to-day performance and semester end internal practical Examination.

4.2 The marks for Seminar will be awarded by internal evaluation made by two staff members of the faculty of the department concerned.

4.3 For taking the University examination in any theory or practical subject, candidates shall be required to obtain a minimum of 50% marks in Internal evaluation in that subject failing which he/she shall be required to repeat the course in that subject when next offered or study any other specified subject as may be required. In case of repetition the new internal marks will be taken into amount.

4.4 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he or she secures a minimum of 50% marks in internal evaluation.

4.5 In case the candidate does not secure the minimum academic requirement in any subject he/she has to reappear in the University examination in that subject or any equivalent subject prescribed.

4.6 Failure to attain the minimum academic requirement in any subject of previous semester (s) is no bar for enrolment to the next semester.

4.7 The performance of the students in each semester shall be evaluated subject wise The distribution of marks between sessional work (based on internal assessment) and University Examination will be as follows:

Nature of the subject	Sessional Marks	University Exam. Marks
Theory subjects	40	60
Practical's	40	60
Seminar / Internship / Project Seminar	100	--
Project work	50	150iva voce)

5.0 AWARD OF CREDITS

Credits are awarded for each Theory/Practical/Seminar/Project Subjects. Each theory subject is awarded 4 credits and each practical/Seminar subjects is awarded 2 credits. Project seminar in III Semester is awarded 8 credits and Project Viva-voce at the end of IV Semester is awarded 16 credits.

6.0 AWARD OF GRADES

S.No.	Range of Marks	Grade	Grade Points
1	≥85%	S	10.0
2	75%-84%	A	9.0
3	65%-74%	B	8.0
4	60%-64%	C	7.0
5	55%-59%	D	6.0
6	50%-54%	E	5.0
7	≤49%	F(Fail)	0.0
8	The grade 'W' represents withdrawal/absent (subsequently changed into pass or E toS or F grade in the same semester)	W	0.0

A Student securing 'F' grade in any subject there by securing 0 grade points has to reappear and secure at least 'E' grade at the subsequent examinations in that subject

'W' denotes withdrawal/absent for a subject:

- After results are declared and Grade sheets will be issued to each student which will contain the following details:
- The list of subjects in the semester and corresponding credits and Grade obtained
- The Grade point average(GPA) for the semester and

- The Cumulative Grade Point Average(CGPA) of all subjects put together up to that semester from first semester onwards

GPA is calculated based on the fallowing formula:

$$\frac{\text{Sum of [No.Credits X Grade Point]}}{\text{Sum of Credits}}$$

CGPA will be calculated in a similar manner, considering all the subjects enrolled from first semester onwards.

7.0 AWARD OF DEGREE AND CLASS

A candidate who becomes eligible for the award of the degree shall be placed in the following three divisions based on the CGPA secured by him/her for the entire Programme

S.No.	Class	CGPA
1	First Class With Distinction	8.0 or more
2	First Class	6.5 or more but less than 8.0
3	Second Class	5.0 or more but less than 6.5

8.0 WITH-HOLDING OF RESULTS

The result of a candidate may be withheld in the following cases

i. The candidate has not paid dues to the institution
ii. A case of indiscipline is pending against the candidate
iii. A case of malpractice in examination is pending against the candidate The issue of degree is liable to be withheld in such cases

9.0 GENERAL

8.1. The University reserves the right of altering the regulations as and when necessary.

8.2 The regulations altered will be applicable to all the candidates on the rolls Irrespective of the fact that the regulations at the time of admission of the student to the programme are different.

8.3 The Academic Regulations should be read as a whole for purpose of any Interpretation Whenever there is a dispute regarding interpretation of regulations, the decision of the Vice-Chancellor is final.

ACHARYANAGARJUNAUNIVERSITY
NAGARJUNA NAGAR
FOUR SEMESTER M.TECH DEGREE COURSE
IN
POWER SYSTEMS ENGINEERING
CURRICULUM & DETAILED SYLLABI

S.No.	Course Number	Subject	Periods/week		Internal marks	End Semester Examination		Credits
			L+T	P		Duration	Marks	
First Semester								
1.	MT/PSE 511	Modern Control Theory	4	--	40	3	60	4
2.	MT/PSE 512	Advanced Power System Protection	4	--	40	3	60	4
3.	MT/PSE 513	Computer Methods in Power Systems	4	--	40	3	60	4
4.	--	Elective Subject – 1	4	--	40	3	60	4
5.	--	Elective Subject – 2	4	--	40	3	60	4
6.	--	Elective Subject – 3	4	--	40	3	60	4
7.	MT/PSE 551	Power Systems Lab	--	3	40	3	60	2
8.	MT/PSE 552	Simulation Lab – I	--	3	100	--	--	2
		TOTAL	24	6	380	--	420	28
Second Semester								
1.	MT/PSE 514	Flexible AC Transmission Systems	4	--	40	3	60	4
2.	MT/PSE 515	Power System Stability	4	--	40	3	60	4
3.	MT/PSE 516	Real time control of Power Systems	4	--	40	3	60	4
4.	--	Elective Subject – 4	4	--	40	3	60	4
5.	--	Elective Subject – 5	4	--	40	3	60	4
6.	--	Elective Subject – 6	4	--	40	3	60	4
7.	MT/PSE 553	Simulation Lab – II	--	3	40	3	60	2
8.	MT/PSE 554	Seminar	--	3	100	--	--	2
		TOTAL	24	6	380	--	420	28
Third Semester								
1.	MT/PSE 711	Summer Internship	--	--	100	-[-	--	2
2.	MT/PSE 712	Project Seminar	--	--	100	--	--	6
		TOTAL	--	--	200	--	--	8
Fourth Semester								
1.	MT/PSE 713	Project Viva	--	--	50	--	150	16
		TOTAL	--	--	50	--	150	16

List of electives:

Subject Code	Subject Title	Prerequisite
PSE 611	Operations Research	
PSE 612	Power System Reliability	--
PSE 613	Advanced Microprocessors & Micro controllers	--
PSE 614	Solid State Power Converters	--
PSE 615	Demand side Energy Management	--
PSE 616	Computer Networks	--
PSE 617	EHV AC Transmission Systems	High Voltage Engineering & Insulation
PSE 618	High Voltage Engineering & Insulation	--
PSE 619	Power Plant Instrumentation	--
PSE 620	HVDC Transmission Systems	Solid State Power Converters
PSE 621	Power Quality	--
PSE 622	Digital Control Systems	Modern Control Theory
PSE 623	Electrical Distribution Systems	--
PSE 624	Voltage Stability	--
PSE 625	Electrical Smart Grids	--
PSE 626	AI Techniques	--
PSE 627	Power System Deregulation	--
PSE 628	Energy Conservation & Audit	--

- 24 credits have to be achieved from Core Subjects.
- 24 credits have to be achieved from Elective Subjects.
- 8 credits have to be achieved from Labs.
- 2 Credits have to be achieved from Internship.
- 22 credits have to be achieved from Project.
- Total 80 credits are required for Awarding the M.Tech Degree.

		L	T	P	M	C
MT/PSE 511	**MODERN CONTROL THEORY ***	**4**	**0**	**0**	**100**	**4**

UNIT –I

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

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

General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems – Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.

UNIT- II

NONLINEAR 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.

UNIT-III

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– Direct method of Lyapunov – Generation of Lyapunov functions – Variable gradient and Krasoviskii's methods – estimation of transients using Lyapunov functions.

UNIT- IV

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

TEXT BOOKS:

1. Modern Control System Theory by M.Gopal – New Age International -2/E
2. Modern Control Engineering by Ogata.K – Prentice Hall – 5thEdition

REFERENCES:

1. Design of Feedback Control Systems by Stefani et.al. – Oxford – 4/E

* CONTINUOUS-TIME SYSTEMS ONLY

		L	T	P	M	C
MT/PSE 512	ADVANCED POWER SYSTEM PROTECTION	4	0	0	100	4

UNIT-I:

Need for protection systems: Nature and causes of faults, types of faults, effects of faults, fault statistics, evolution of protective relays, zones of protection, primary & back up protection, essential qualities of protection, classification of protective relays and schemes, Current Transformers for protection: Requirements of CT's used for protection-core material-magnetization characteristics-accuracy-CT burden-transient behavior of CT's-modern trends in CT design.
Potential transformers used for protection**: T**ypes of construction-electromagnetic and capacitor types, summation transformer, phase-sequence current segregating network.

UNIT-II:

Wire pilot protection: circulating current scheme- balanced voltage scheme - transley scheme- - Carrier current protection: Direct transfer tripping, permissive under-reach and over-reach transfer tripping schemes – carrier acceleration & carrier blocking scheme. Use of optical fibers for protection schemes

UNIT-III:

Static Over Current Relays**:**Instantaneous- Definite time – Inverse time- Directional-IDMT- Very inverse Time-Extremely inverse time over current relays. Time- current characteristics of over current relays-applications -static differential relay using amplitude comparator, use of sampling comparator.
Static Distance Protection: Static Impedance Relay- Static reactance relay- static MHO relay-effect of arc resistance, effect of power surges, effect of line length and source impedance on performance of distance relays- selection of distance relays

UNIT-IV:

Microprocessor based protection relays**:**– Working principles of microprocessor based over current, and distance relays: impedance, reactance and mho relays.
Protection of overhead lines against lightning: shielded wires and ground wires.

TEXT BOOKS:

1. T.S.M.Rao – Power System Protection : Static Relays With Microprocessor Applications – Tata McGraw-Hill.
2. Badri Ram & DN Viswakarma – Power System Protection & Switch Gear – McGraw Hill.
3. Computer Relaying For Power Systems – Research Studies Press, 1988.
REFERENCE BOOKS: 1. A.R.VanC.Washington – Protective Relays – Their Theory & Practice, Vol.I& II – John Wiley & Sons.
2. D.Robertson – Power System Protection – Reference Manual – Oriel Press – London, 1982.
3. C.R.Mason – The Art and Science of Protective Relaying – John Wiley.
4. S.S.Rao – Switch Gear & Protection – Khanna Publisher's, Delhi. 5.
Microprocessors & Microcomputer Development Systems: Designing Micro.

		L	T	P	M	C
MT/PSE513	**COMPUTER METHODS IN POWER SYSTEMS**	**4**	**0**	**0**	**100**	**4**

UNIT-I:

Network Matrices and Modeling: Introduction, linear transformation techniques (bus, branch, loop frame of references), single phase modeling of transmission lines, off-nominal transformer tap representation, phase shift representation, 3-phase models of transmission lines, modeling of loads, representation of synchronous machines

UNIT-II:

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

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

UNIT-III:

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

UNIT-IV:

Z_{BUS} methods in Contingency Analysis: Adding and removing multiple lines (current injection methods), piece wise solution of interconnected systems, analysis of single and multiple contingencies, external system representation for fault and contingencies by Ward and REI approaches.

***TEXT BOOKS*:**

1. Stagg G.Ward, El-Abiad: Computer methods in power system analysis. McGraw Hill, ISE, 1968.
2. J.Arrilaga and C.P.Arnold: Computer modeling of electric power systems, John Wiley & Sons, N.Y. 1983.
3. J.J.Grainger, W.D.Stevenson JR, Power system analysis, TMH, Delhi 2007.
4. George Kusic, Computer Aided Power System Analysis, CRC Press, 2nd Edition,2008.

***REFERENCES*:**

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

		L	T	P	M	C
MT/PSE 514	**FLEXIBLE AC TRANSMISSION SYSTEMS**	**4**	**0**	**0**	**100**	**4**

UNIT-I

FACTS Concept and General system Considerations:Power Flow in AC system - definitions on FACTS - Basic types of FACTS Controllers. Converters for Static Compensation – Basic concept of voltage-sourced converters.Single phase, three phase full wave bridge converters operation, Transformer connections for 12 pulse 24 and 48 pulse operation.Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, comparison of current source converters with voltage source converters.

UNIT-II

Static Shunt Compensators: SVC and STATCOM - Operation and Control of TSC, TCR, STATCOM - Comparison between SVC and STATCOM - STATCOM for transient and dynamic stability enhancement.

UNIT-III

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.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Power Electronics by Ned Mohan et. al , John Wiley & sons
2. Reactive Power Control in Electric Systems by T.J.E. Miller , John Wiley & sons
3. Introduction to FACTS controllers by Kalyan K Sen, Mey Ling Sen – John Wiley 2009

		L	T	P	M	C
MT/PSE 515	**POWER SYSTEM STABILITY**	**4**	**0**	**0**	**100**	**4**

UNIT – I

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

UNIT – II

Voltage stability analysis: Voltage stability concepts – voltage collapse phenomenon – prevention of voltage collapse.

Voltage stability of Single machine connected to infinite bus system – PV curves – QV curves. Effect of compensation – Series, shunt and SVCs.

UNIT – III

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

Swing Equation solution by point by point method – modified Euler's method and Gauss Seidel method.

UNIT – IV

Effects on stability due to losses – governor action – inertia – saturation – SCR – saliency – damper windings – methods of grounding.

Methods of improving stability: High speed fault clearing, Reduction of transmission system reactance, regulated shunt compensation, Dynamic braking, Reactor switching, Single pole switching, Steam turbine fast valving, Generator tripping, load shedding, High speed excitation systems, HVDC transmission links, SVC.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

		L	T	P	M	C
MT/PSE 516	**REAL TIME CONTROL OF POWERSYSTEMS**	**4**	**0**	**0**	**100**	**4**

UNIT-I:
Economic dispatch: Economic importance - characteristics of thermal, nuclear and hydro-generator units - Economic dispatch problem – Thermal system dispatch with network losses - The first order gradient method –Newton's method -base point and participation factor method.

UNIT-II:
Unit Commitment and solution methods-priority list methods, dynamic-programming solution - Security-Constrained Unit Commitment (SCUC) - daily auctions using a Unit Commitment- ,backward DP approach- forward DP approach-restricted search ranges -strategies –reliability considerations.
Load frequency control: Necessity of keeping frequency constant-Definition of control area – single area control – Block diagram representation of an isolated power system – steady state analysis – dynamic response – proportional plus integral control of single area and its block diagram representation – steady state response.

UNIT-III:
Computer control of power systems: Energy control centre – various levels – SCADA system – computer configuration functions – monitoring – data acquisition and controls – EMS system – expert system applications for power system operation.
Security control: Factors affecting power system security-Security analysis and monitoring – system operating states by security control functions – generator and line outages by linear sensitivity factors.

UNIT-IV:
State estimation: Power system state estimation – Maximum likelihood weighted least square estimation-introduction-maximum likelihood concepts-matrix formulation-weighted least squares estimation– detection and identification of bad measurements – network observability and pseudo measurements.

TEXT BOOKS:
1. Allen J. Wood and Bruce F. Wollenberg "Power Generation, Operation & Control" 2nd edition, John Wiley and Sons.
2. I.J. Nagarath& D. P. Kothari , "Modern power system analysis" 3rd Edition, TMH
3. Mahalanabis A.K., Kothari D.P. and Ahson S.I., "Computer aided power system analysis and control", TMH
4. J.J.Grainger, W.D.Stevenson JR, "Power system analysis", Tata McGraw Hill N.D. 2007.

REFERENCES:
I. Elgard , "Electric Energy Systems Theory – An Introduction" Tata McGraw Hill Publishing Company Ltd,Newdelhi,second edition,2003.
2. AbhijitChakrabarti&SunitaHalder" Power System Analysis operation and Control " 1st edition, PHI.

		L	T	P	M	C
MT/PSE 551	**POWER SYSTEMS LAB**	**0**	**0**	**3**	**100**	**2**

List of Experiments*

1. Evaluation of ABCD parameters for transmission line
2. Sequence reactances and fault studies on synchronous machine
3. Sequence impedances of three phase transformer
4. Surge Impedance Loading limits of transmission line
5. Active and Reactive power control of synchronous machine connected to infinite bus
6. Reactive power control by tap changing transformer
7. Line and load compensation of power system network
8. Characteristics of electromagnetic relays
9. Implementation of microprocessor based relays
10. Characteristics of static relays
11. Study of 3-phase bridge converter
12. Study of characteristics of Dual converter
13. Study of single-phase inverter
14. Study of PWM controlled 3-phase inverter
15. H.V. testing of insulators
16. High voltage testing of Cables
17. Study of corona phenomenon
18. Harmonic analysis by Power network analyzer
19. Short circuit studies on DC Network analyzer
20. Grid synchronization of Solar PV Inverter

*** Any EightExperiments to be completed**

		L	T	P	M	C
MT/PSE 552	**SIMULATION LAB – I**	**0**	**0**	**3**	**100**	**2**

List of Experiments*

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

*** Any Eight experiments to be completed**

		L	T	P	M	C
MT/PSE 553	**SIMULATION LAB – II**	**0**	**0**	**3**	**100**	**2**

List of Experiments*

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

*** Any Eight experiments to be completed**

		L	T	P	M	C
MT/PSE 611	**OPERATIONS RESEARCH**	**4**	**0**	**0**	**100**	**4**

UNIT I

LINEAR PROGRAMMING: Definition and Scope of Operations Research, Mathematical formulation of the problem, graphical method, Simplex method , artificial basis technique , Degeneracy , alternative optima , unbounded solution , infeasible solution.

UNIT II

TRANSPORTATION PROBLEM : Introduction to the problem , LP formulation of a ransportation problem . Basic feasible solution by north-west corner method, Vogel's approximation method, least cost method. Finding optimal solution by MODI method, degeneracy , unbalanced transportation matrix.
Non linearprogramming : Kuhn-Tucker conditions.

UNIT III

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

UNIT IV

SIMULATION : Definition and applications. Monte Carlo simulation. Application problems in queuing and inventory.

DYNAMIC PROGRAMMING : Characteristics of D.P. model , solution of optimal sub-division problem.

Text Books :

1. Operations Research –H.A. Taha, 6th Edition, PHI
2. Introduction to Operations Research – Hiller and Liberman

Reference Books :

1. Introduction to operations Research-Phillips, Ravindran, James Solegerg.
2. Optimization theory and applications – S.S. Rao 3rd Ed., New Age International
3. Operations Research – Gupta and Hira
4. Pert and CPM principles and applications – L.S.Srinadh

		L	T	P	M	C
MT/PSE 612	**POWER SYSTEM RELIABILITY**	**4**	**0**	**0**	**100**	**4**

UNIT-I

Elements of Probability theory: Introduction, rules for combining probabilities of events, Bernoulli's trials; probability distributions: Random variables, density and distribution functions- Binomial, Poisson, normal and exponential distributions; expected value and standard deviation of Binomial distribution and exponential distribution – Bath tub curve.

UNIT-II

Reliability of engineering systems: Component reliability, hazard models, reliability analysis of networks with non repairable components- series, parallel, series- parallel configurations and non-series-parallel configurations- minimal tie-set, minimal cut-set and decomposition methods, reliability measures, MTTF, MTTR, MTBF.

UNIT-III

Markov Chains: Introduction; transition probabilities and the stochastic transition probability matrix; classification of states; evaluation of limiting state probabilities; Markov processes – one component repairable system, time dependent probability evaluation using Laplace Transform approach, evaluation of limiting state probabilities using STPM; two component repairable modes - frequency and duration concept-evaluation of frequency of encountering state, mean cycle time for one, two component repairable models, evaluation of cumulative probability and cumulative frequency of encountering merged states.

UNIT-IV

Power system reliability: Generation system reliability analysis- reliability model of generation system, recursive relation for unit addition and removal, load modeling, merging of generation model with load model, evaluation of transition rates for merged state model; cumulative probability, cumulative frequency of failure evaluation; LOLP. LOLE. Expected value of the Demand not served E (D)

Distribution system reliability analysis- radial networks, weather effects on transmission lines; evaluation of load and energy indices

Composite system reliability – decomposition method

TEXT BOOKS:

1. Reliability evaluation of engineering systems by R.Billinton and Ronald N.Allan, Plenum press, NY&London
2. Reliability evaluation of power systems by R.Billinton and Ronald N.Allam, Plenum press, NY&London
3. An introduction to reliability and maintainability engineering by SharlesE.Ebeling, TMH

REFERENCE BOOKS:

1. Reliability modelling in electric power systems by J.Endrenyi, John Wiley & sons
2. Power System planning by R.Sullivan , McGraw Hill
3. Probability, Random variables and Stochastic processes by Athanasios Papoulis and S.UnnikrishnaPillai, TMH

		L	T	P	M	C
MT/PSE 613	**ADVANCED MICROPROCESSORS & MICROCONTROLLERS**	**4**	**0**	**0**	**100**	**4**

UNIT – I

Microprocessors: Introduction to Microcomputers and Microprocessors, Introduction to 8086 microprocessor family, 8086 internal architecture, Addressing modes, Programming the 8086, Instruction descriptions, Assembler directives, Minimum and Maximum Mode and Bus Timings, Ready and Wait states and 8086 based micro-computing system.

Advanced Processors

Architectural features of 80386, 486 and Pentium Processors their memory management, Introduction to Pentium Pro Processors their features.

UNIT – II

Digital & Analog Interfacing: Addressing memory and ports in Microcomputer system, 8086 interrupts and Interrupt Responses, Programmable parallel ports and Handshake input/output, interfacing a microprocessor to keyboards.

D/A converter operation, Interfacing and applications, A/D converter specifications types and interfacing.

UNIT – III

Programmable Devices: Introduction to programmable peripheral devices: 8253/8254, 8259, 8251. The DMA data transfer, RISC Vs CISC, RISC properties, RISC evaluations, overview of RISC development and current schemes, Memory Interfacing (DRAM), PPI-Modes of operation of 8255.

UNIT – IV

8051 Microcontrollers: Introduction to 8 bit and 16 bit microcontrollers; 8031/8051 microcontroller architecture and memory organization, Addressing modes, Instruction formats, CPU timings, Interrupt structure and interrupt priorities; port structures and operations. Accessing internal and external memories, Timer / Counter functions and different modes of operations. Interfacing of stepper motor , LED display , and robotic control.

TEXT BOOKS:

1. Dougles V Hall, Microprocessor and Interfacing: Programming and hardware, 2nd Editon, TMH 2003

2. Barry B. Brey – The Intel Microprocessors 8086/ 8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Preprocessor, Architecture, Programming and Interfacing, PHI, 4th Edition.

REFERENCE BOOKS:

1. Yu-Cheng Liu, Glenn A Gibson, Microcomputer systems: the 8086/8088 Family, Architecture, Programming and Design, 2nd Edition, PHI, 2003

2. A K Ray, K M Bhurchandi, Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing, TMH 2004

3. DenielTabak – Advanced Microprocessors, McGraw Hill , 2nd edition

4. 8086 Micro Processors by Kenrith J Ayala, Thomson Publishers.

5.The 8088 and 8086 Microprocessor- W.A. Triebel&Avtar Singh- PHI, 4th Edition,2002.

		L	T	P	M	C
MT/PSE 614	**SOLID STATE POWER CONVERTERS**	**4**	**0**	**0**	**100**	**4**

UNIT-I

LINE COMMUTATED CONVERTERS:AC to DC Converter- single phase controlled rectifier bridge type - with R load- RL load- with and without FWD- analysis & wave forms- three phase controlled rectifier bridge type with R, RL loads with & without FEWD- analysis & waveforms – performance factors of line commutated converters - advantages- applications - power factor improvements. twelve pulse converter.

UNIT-II

AC VOLTAGE CONTROLLERS: Single phase Ac voltage controllers- with R & RL loads- Analysis & waveforms- three phase AC voltage controllers- analysis& wave forms – AC synchronous tap changers - Matrix converters.

CYCLO CONVERTER:

Single phase – bridge type- R & RL loads- 3 phase bridge type principle of operation & wave forms.

UNIT-III

INVERTERS: Bridge type- Single phase Inverters. MC Murray- Bedford inverter- and their analysis & waveforms – Bridge type three phase Inverters –analysis of 180 degree & 120 degree conduction modes. Current Source Inverter- some applications- comparison of VSI & CSI- problems.

UNIT-IV

VOLTAGE CONTROL OF SINGLE PHASE INVERTERS:single PWM – Multiple PWM – sinusoidal PWM – modified PWM – phase displacement Control – Advanced modulation techniques for improved performance – Trapezoidal, staircase, stepped, harmonic injection and delta modulation –Advantage – application

VOLTAGE CONTROL OF THREE PHASE INVERTERS:sinusoidal PWM – Third Harmonic PWM – 60 degree PWM – space vector modulation – Comparison of PWM techniques – harmonic reductions

TEXT BOOKS:

1. Power Electronics – Mohammed H. Rashid – Pearson Education – Third Edition – First Indian reprint 2004.
2. Power electronics – V R Moorthy – Oxford Publications

REFERENCE BOOKS:

1. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley & Sons – Second Edition.

		L	T	P	M	C
MT/PSE 615	**DEMAND SIDE ENERGY MANAGEMENT**	**4**	**0**	**0**	**100**	**4**

Unit – I

Energy Audit : Definitions-Need-concepts-Types of energy audit; Energy index – cost index – pieharts – Sankey diagrams.

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

Unit – II

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

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

Unit – III

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

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

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

Unit – IV

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

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

TEXT BOOKS:

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGrawhill publishing company ltd. New Delhi
2. Energy conversion systems by Rakosh Das Begamudre New age international publishers
3. Energy efficient electric motors selection and application by John C.Andreas

REFERENCE BOOKS:

1. Energy management by Paul W.O' Callaghan McGraw hill book company
2. Energy Management – by W.R.Murphy&G.MckeyButterworths.
3. Energy management Hand book by Wayne C.Turner, John wiley and sons publications
4. Hand book on Energy Audit and Management by AmitkumarTyagi,published by TERI(Tata energy research Institute).

		L	T	P	M	C
MT/PSE 616	**COMPUTER NETWORKS**	**4**	**0**	**0**	**100**	**4**

UNIT-I

Evolution of computer Networks -Needs/advantages and problems of computer networks - Network Topologies - Transmission media- Modems and multiplexers.

UNIT-II

Network protocols - Network switching methods - Network Architecture - OSI model - Purpose layered design – Error detection and correction - Data link protocols - sliding window protocols - data compression techniques.

UNIT-III

Local Area Networks - Medium access methods - IEEE 802. x standards - Wide Area Networks - Routing Algorithms - Network Interconnectivity -Bridges and Gateways. Congestion control algorithms.

UNIT-IV

Evolution of the Internet - TCP/IP protocols, DNS, electronic mail - File Transfer Protocols, World Wide Web - File Transfer Access and Management - Virtual terminals.

TEXT BOOKS :

1. Andrew S Tannenbaum, “Computer Networks” , PHI

REFERENCES:

1. Kurose & Ross, “Computer networks – A top down approach featuring the Internet”,

Pearson Education.

2. Leon-Gartia, IndraWidjaja, “ Communication networks Fundamental Concepts and Key architectures”, TMH

3. Nader F. Mir, “ Computer and Communication networks”, PHI.

		L	T	P	M	C
MT/PSE 617	**EHV AC TRANSMISSION SYSTEMS**	**4**	**0**	**0**	**100**	**4**

Unit I

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

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

Unit II

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

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

Unit III

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

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

Unit IV

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

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

TEXT BOOKS :

1. Extra High Voltage AC Transmission Engineering – Rakosh Das Begamudre, Wiley Eastem ltd., New Delhi
2. EHV Transmission line reference book – Edision Electric Institute (GEC) 1986.

REFERENCE BOOKS:

1.EHV AC/ DC Transmission engineering and practice by S.Rao, Khanna publications

		L	T	P	M	C
MT/PSE 618	HIGH VOLTAGE ENGINEERING & INSULATION	4	0	0	100	4

UNIT I:

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

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

UNIT II:

Measurement of high voltage and currents:
Measurement of high d.c.voltages, Measurement of high a.c. and impulse voltages, Measurement of high d.c., a.c. and impulse currents. Cathode Ray Oscilloscope for impulse voltage and current measurements.

UNIT III:

Testing of Materials and Apparatus:
Measurement of D.C. resistivity, measurement of dielectric constant and loss factor, partial discharge measurements, testing of insulators, bushing, circuits breakers, transformers and surge diverters.
Over Voltage Phenomenon Insulation Coordination:Causes of over voltage, lighting phenomenon, switching over voltages and power frequency over voltages in power systems,

UNIT IV:

Insulation Coordination:
Principle of insulation coordination on high voltage and extra high voltage power systems.
Gas insulated substations:
Advantages of Gas Insulated Substations, Comparison of Gas Insulated substations and Air Insulated Substations, Design and Layout of Gas Insulated Substations, Description of Various components in GIS.

TEXT BOOKS:

1. High Voltage Engineering by M.S.Naidu and V.Kamaraju – TMH.
2. High Voltage Engineering fundamentals by Kuffel and Zungel, Elsavier Publications
3. High voltage Engineering by CL Wadhwa

REFERENCES:

1. Fundamentals of Gaseous Ionization and plasma Electronics by Essam Nasser – Wiley - Inter Science.
2. High Voltage Technology by ALSTOM
3. High Voltage and Electrical Insulation engineering by R Arora, W Mosch John Wiley - 2011

		L	T	P	M	C
MT/PSE 619	**POWER PLANT INSTRUMENTATION**	**4**	**0**	**0**	**100**	**4**

4. Switchgear By BHEL, TMH

Unit – I

OVERVIEW OF POWER GENERATION
Brief survey of methods of power generation – Hydro, thermal, nuclear, solar and wind power – Importance of instrumentation and control in power generation –piping & instrumentation diagram – Cogeneration of power – control rooms

Unit – II

Instrumentation and control in water circuit and air-fuel circuit
Boiler feed water circulation – Measurements in water circuit – controls in water circuit – impurities in water and steam
Air fuel circuit – measurements in air fuel circuit – controls in air fuel circuit – analytical measurement

Unit – III
Power plant management
Mater control – combustion process – boiler efficiency – maintenance and measuring instruments – intrinsic and electrical safety – interlocks for boiler operation – computer based control and data logging systems – distributed control systems

Unit – IV
TURBINE – MONITORING AND CONTROL
Turbine steam inlet system – turbine measurements – turbine control system – lubrication and cooling systems

TEXT BOOKS
1. K. Krishnaswamy and M. PonniBala Power plant Instrumentation, PHI
2. .Al. Wakil, 'Power Plant Engineering', Tata McGraw Hill

REFERENCE BOOKS
1. S.M. Elonka and A.L. Kohal, 'Standard Boiler Operations', Tata McGraw Hill, New Delhi,1994.
2. Arora and Domakundwar Power plant engineering Dhanpatrai&sons

		L	T	P	M	C
MT/PSE 620	**HVDC TRANSMISSION SYSTEMS**	**4**	**0**	**0**	**100**	**4**

UNIT I:

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

Static Power Converters: 3-pulse, 6-pulse and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers.

UNIT II:

Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters. Control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control., DC power flow control.

UNIT III:

Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

UNIT IV:

Transient over voltages in HVDC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.Converter faults and protection in HVDC Systems: Converter faults, over current protection, Over voltage protection, surge arrestors.

TEXT BOOKS:

1. H.V.D.C Power transmission systems : Technology and system interactions by K.R.Padiyar, 2nd Edition, New Age Intl. Pvt. Ltd., 2012.
2. H.V.D.C.Transmissionby J.Arillaga : Peter Peregrinus ltd., London UK 1983.

REFERENCE BOOKS:

1. Direct current Transmission, by . E.W. Kimbark ,Wiely Inter Science – NewYork.
2. EHV-AC & HVDC transmission Engg. &Practice byS.Rao, Khanna Publishers.
3. HVDC transmission by Adamson and Hingorani.
4. Power Transmission by Direct Current, by E.Uhlman- Springer Verlag, Berlin Helberg – 1985.

		L	T	P	M	C
MT/PSE 621	**POWER QUALITY**	**4**	**0**	**0**	**100**	**4**

Unit – I

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

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

Unit – II

Voltage sags and Interruptions :Sources of sags and Interruptions. Estimating Voltage sag performance.

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

Unit III

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

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

Unit – IV

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

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

TEXT BOOK:

1. Electrical Power Systems Quality : By ROGER C.DUGAN, Electrotek Concepts Inc. (second edition)
2. Electrical Power Systems Quality, Second Edition by Roger C Dugan, Mark F. c Granaghan, Surya Santoso, H.WayneBeaty - McGraw Hill

REFERENCE BOOK:

1. Handbook of power quality by Angelo Baggini , John Wiley 2008
2. Power Quality by C. Sankaran - CRC PRESS

		L	T	P	M	C
MT/PSE 622	**DIGITAL CONTROL SYSTEMS**	**4**	**0**	**0**	**100**	**4**

UNIT – I

SAMPLING AND Z-PLANE ANALYSIS

Introduction, sample and hold operations, Sampling theorem, Reconstruction of original sampled signal to continuous-time signal.

Review of Z-transforms

Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: Primary strips and Complementary Strips.

UNIT – II

STATE SPACE ANALYSIS

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

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

UNIT – III

STABILITY ANALYSIS

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

DESIGN OF DISCRETE TIME CONTROL SYSTEM BY CONVENTIONAL METHODS

Design of digital control based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers. Design digital control through deadbeat response method.

UNIT – IV

STATE FEEDBACK CONTROLLERS AND OBSERVERS

Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.

LINEAR QUADRATIC REGULATORS

Min/Max principle, Linear Quadratic Regulators

TEXT BOOKS:

1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003
2. Digital Control and State Variable Methods by M.Gopal, TMH

REFERENCE BOOKS:

1. Discrete-Time Control systems - K. Ogata, Pearson Education/PHI, 2nd Edition
2. Digital Control Engineering, M. Gopal

		L	T	P	M	C
MT/PSE 623	**ELECTRICAL DISTRIBUTION SYSTEMS**	**4**	**0**	**0**	**100**	**4**

UNIT – I

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

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

UNIT – II

Distribution transformers: Types - Regulation and Efficiency - Use of monograms for obtaining efficiency.

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

UNIT – III

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

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

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

UNIT-IV

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

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

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

TEXT BOOKS:

1. TuranGonen "Electric Power Distribution system Engineering", 3rd Edition, TMH.
2. Dr. V. Kamaraju "Electrical distribution systems", TMH, 2009

REFERENCE BOOK:

1. A.S. Pabla "Electric Power Distribution" TMH, 5th Edition
2. S. Sivanagaraju and V. Sankar, "Electrical distribution systems and automation", Dhanpatrai& Sons

		L	T	P	M	C
MT/PSE 624	**VOLTAGE STABILITY**	**4**	**0**	**0**	**100**	**4**

Unit – I

Power system loads : Load characteristics that influence voltage stability such as – Discharge lighting, Induction motor, Air conditioning and heat pumps, Electronic power supplies, Over Head lines and cables.

Reactive Power compensation: Generation and absorption of reactive power – Reactive power compensators & voltage controllers : - shunt capacitors, synchronous phase modifier – static VAR system – on load tap changing transformer, booster transformers.

Unit – II

Reactive Power flow and voltage stability in power systems: Physical relationship indicating dependency of voltage on reactive power flow - reactive power transient stability; Q-V curve; definition of voltage stability, voltage collapse and voltage security. Voltage collapse phenomenon, Factors of voltage collapse, effects of voltage collapse, voltage collapse analysis.

Reasons for aggravation of the problem.

Unit – III

Voltage stability static indices : Development of voltage collapse index – power flow studies – singular value decomposition – minimum singular value of voltage collapse – condition number as voltage collapse index.

Unit – IV

Voltage stability margins &Improvement of voltage stability: Stability margins, voltage stability margin of un compensated and compensated power system . Dynamic voltage stability – voltage security , Methods of improving voltage stability and its practical aspects.

TEXT BOOKS:

1. Performance operation and control of EHV power transmission Systems A chakrabarti, D.P.Kothari, A.K. Mukhopadhyay, A.H. Wheeler publishing, 1995.

2. Power system Voltage stability - C.W. Taylor , Mc. Graw Hill, 1994

REFERENCE BOOKS:

1. Reactive power control in electrical systems by TJE Miller – John Wiley

2. Power system stability and control PrabhaKundur Tata McGraw Hill

3.Introduction to reactive power control and voltage stability in power transmission system by Chakrabarthi, D.P.Kothari and A.K. Mukhopadhyay - PHI

		L	T	P	M	C
MT/PSE 625	**ELECTRICAL SMART GRIDS**	**4**	**0**	**0**	**100**	**4**

UNIT–I:

INTRODUCTION: Introduction to smart grid- Electricity network-Local energy networks-Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid.
SMART GRID TO EVOLVE A PERFECT POWER SYSTEM: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system -Nodes of innovation.

UNIT–II:
DC DISTRIBUTION AND SMART GRID: AC vs DC sources-Benefits of and drives of DC power delivery systems - Powering equipment and appliances with DC-Data centers and information technology loads-Future neighborhood- Potential future work and research.
INTELLIGRID ARCHITECTURE FOR THE SMARTGRID: Introduction- Launching intelligrid- Intelligrid today- Smart grid vision based on the intelligrid architecture-Barriers and enabling technologies.

UNIT–III:
DYNAMIC ENERGY SYSTEMS CONCEPT: Smart energy efficient end use devices-Smart distributed energy resources-Advanced whole building control systems- Integrated communications architecture-Energy management-Role of technology in demand response-Current limitations to dynamic energy management-Distributed energy resources-Overview of a dynamic energy management-Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.
ENERGY PORT AS PART OF THE SMART GRID: Concept of energy -Port, generic features of the energy port.
POLICIES AND PROGRAMS TO ENCOURAGE END – USE ENERGY EFFICIENCY:
Policies and programs in action - multinational - national-state-city and corporate levels.

UNIT–IV:
MARKET IMPLEMENTATION: Framework-factors influencing customer acceptance and response - program planning-monitoring and evaluation.
EFFICIENT ELECTRIC END – USE TECHNOLOGY ALTERNATIVES: Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating - hyper efficient appliances - Ductless residential heat pumps and air conditioners – Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances - Data center energy efficiency- LED street and area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage - Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

TEXT BOOKS:
1. Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”- CRC Press, 2009.
2. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong.Wu, Akihiko Yokoyama, Nick Jenkins, “Smart Grid: Technology and Applications”- Wiley, 2012.
REFERENCE BOOKS:
1. James Momoh, “Smart Grid: Fundamentals of Design and analysis”- Wiley, IEEE Press, 2012.

		L	T	P	M	C
MT/PSE 626	**AI TECHNIQUES**	**4**	**0**	**0**	**100**	**4**

Unit I

Introduction to Neural Networks

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

Feed Forward Neural Networks

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

ANN paradigm-back propagation-RBF algorithms-Hope field networks

Unit II

Genetic algorithms-introduction-encoding-fitness function-reproduction operators

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

Unit III

Classical AND Fuzzy Sets

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

Fuzzy Logic System Components

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

UNIT IV

APPLICATION OF AI TECHNIQUES

Neural network applications: Process identification, Function Approximation, control and Process Monitoring, fault diagnosis and load forecasting. **Fuzzy logic applications:** Fuzzy logic control and Fuzzy classification specific applications to power systems load frequency control, fault diagnosis.

TEXT BOOKS:

1. . Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publication.
2. Chennakesava R Alavala “Fuzzy logic and neural networks”, New Age International Publishers.
3. S N Sivanandam, S N Deepa “ Principles of soft computing “, John Wiley 2007

REFERENCES:

1. Neural and Fuzzy Systems: Foundation, Architectures and Applications, - N. Yadaiah and S. BapiRaju, Pearson Education
2. Neural Engineering by C.Eliasmith and CH.Anderson, PHI
3. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.

		L	T	P	M	C
MT/PSE 627	**POWER SYSTEM DEREGULATION**	**4**	**0**	**0**	**100**	**4**

UNIT – I
INTRODUCTION
Power industry restructuring - Electricity market models - Electricity market fundamentals for planning purpose

UNIT – II
POWER SYSTEM PLANNING FUNDAMENTALS & RELIABILITY
Planning criteria - Uncertainties - Planning process - Generation planning - Transmission planning - Least cost planning - Risks and making choices in planning. Power system reliability - Reliability assessment - Security assessment.

UNIT - III
SHORT TERM LOAD AND PRICE FORECASTING
Short term load forecasting - Short term market price forecasting - Regression models for load forecasting - Artificial neural networks for load forecasting - Other approaches for forecasting such as data mining approaches; Issues in load and price forecasting.

UNIT - IV
NEW CHALLENGES OF POWER SYSTEM PLANNING IN A DEREGULATED ENVIRONMENT
Deterministic vs probabilistic approaches - Probabilistic power system reliability assessment - Probabilistic power system security assessment and Probabilistic power system planning.

TEXT BOOKS:

1. M. Ilic, F. Grliana, L. Fink “Power System Restructuring” Kluwer Academic Publisher.
2. Kankar Bhattacharya, Math H.J.Bollen, JaapE.Daader, Operation of restructured power systems, Kluwer academic publishers
3. R.L. Sullivan “Power System Planning “ Tata McGraw-Hill

REFERENCE BOOKS:

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

		L	T	P	M	C
MT/PSE 628	**ENERGY CONSERVATION & AUDIT**	**4**	**0**	**0**	**100**	**4**

Unit-I

System approach and End use approach to efficient use of Electricity - Electricity tariff types - Energy auditing: Types and objectives - audit instruments-ECO assessment and Economic methods- - specific energy analysis-Minimum energy paths-consumption models- Energy auditing of a typical industrial unit-case study.

Unit- II

Electric motors- Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis-Energy efficient / high efficient Motors-Case study; Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies-optimal selection and sizing – Optimal operation and storage; Case study

Unit-III

Transformer Loading/Efficiency analysis - feeder/cable loss evaluation, case study. Reactive power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-placement-Maintenance, case study; Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling-case study; Lighting-Energy efficient light sources-Energy conservation in Lighting Schemes-Electronic ballast-Power quality issues-Luminaries, case study;

Unit-IV

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study;Electric loads of Air conditioning & Refrigeration-Energy conservation measures-Cold storage - Types – Optimal operation – case study; Electric water heating-Gysers-Solar Water Heaters - Power Consumption in Compressors - Energy conservation measures - Electrolytic Process; Computer Controls-softwares-EMS.

TEXT BOOKS:

1. Industrial Energy Management: Principles and Applications by Giovanni and Petrecca, The Kluwer international series-207 (1999)
2. Guide to Electric Load Management by Anthony J.Pansini, Kenneth D.Smalling, Pennwell pub (1988)
3. Energy-Efficient Electric Motors and their applications by Howard E.Jordan, Plenum pub corp; 2nd ed. (1994)
4. Energy Management Hand book by Turner, Wayne C, Lilburn, The Fairmont press, 2001

REFERENCE BOOKS:

1. Plant Engineers and Managers Guide to Energy Conservation- 7th Ed. By Albert Thumann, P.W, TWI press Inc. Terre Haute
2. Energy Efficiency manual by Donald R.W, Energy Institute press
3. Art and Science of Utilization of Electrical Energy by Partab H, DhanpatRai& sons ,New Delhi
4. Electric Energy Utilization and Conservation by TripathyS.C , TMH
5. Guide Book on promotion of sustainable energy consumption by NEDCAP
6. Handbook of Energy Audits by Albert Thumann, Fairmont Pr; 5th edition (1998)
7. Recommended practice for Energy Conservation and cost effective planning in Industrial facilities by IEEE Bronze book, IEEE Inc, USA.