HINDUSTAN UNIVERSITY

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE

(Estd. u/s 3 of the UGC Act, 1956)

Padur, Kancheepuram District - 603 103.

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING

Regulations Curriculum and Syllabus 2013

M.Tech.
POWER SYSTEMS ENGINEERING

ACADEMIC REGULATIONS
(M.TECH./ M.B.A. / M.C.A.) (Full - Time / Part - Time)
(Effective 2013-14)

1. Vision, Mission and Objectives

1.1 The Vision of the Institute is "To make every man a success and no man a failure".

In order to progress towards the vision, the Institute has identified itself with a mission to provide every individual with a conducive environment suitable to achieve his / her career goals, with a strong emphasis on personality development, and to offer quality education in all spheres of engineering, technology, applied sciences and management, without compromising on the quality and code of ethics.

1.2 Further, the institute always strives

- To train our students with the latest and the best in the rapidly changing fields of Engineering, Technology, Management, Science & Humanities.
- To develop the students with a global outlook possessing, state of the art skills, capable of taking up challenging responsibilities in the respective fields.
- To mould our students as citizens with moral, ethical and social values so as to fulfill their obligations to the nation and the society.
- To promote research in the field of science, Humanities, Engineering, Technology and allied branches.

1.3 Our aims and objectives are focused on

- Providing world class education in engineering, technology, applied science and management.
- Keeping pace with the ever changing technological scenario to help our students to gain proper direction to emerge as competent professionals fully aware of their commitment to the society and nation.
- To inculcate a flair for research, development and entrepreneurship.

2. Admission

2.1 The admission policy and procedure shall be decided from time to time by the Board of Management (BOM) of the Institute, following guidelines issued by Ministry of Human Resource Development (MHRD), Government of India. The number of seats in each branch of the (M.TECH / M.B.A. / M.C.A.) programme will be decided by BOM as per the directives from Ministry of Human Resource Development (MHRD), Government of India and taking into account the market demands. Some seats for Non Resident Indians and a few seats for foreign nationals shall be made available.

2.2 The selected candidates will be admitted to the (M.TECH / M.B.A. / M.C.A.) programme after he/she fulfills all the admission requirements set by the Institute and after payment of the prescribed fees.

2.3 Candidates for admission to the first semester of the Master's Degree Programme shall be required to have passed an appropriate Degree Examination recognized by Hindustan University.

2.4 In all matters relating to admission to the (M.TECH / M.B.A. / M.C.A.). Programme, the decision of the Institute and its interpretation given by the Chancellor of the Institute shall be final.

2.5 If at any time after admission, it is found that a candidate has not fulfilled any of the requirements stipulated by the Institute, the Institute may revoke the admission of the candidate with information to the Academic Council.

3. Structure of the programme

3.1 The programme of instruction will have the following structure

i) Core courses of Engineering / Technology / Management.

ii) Elective courses for specialization in areas of student's choice

3.2 The minimum durations of the programmes are as given below:

Program	No. of Semesters
M.Tech.(Full-Time)	4
M.Tech.(Part -Time)	6
M.B.A. (Full - Time)	4
M.B.A. (Part - Time)	6
M.C.A.(Full - Time)	6
M.C.A.(Part -Time)	8

Every (M.TECH / M.B.A. / M.C.A.) programme will have a curriculum and syllabi for the courses approved by the Academic Council.

3.3 Each course is normally assigned certain number of credits. The following norms will generally be followed in assigning credits for courses.

- One credit for each lecture hour per week per semester
- One credit for each tutorial hour per week per semester
- One credit for each laboratory practical of three hours per week per semester.
- One credit for 4 weeks of industrial training and
- One credit for 2 hours of project per week per semester.

3.4 For the award of degree, a student has to earn certain minimum total number of credits specified in the curriculum of the relevant branch of study. The curriculum of the different programs shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below.

Program	Minimum prescribed credit range
M.Tech. (Full time / Part time)	75 - 85
M.B.A. (Full time / Part time)	85 - 95
M.C.A (Full time / Part time)	115 - 125

3.5 The medium of instruction, examination and the language of the project reports will be English.

4. Faculty Advisor

4.1 To help the students in planning their courses of study and for getting general advice on the academic programme, the concerned Department will assign a certain number of students to a Faculty member who will be called their Faculty Advisor.

5. Class Committee

5.1 A Class Committee consisting of the following will be constituted by the Head of the Department for each class:

(i) A Chairman, who is not teaching the class.

(ii) All subject teachers of the class.

(iii) Two students nominated by the department in consultation with the class.

The Class Committee will meet as often as necessary, but not less than three times during a semester.

The functions of the Class Committee will include:

(i) Addressing problems experienced by students in the classroom and the laboratories.

(ii) Analyzing the performance of the students of the class after each test and finding ways and means of addressing problems, if any.

(iii) During the meetings, the student members shall express the opinions and suggestions of the class students to improve the teaching / learning process.

6. Grading

6.1 A grading system as below will be adhered to.

Range of Marks	Letter Grade	Grade points
95-100	S	10
85 - 94	A	09
75- 84	B	08
65-74	C	07
55-64	D	06
50-54	E	05
< 50	U	00
	I (Incomplete)	–

6.2 GPA & CGPA

GPA is the ratio of the sum of the product of the number of credits C_i of course "i " and the grade points P_i earned for that course taken over all courses "i" registered by the student to the sum of Ci for all "i ". That is,

$$GPA = \frac{\sum_i C_i P_i}{\sum_i C_i}$$

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

6.3 For the students with letter grade I in certain subjects, the same will not be included in the computation of GPA and CGPA until after those grades are converted to the regular grades.

6.4 Raw marks will be moderated by a moderation board appointed by the Vice-Chancellor of the University. The final marks will be graded using an absolute grading system. The Constitution and composition of the moderation board will be dealt with separately.

7. Registration and Enrollment

7.1 Except for the first semester, registration and enrollment will be done in the beginning of the semester as per the schedule announced by the University.

7.2 A student will be eligible for enrollment only if he/she satisfies regulation 10 (maximum duration of the programme) and will be permitted to enroll if (i) he/ she has cleared all dues in the Institute, Hostel & Library up to the end of the previous semester and (ii) he/she is not debarred from enrollment by a disciplinary action of the University.

7.3 Students are required to submit registration form duly filled in.

8. Registration requirement

8.1 **(i)** A Full time student shall not register for less than 16 credits or more than 26 credits in any given semester.

8.1 **(ii)** A part time student shall not register for less than 10 credits or more than 20 credits in any given semester.

8.2 If a student finds his/her load heavy in any semester, or for any other valid reason, he/she may withdraw from the courses within three weeks of the commencement of the semester with the written approval of his/her Faculty Advisor and HOD. However the student should ensure that the total number of credits registered for in any semester should enable him/her to earn the minimum number of credits per semester for the completed semesters.

9. Minimum requirement to continue the programme

9.1 For those students who have not earned the minimum required credit prescribed for that particular semester examination, a warning letter to the concerned student and also to his parents regarding the shortage of his credit will be sent by the HOD after the announcement of the results of the university examinations.

10. Maximum duration of the programme

The minimum and maximum period for the completion of various programs are given below.

Program	Min. No. of Semesters	Max. No. of Semesters
M.Tech (Full - time)	4	8
M.Tech (Part - time)	6	10
M.B.A. (Full Time)	4	8
M.B.A. (Part Time)	6	10
M.C.A. (Full - Time)	6	12
M.C.A (Part -Time)	8	14

11. Temporary discontinuation

11.1 A student may be permitted by the Director(academic) to discontinue temporarily from the programme for a semester or a longer period for reasons of ill health or other valid reasons. Normally a student will be permitted to discontinue from the programme only for a maximum duration of two semesters.

12. Discipline

12.1 Every student is required to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the University.

12.2 Any act of indiscipline of a student reported to the Director (Academic) will be referred to a Discipline Committee so constituted. The Committee will enquire into the charges and decide on suitable punishment if the charges are substantiated. The committee will also authorize the Director(Academic) to recommend to the Vice-Chancellor the implementation of the decision. The student concerned may appeal to the Vice-Chancellor whose decision will be final. The Director (Academic) will report the action taken at the next meeting of the Council.

12.3 Ragging and harassment of women are strictly prohibited in the University campus and hostels.

13. Attendance

13.1 A student whose attendance is less than 75% is not eligible to appear for the end semester examination for that semester. The details of all students who have attendance less than 75% will be announced by the teacher in the class. These details will be sent to the concerned HODs and Director (Academic).

13.2 Those who have less than 75% attendance will be considered for condonation of shortage of attendance. However a condonation of 10% in attendance will be given on medical reasons. Application for condonation recommended by the Faculty Advisor, concerned faculty member and the HOD is to be submitted to the Director (Academic) who, depending on the merits of the case, may permit the student to appear for the end semester examination. A student will be eligible for this concession at most in two semesters during the entire degree programme. Application for medical leave, supported by medical certificate with endorsement by a Registered Medical Officer, should reach the HOD within seven days after returning from leave or, on or before the last instructional day of the semester, whichever is earlier.

13.3 As an incentive to those students who are involved in extra curricular activities such as representing the University in Sports and Games, Cultural Festivals, and Technical Festivals, NCC/ NSS events, a relaxation of up to 10% attendance will be given subject to the condition that these students take prior approval from the officer-in-charge. All such applications should be recommended by the concerned HOD and forwarded to Director (Academic) within seven instructional days after the programme/activity.

14. Assessment Procedure

14.1 The Academic Council will decide from time to time the system of tests and examinations in each subject in each semester.

14.2 For each theory course, the assessment will be done on a continuous basis as follows:

Test / Exam	Weightage	Duration of Test Exam
First Periodical Test*	10%	2 Periods
Second Periodical Test*	10%	2 Periods
Model exam	20%	3 hours
Seminar/ Assignments/Quiz	20%	
End - semester examination	50%	3 Hours

*** Best out of the two tests will be considered.**

14.3 For practical courses, the assessment will be done by the subject teachers as below:

(i) Weekly assignment/Observation note book / lab records - weightage 60%.

(ii) End semester examination of 3 hours duration including viva - weightage 40%

15. Make up Examination/model examination

15.1 Students who miss the end-semester examinations / model examination for valid reasons are eligible for make-up examination /model examination. Those who miss the end-semester examination / model examination should apply to the Head of the Department concerned within five days after he / she missed examination, giving reasons for absence.

15.2 Permission to appear for make-up examination / model exam will be given under exceptional circumstances such as admission to a hospital due to illness. Students should produce a medical certificate issued by a Registered Medical Practitioner certifying that he/she was admitted to hospital during the period of examination / model exam and the same should be duly endorsed by parent / guardian and also by a medical officer of the University within 5 days.

16. Project evaluation

16.1 For Project work, the assessment will be done on a continuous basis as follows:

Review / Examination	Weightage
First Review	10%
Second Review	20%
Third Review	20%
End semester Examination	50%

For end semester exam, the student will submit a Project Report in a format specified by the Director (Academic). The first three reviews will be conducted by a Committee constituted by the Head of the Department. The end - semester examination will be conducted by a Committee constituted by the Controller of Examinations. This will include an external expert.

17. Declaration of results

17.1 A candidate who secures not less than 50% of total marks prescribed for a course with a minimum of 50% of the marks prescribed for the end semester examination shall be declared to have passed the course and earned the specified credits for the course.

17.2 After the valuation of the answer scripts, the tabulated results are to be scrutinized by the Result Passing Boards of PG programmes constituted by the Vice-Chancellor. The recommendations of the Result Passing Boards will be placed before the Standing Sub Committee of the Academic Council constituted by the Chancellor for scrutiny. The minutes of the Standing Sub Committee along with the results are to be placed before the Vice-Chancellor for approval. After getting the approval of the Vice-Chancellor, the results will be published by the Controller of Examination/ Registrar.

17.3 If a candidate fails to secure a pass in a course due to not satisfying the minimum requirement in the end semester examination, he/she shall register and re-appear for the end semester examination during the following semester. However, the sessional marks secured by the candidate will be retained for all such attempts.

17.4 If a candidate fails to secure a pass in a course due to insufficient sessional marks though meeting the minimum requirements of the end semester examination, wishes to improve on his/ her sessional marks, he/she will have to register for the particular course and attend the course with permission of the HOD concerned and the Registrar. The sessional and external marks obtained by the candidate in this case will replace the earlier result.

17.5 A candidate can apply for the revaluation of his/her end semester examination answer paper in a theory course within 2 weeks from the declaration of the results, on payment of a prescribed fee through proper application to the Registrar/Controller of Examinations through the Head of the Department. The Registrar/ Controller of Examination will arrange for the revaluation and the results will be intimated to the candidate concerned through the Head of the Department. Revaluation is not permitted for practical courses and for project work.

17.6 The weightage for internal marks in finalizing results and grades shall be waived off after completion of 5 semesters.

18. Grade Card

18.1 After results are declared, grade sheet will be issued to each student, which will contain the following details:

(i) Program and branch for which the student has enrolled.

(ii) Semester of registration.

(iii) List of courses registered during the semester and the grade scored.

(iv) Semester Grade Point Average (GPA)

(v) Cumulative Grade Point Average (CGPA).

19. Class / Division

19.1 Classification is based on CGPA and is as follows:

$CGPA \geq 8.0$: **First Class with distinction**

$6.5 \leq CGPA < 8.0$: **First Class**

$5.0 \leq CGPA < 6.5$: **Second Class.**

19.2 (i) Further, the award of 'First class with distinction' is subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses in his/her first appearance within the minimum duration of the programme.

(ii) The award of 'First Class' is further subject to the candidate becoming eligible to the award of the degree having passed the examination in all the courses within the below mentioned duration of the programme.

Program	No. of Semesters
M.Tech.(Full-Time)	5
M.Tech.(Part -Time)	7
M.B.A. (Full - Time)	5
M.B.A. (Part - Time)	7
M.C.A.(Full - Time)	7
M.C.A.(Part -Time)	9

(iii) The period of authorized discontinuation of the programme (vide clause 11.1) will not be counted for the purpose of the above classification.

20. Transfer of credits

20.1 Within the broad framework of these regulations, the Academic Council, based on the recommendation of the transfer of credits committee so constituted by the Chancellor may permit students to earn part of the credit requirement in other approved institutions of repute and status in the country or abroad.

21. Eligibility for the award of (M.TECH / M.B.A. / M.C.A.) Degree

21.1 A student will be declared to be eligible for the award of the (M.TECH / M.B.A. / M.C.A.). Degree if he/she has

i) registered and successfully credited all the core courses,

ii) successfully acquired the credits in the different categories as specified in the curriculum corresponding to the discipline (branch) of his/her study within the stipulated time,

iii) has no dues to all sections of the Institute including Hostels, and

iv) has no disciplinary action pending against him/her.

The award of the degree must be recommended by the Academic Council and approved by the Board of Management of the University.

22. Power to modify

22.1 Notwithstanding all that has been stated above, the Academic Council has the right to modify any of the above regulations from time to time subject to approval by the Board of Management.

HINDUSTAN UNIVERSITY
HINDUSTAN UNIVERSITY CHENNAI

M.Tech. POWER SYSTEMS ENGINEERING
CURRICULUM 2013

Objective of the Programme:

This course will enable the students to understand the concept of power generation, transmission, distribution and utilization. This course provides an insight into the sophisticated methods of power system control and operation using computer. The students can pursue their research in the field of power quality, power system planning, power system reliability and application of power electronics to power systems. The students will be exposed to renewable energy sources.

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C	TCH
THEORY							
1	PMA107	Advanced Mathematics for Electrical Engineers *	4	0	0	4	4
2	PPS101	Power System Operation and Control	3	1	0	4	4
3	PPS102	Power System Analysis	3	1	0	4	4
4	PPS103	Power System Protection	3	1	0	4	4
5	PPD104	Analysis of Inverters$	3	1	0	4	4
6	PPD105	Special Electrical Machines*	3	1	0	4	4
		TOTAL				**24**	**24**

***Common to M.Tech(PED)/M.Tech(EC)**

$Common to M.Tech(PED)

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C	TCH
THEORY							
1	PPD204	Linear and Non-Linear System Theory*	3	1	0	4	4
2	PPS201	Electrical Transients in Power Systems	3	1	0	4	4
3	PPS202	Restructured Power Systems	3	1	0	4	4
4	PPS203	Power System Dynamics	3	1	0	4	4
5	-	Elective I	3	1	0	4	4
6	-	Elective II	3	1	0	4	4

PRACTICAL							
7	PPS205	Power System Simulation Laboratory II	0	0	3	2	3
		TOTAL				**26**	**27**

***Common to M.TECH(PED)/M.TECH(EC)**

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C	TCH
THEORY							
1	EIV	Elective III	3	1	0	4	4
2	EV	Elective IV	3	1	0	4	4
3	EVI	Elective V	3	1	0	4	4
PRACTICAL							
4	PPS301	Project Work (Phase -I)	0	0	12	6	12
		TOTAL				**18**	**24**

SEMESTER IV

S.NO	COURSE CODE	COURSE TITLE	L	T	P	C	TCH
PRACTICAL							
4	PPS401	Project Work (Phase -II)	0	0	24	12	24
		TOTAL				**12**	**24**

ELECTIVES FOR POWER SYSTEM ENGINEERING

S. No	COURSE CODE	COURSE TITLE	L	T	P	C
1	PPD702	Intelligent Control *	3	1	0	4
2	PPD703	Flexible AC Transmission Systems *	3	1	0	4
3	PPD705	High Voltage Direct Current Transmission *	3	1	0	4
4	PPD707	Power Quality *	3	1	0	4
5	PPS701	Electro Magnetic Field Computation and Modelling	3	1	0	4
6	PPS702	Analysis of Electrical Machines	3	1	0	4
7	PPS703	Power System Planning and Reliability	3	1	0	4
8	PPS704	Advanced Power System Dynamics	3	1	0	4
9	PPS705	Wind Energy Conversion Systems**	3	1	0	4
10	PPS706	Power Electronics for Renewable Energy Systems **	3	1	0	4

***Common to M.TECH(PED)/M.TECH(EC)**

**** Common to M.TECH(EC)**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 80

HINDUSTAN UNIVERSITY

M.Tech. POWER SYSTEMS ENGINEERING

SEMESTER I

PMA107 ADVANCED MATHEMATICS FOR ELECTRICAL ENGINEERS

Common to M.TECH(PED)/M.TECH(EC)

L	T	P	C
4	0	0	4

Goal

To equip the students with knowledge of advanced mathematical techniques required for the analytical study of the technical subjects under power electronics.

Objectives

1. To know about probability theory useful for power system
2. To know about dynamic programming For optimization techniques
3. to know about differential calculus

Out come

1. Getting idea about basic fundamentals of probability
2. Getting idea about optimization techniques
3. Getting idea about differential calculus

UNIT I ADVANCED MATRIX THEORY 9

Matrix norms - Jordan canonical form - Generalized eigenvectors - Singular value decomposition - Pseudo inverse - Least square approximations - QR algorithm.

UNIT II CALCULUS OF VARIATIONS 9

Variation and its properties - Euler's equation - Functional dependent on first and higher order derivatives - Functional dependent on functions of several independent variables - Some applications - Direct methods: Ritz and Kantorovich methods.

UNIT III LINEAR PROGRAMMING 9

Basic concepts - Graphical and Simplex methods -Transportation problem - Assignment problem.

UNIT IV DYNAMIC PROGRAMMING 9

Elements of the dynamic programming model - optimality principle - Examples of dynamic programming models and their solutions.

UNIT V RANDOM PROCESSES 9

Classification - Stationary random processes - Auto Correlation - Cross Correlations - Power spectral density - Linear system with random input - Gaussian Process.

L = 60 TOTAL = 60

REFERENCES

1. Lewis.D.W., "Matrix Theory", Allied Publishers,Chennai 1995.
2. Bronson,R, "Matrix Operations", Schaums outline Series ,McGraw Hill ,New York. 1989.
3. Elsgoltis, " Differential Equations and Calculus of Variations ", MIR Publishers,Moscow (1970).
4. Gupta.A.S., "Calculus of Variations with Applications", Prentice Hall of India,New Delhi,1999.
5. Taha, H.A., " Operations research - An Introduction ", Mac Millan publishing Co., (1982).
6. Gupta, P.K.and Hira, D.S., "Operations Research", S.Chand & Co., New Delhi, (1999).
7. Ochi, M.K. " Applied Probability and Stochastic Processes ", John Wiley & Sons (1992).
8. Peebles Jr., P.Z., "Probability Random Variables and Random Signal Principles", McGraw Hill Inc., (1993).

PPS101 POWER SYSTEM OPERATION AND CONTROL

L	T	P	C
3	1	0	4

Objectives

1. To know the various techniques for optimizing unit operation according to load demand.
2. To know about latest power frequency control , SCADA operation, economic dispatching.

Outcome

1. To get idea about load forecasting ,optimizing unit operation
2. To get an idea about power frequency control, SCADA operation, economic dispatching.

UNIT I LOAD FORECASTING 9

Introduction - Estimation of Average and trend terms - Estimation of periodic components - Estimation of Stochastic components : Time series approach - Auto- Regressive Model, Auto-Regressive Moving - Average Models - Kalman Filtering Approach - On-line techniques for non stationary load prediction.

UNIT II UNIT COMMITMENT 9

Constraints in unit commitment - Spinning reserve - Thermal unit constraints - Other constraints - Solution using Priority List method, Dynamic programming method - Forward DP approach Lagrangian relaxation method - adjusting .

UNIT III GENERATION SCHEDULING 9

The Economic dispatch problem - Thermal system dispatching with network losses considered - The Lambda - iteration method - Gradient method of economic dispatch - Economic dispatch with Piecewise Linear cost functions - Transmission system effects - A two generator system - coordination equations - Incremental losses and penalty factors-Hydro Thermal Scheduling using DP.

UNIT IV CONTROL OF POWER SYSTEMS 9

Review of AGC and reactive power control -System operating states by security control functions - Monitoring, evaluation of system state by contingency analysis - Corrective controls (Preventive, emergency and restorative) - Energy control center - SCADA system - Functions - monitoring , Data acquisition and controls - EMS system.

UNIT V STATE ESTIMATION 9

Maximum likelihood Weighted Least Squares Estimation: - Concepts - Matrix formulation - Example for Weighted Least Squares state estimation ; State estimation of an AC network: development of method - Typical results of state estimation on an AC network - State Estimation by Orthogonal Decomposition algorithm - Introduction to Advanced topics : Detection and Identification of Bad Measurements , Estimation of Quantities Not Being Measured , Network Observability and Pseudo - measurements - Application of Power Systems State Estimation.

L= 45 T=15 TOTAL = 60

REFERENCES

1. O.I.Elgerd, "Electric Energy System Theory - an Introduction", - Tata McGraw Hill, New Delhi - 2002.
2. P.Kundur ; "Power System Stability and Control", EPRI Publications, California , 1994.
3. Allen J.Wood and Bruce.F.Wollenberg, "Power Generation Operation and Control', John Wiley & Sons , New York, 1996.
4. A.K.Mahalanabis, D.P.Kothari. and S.I.Ahson., "Computer Aided Power System Analysis and Control", Tata McGraw Hill publishing Ltd , 1984.

PPS102 POWER SYSTEM ANALYSIS

L	T	P	C
3	1	0	4

Objective

1. To know about power flow analysis and Solutions with latest techniques
2. To know about Sequence network analysis and solutions
3. To know about transient stability analysis With faults

Outcome

1. To get an idea about power flow analysis and Solutions with latest techniques
2. To get an idea about Sequence network analysis and solutions
3. To get an idea about transient stability analysis With faults

UNIT I SOLUTION TECHNIQUE 9

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.

UNIT II POWER FLOW ANALYSIS 9

Power flow equation in real and polar forms; Review of Newton's method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment; Net Interchange power control in Multi-area power flow analysis: ATC, Assessment of Available Transfer Capability (ATC) using Repeated Power Flow method; Continuation Power Flow method.

UNIT III OPTIMAL POWER FLOW 9

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 IV SHORT CIRCUIT ANALYSIS 9

Fault calculations using sequence networks for different types of faults. Bus impedance matrix (ZBUS) construction using Building Algorithm for lines with mutual coupling; Simple numerical problems. 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 domain using Thevenin's equivalent and ZBUS matrix for different faults.

UNIT V TRANSIENT STABILITY ANALYSIS 9

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.

L= 45 T=15 TOTAL = 60

REFERENCES:

1. G W Stagg , A.H El. Abiad "Computer Methods in Power System Analysis", McGraw Hill, 1968.
2. P.Kundur, "Power System Stability and Control", McGraw Hill, 1994.
3. A.J.Wood and B.F.Wollenberg, "Power Generation Operation and Control",John Wiley and sons, New York, 1996.
4. 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.
5. 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.

PPS103 POWER SYSTEM PROTECTION

L	T	P	C
3	1	0	4

Objective

To know about different protection schemes in digital advancement.

Outcome

To get an idea about different digital protection Schemes in transmission systems

UNIT I EQUIPMENT PROTECTION 9

Types of transformers - Phasor diagram for a three - Phase transformer-Equivalent circuit of transformer - Types of faults in transformers- Over - current protection Percentage Differential Protection of Transformers - Inrush phenomenon-High resistance Ground Faults in Transformers - Inter-turn faults in transformers - Incipient faults in transformers - Phenomenon of over-fluxing in transformers - Transformer protection application chart .Electrical circuit of the generator -Various faults and abnormal operating conditions-rotor fault -Abnormal operating conditions; numerical examples for typical transformer and generator protection schemes

UNIT II OVER CURRENT PROTECTION 9

Time - Current characteristics-Current setting - Time setting-Over current protective schemes - Reverse power or directional relay - Protection of parallel feeders - Protection of ring feeders - Earth fault and phase fault protection - Combined Earth fault and phase fault protection scheme - Phase fault protective scheme directional earth fault relay - Static over current relays; numerical example for a radial feeder.

UNIT III DISTANCE AND CARRIER PROTECTION OF TRANSMISSION LINES 9

Braw back of over - Current protection - Introduction to distance relay - Simple impedance relay - Reactance relay - mho relays comparison of distance relay - Distance protection of a three - Phase line-reasons for inaccuracy of distance relay reach - Three stepped distance protection - Trip contact configuration for the three - Stepped distance protection - Three-stepped protection of three-phase line against all ten shunt faults - Impedance seen from relay side - Three-stepped protection of double end fed lines-need for carrier - Aided protection - Various options for a carrier -Coupling and trapping the carrier into the desired line section - Unit type carrier aided directional comparison relaying - Carrier aided distance schemes for acceleration of zone ??.; numerical example for a typical distance protection scheme for a transmission line.

UNIT IV BUSBAR R PROTECTION 9

Introduction - Differential protection of busbars-external and internal fault - Actual behaviors of a protective CT - Circuit model of a saturated CT - External fault with one CT saturation :need for high impedance - Minimum internal fault that can be detected by the high - Stability ratio of high impedance busbar differential scheme - Supervisory relay-protection of three - Phase busbars-Numerical examples on design of high impedance busbar differential scheme.

UNIT V NUMERICAL PROTECTION 9

Introduction - Block diagram of numerical relay - Sampling theorem- Correlation with a reference wave - Least error squared (LES) technique - Digital filtering-numerical over - Current protection - Numerical transformer differential protection-Numerical distance protection of transmission line

L= 45 T=15 TOTAL = 60

REFERENCES

1. Y.G. Paithankar and S.R Bhide, "Fundamentals of Power System Protection", Prentice-Hall of India, 2003.
2. P.Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
3. Badri Ram and D.N. Vishwakarma, "Power System Protection and Switchgear", Tata McGraw-Hill Publishing Company, 2002.

PPD104 ANALYSIS OF INVERTERS
Common to M.TECH (PED)

L	T	P	C
3	1	0	4

Objective

To provide the basic idea about fundamentals of inverter technologies and it's Power conversion with on/off techniques For 1-phase as well as 3-phase

Outcome

To get the knowledge about fundamentals of inverter technologies and it's power conversion with on/off techniques for 1-phase as well as 3-phase.

UNIT I SINGLE PHASE INVERTERS 9

Principle of operation of half and full bridge inverters - Performance parameters - Voltage control of single phase inverters using various PWM techniques - various harmonic elimination techniques - forced commutated Thyristor inverters.

UNIT II THREE PHASE VOLTAGE SOURCE INVERTERS 9

180 degree and 120 degree conduction mode inverters with star and delta connected loads - voltage control of three phase inverters.

UNIT III CURRENT SOURCE INVERTERS 9

Operation of six-step thyristor inverter - inverter operation modes - load - commutated inverters - Auto sequential current source inverter (ASCI) - current pulsations - comparison of current source inverter and voltage source inverters

UNIT IV MULTILEVEL INVERTERS 9

Multilevel concept - diode clamped - flying capacitor - cascade type multilevel inverters - comparison of multilevel inverters - application of multilevel inverters

UNIT V RESONANT INVERTERS **9**

Series and parallel resonant inverters - voltage control of resonant inverters - Class E resonant inverter - resonant DC - link inverters.

L = 45 T = 15 TOTAL = 60

TEXT BOOKS

1. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.

2. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, Second Edition,2002.

PPD105 SPECIAL ELECTRICAL MACHINES
Common to M.TECH(PED)/M.TECH(EC)

L	T	P	C
3	1	0	4

Objective

To provide idea about the principles of special electrical machines used in industries.

Outcome

To get the knowledge about principles of special electrical machines used in industries.

UNIT I SYNCHRONOUS RELUCTANCE MOTORS **9**

Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque - phasor diagram, motor characteristics.

UNIT II SWITCHED RELUCTANCE MOTORS **9**

Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control Microprocessor based controller.

UNIT III PERMANENT MAGNET SYNCHRONOUS MOTORS **9**

Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes.

UNIT IV PERMANENT MAGNET BRUSHLESS DC MOTORS **9**

Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller.

UNIT V STEPPING MOTORS **9**

Constructional features, principle of operation, modes of excitation torque production in Variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor.

L = 45 T=15 TOTAL = 60

TEXT BOOKS

1. Miller, T.J.E. " Brushless permanent magnet and reluctance motor drives ", Clarendon Press, Oxford, 1989.
2. Kenjo, T, " Stepping motors and their microprocessor control ", Clarendon Press, Oxford, 1989.

REFERENCES

1. Kenjo, T and Naganori, S " Permanent Magnet and brushless DC motors ", Clarendon Press, Oxford, 1989.
2. Kenjo, T. Power Electronics for the microprocessor Age, 1989.
3. B.K. Bose, "Modern Power Electronics & AC drives"
4. R.Krishnan, " Electric Motor Drives - Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

SEMESTER II
PPD204 LINEAR AND NON LINEAR SYSTEM THEORY
Common to M.TECH(PED)/M.TECH(EC)

L	T	P	C
3	1	0	4

Goal:

To provide the knowledge about system stability and outputs under linear as well as Nonlinear models with approximations

Objective

1. To know about Non linear System solutions using various techniques
2. To know the difference Between SISO and MIMO Systems
3. To know about state feed Back techniques.

Outcome

1. To get the knowledge about Non linear system solutions using various techniques
2. To get the knowledge about the difference between SISO and MIMO systems
3. To know about state feed back techniques.

UNIT I STATE VARIABLE REPRESENTATION 9

Introduction-Concept of State-State equation for Dynamic Systems-Time invariance and linearity-Nonuniqueness of state model-State Diagrams-Physical System and State Assignment.

UNIT II SOLUTION OF STATE EQUATION 9

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential-System modes-Role of Eigenvalues and Eigenvectors.

UNIT III CONTROLLABILITY AND OBSERVABILITY 9

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT IV STABILITY 9

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

UNIT V MODAL CONTROL 9

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

L = 45 T = 15 TOTAL = 60

REFERENCES:

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.
2. K. Ogatta, "Modern Control Engineering", PHI, 2002.
3. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.
4. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.
5. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003.
6. Z. Bubnicki, "Modern Control Theory", Springer, 2005.

PPS201 ELECTRICAL TRANSIENTS IN POWER SYSTEMS

L	T	P	C
3	1	0	4

Objectives

1. To know about high voltage transient Behavior travelling on line.
2. To know about voltage solutions under transient conditions using lattice diagram
3. To know about lightning and switching voltage travelling behavior using EMTP
4. To know about insulation coordination under transients.

Out come

1. To get knowledge about high voltage Transient behavior travelling on line.
2. To get knowledge about voltage solutions under transient conditions using lattice diagram
3. To get knowledge about lightning and switching voltage travelling behavior using EMTP
4. To get knowledge about insulation coordination under transients.

UNIT I TRAVELLING WAVES ON TRANSMISSION LINE 9

Lumped and Distributed Parameters - Wave Equation - Reflection, Refraction, Behaviour of Travelling waves at the line terminations - Lattice Diagrams - Attenuation and Distortion - Multi-conductor system and Velocity wave.

UNIT II COMPUTATION OF POWER SYSTEM TRANSIENTS 9

Principle of digital computation - Matrix method of solution, Modal analysis, transforms, Computation using EMTP - Simulation of switches and non-linear elements.

UNIT III LIGHTNING, SWITCHING AND TEMPORARY OVERVOLTAGES 9

Lightning: Physical phenomena of lightning - Interaction between lightning and power system - Factors contributing to line design - Switching: Short line or kilometric fault - Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault - Very Fast Transient Overvoltage (VFTO)

UNIT IV BEHAVIOUR OF WINDING UNDER TRANSIENT CONDITION 9

Initial and Final voltage distribution - Winding oscillation - traveling wave solution - Behaviour of the transformer core under surge condition - Rotating machine - Surge in generator and motor

UNIT V INSULATION CO-ORDINATION 9

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.

L = 45 T = 15 TOTAL = 60

REFERENCES

1. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., 1996.
2. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991.
3. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980.
4. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", (Second edition) Newage International (P) Ltd., New Delhi, 1990.
5. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
6. IEEE Guide for safety in AC substation grounding IEEE Standard 80-2000.
7. Working Group 33/13-09 (1988), 'Very fast transient phenomena associated with Gas Insulated System', CIGRE, 33-13, pp. 1-20.

PPS202 RESTRUCTURED POWER SYSTEMS

L	T	P	C
3	1	0	4

Objective

1. To know about best optimum pricing Methods by refer US market conditions
2. To know about price forecasting methods.

Outcome

1. To get the knowledge about best optimum Pricing methods by refer US market Conditions
2. To get the knowledge about price forecasting methods.

UNIT I OVERVIEW OF KEY ISSUES IN ELECTRIC UTILITIES RESTRUCTURING 9

Restructuring Models: PoolCo Model, Bilateral Contracts Model, Hybrid Model - Independent System Operator (ISO): The Role of ISO - Power Exchange(PX): Market Clearing Price(MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic Markets - Market Power - Stranded costs - Transmission Pricing: Contract Path Method, The MW-Mile Method - Congestion

Pricing: Congestion Pricing Methods, Transmission Rights - Management of Inter-Zonal/Intra Zonal Congestion: Solution procedure, Formulation of Inter-Zonal Congestion Sub problem, Formulation of Intra-Zonal Congestion Sub problem.

UNIT II ELECTRIC UTILITY MARKETS IN THE UNITED STATES: 9

California Markets: ISO, Generation, Power Exchange, Scheduling Co-ordinator, UDCs, Retailers and Customers, Day-ahead and Hour-Ahead Markets, Block forwards Market, Transmission Congestion Contracts(TCCs) - New York Market: Market operations - PJM interconnection - Ercot ISO - New England ISO - Midwest ISO: MISO's Functions, Transmission Management, Transmission System Security, Congestion Management, Ancillary Services Coordination, Maintenance Schedule Coordination - Summary of functions of U.S. ISOs.

UNIT III OASIS: OPEN ACCESS SAME-TIME INFORMATION SYSTEM: 9

FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Implementation of OASIS Phases: Phase 1, Phase 1-A, Phase 2 - Posting of information: Types of information available on OASIS, Information requirement of OASIS, Users of OASIS - Transfer Capability on OASIS: Definitions, Transfer Capability Issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation - Transmission Services - Methodologies to Calculate ATC - Experiences with OASIS in some Restructuring Models: PJM OASIS, ERCOT OASIS.

UNIT IV ELECTRIC ENERGY TRADING: 9

Essence of Electric Energy Trading - Energy Trading Framework: The Qualifying factors - Derivative Instruments of Energy Trading: Forward Contracts, Futures Contracts, Options, Swaps, Applications of Derivatives in Electric Energy Trading - PortFolio Management: Effect of Positions on Risk Management - Energy Trading Hubs - Brokers in Electricity Trading - Green Power Trading.

UNIT V ELECTRICITY PRICING - VOLATILITY, RISK AND FORECASTING: 9

Electricity Price Volatility: Factors in Volatility, Measuring Volatility - Electricity Price Indexes: Case Study for Volatility of Prices in California, Basis Risk - Challenges to Electricity Pricing: Pricing Models, Reliable Forward Curves - Construction of Forward Price Curves: Time frame for Price Curves, Types of Forward Price Curves - Short-term Price Forecasting: Factors Impacting Electricity Price, Forecasting Methods, Analyzing Forecasting Errors, Practical Data Study.

L= 45 T=15 TOTAL = 60

REFERENCES

1. G.W.Stagg, A.H.El.Abiad "Computer Methods in Power System Analysis", McGraw Hill, 1968.
2. M.K. Jain, N.D.Rao, G.J.Berg, "Improved Area Interchange Control Method for use with any Numerical Technique", I.E.E.E. P.E.S Winter Power Meeting 1974.
3. J.P.Britton, "Improved Area Interchange Control for Newton's method Load Flows", Paper 69 TP 124-PWR presented at IEEE Winter Power Meeting, NewYork, Jan 26-31, 1969.

4. 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.

5. 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.

PPS203 POWER SYSTEM DYNAMICS

L	T	P	C
3	1	0	4

Objective

1. To know about synchronous machine modeling for better power flow analysis with Stability
2. To know about power system stabilizers.

Outcome

1. To get knowledge about synchronous machine modeling for better power flow analysis,with stability
2. To get idea about power system stabilizers.

UNIT I SYNCHRONOUS MACHINE MODELLING 9

Schematic Diagram, Physical Description: armature and field structure, machines with multiple pole pairs, mmf waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation, Per Unit Representations: Lad-reciprocal per unit system and that from power-invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady-state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values, Equations of Motion: Swing Equation, calculation of inertia constant, Representation in system studies, Synchronous Machine Representation in Stability Studies: Simplifications for large-scale studies : Neglect of stator terms and speed variations, Simplified model with amortisseurs neglected: two-axis model with amortisseur windings neglected, classical model.

UNIT II MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS 9

Excitation System Requirements; Elements of an Excitation System; Types of Excitation System;Control and protective functions;IEEE (1992) block diagram for simulation of excitation systems. Turbine and Governing System Modelling: Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant, classical transfer function of a hydraulic turbine (no derivation), special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modelling: Single reheat tandem compounded type only and IEEE block diagram for dynamic simulation; generic speed-governing system model for normal speed/ load control function.

UNIT III SMALL-SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS 9

Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, The Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: State-space representation, stability of dynamic system, Linearisation, Eigen properties of the state matrix: Eigen values and eigenvectors, modal matrices, eigen value and stability, mode shape and participation factor. Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine, network and linearised system equations, block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability: analysis with numerical example,

UNIT IV SMALL-SIGNAL STABILITY ANALYSIS WITH CONTROLLERS 9

Effects Of Excitation System: Equations with definitions of appropriate K-constants and simple thyristor excitation system and AVR, block diagram with the excitation system, analysis of effect of AVR on synchronizing and damping components using a numerical example, Power System Stabiliser: Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example, Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical a example. Multi-Machine Configuration: Equations in a common reference frame, equations in individual machine rotor coordinates, illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines, illustration of stability analysis using a numerical example. Principle behind small-signal stability improvement methods: delta-omega and delta P-omega stabilizers.

UNIT V ENHANCEMENT OF SMALL SIGNAL STABILITY 9

Power System Stabilizer - Stabilizer based on shaft speed signal (delta omega) - Delta -P-Omega stabilizer-Frequency-based stabilizers - Digital Stabilizer - Excitation control design - Exciter gain - Phase lead compensation - Stabilizing signal washout stabilizer gain - Stabilizer limits

L= 45 T=15 TOTAL =60

REFERENCES

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. IEEE Committee Report, "Dynamic Models for Steam and Hydro Turbines in Power System Studies", IEEE Trans., Vol.PAS-92, pp 1904-1915, November/December, 1973. on Turbine-Governor Model.
3. P.M Anderson and A.A Fouad, "Power System Control and Stability", Iowa State University Press, Ames, Iowa, 1978.

PPS205 POWER SYSTEM SIMULATION LABORATORY-II

L	T	P	C
0	0	3	2

Objective

To know about the computational methods for power load flow solutions

Outcome

1. To get the knowledge about the computational methods for power load flow solutions.

LIST OF EXPERIMENTS

1. Small-signal stability analysis of single machine-infinite bus system using classical machine model
2 Small-signal stability analysis of multi-machine configuration with classical machine model
4. Co-ordination of over-current and distance relays for radial line protection
5. Induction motor starting analysis
6. Load flow analysis of two-bus system with STATCOM
7. Transient analysis of two-bus system with STATCOM
8. Available Transfer Capability calculation using an existing load flow program
9. Computation of harmonic indices generated by a rectifier feeding a R-L load.

TOTAL = 45

ELECTIVES FOR POWER SYSTEM ENGINEERING

PPD702 INTELLIGENT CONTROL
Common to M.TECH(PED)/M.TECH(EC)

L	T	P	C
3	1	0	4

Objective

1. To provide the basic idea about fuzzy and neural controlling models for power System optimization
2. To provide the basic idea about genetic algorithm controlling models for power System optimization.

Outcome

1. To gain the knowledge about fuzzy and neural controlling models for power System optimization
2. To gain the knowledge about genetic algorithm controlling models for power System optimization.

UNIT I INTRODUCTION 9

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

UNIT II ARTIFICIAL NEURAL NETWORKS 9

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller

UNIT III GENETIC ALGORITHM 9

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT IV FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system.

UNIT V APPLICATIONS 9

GA application to power system optimisation problem, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of

Neural-Network interconnection systems. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

L=45 T=15 TOTAL=60

REFERENCES

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. KOSKO,B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd.,1994.
3. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.

PPD703 FLEXIBLE AC TRANSMISSION SYSTEMS
Common to M.TECHPED)/M.TECH(EC)

L	T	P	C
3	1	0	4

Objective

1. To know about different advanced compensating devices like shunt and series compensators
2. To know about transient behavior Using compensating devices.

Outcome

1. To get the knowledge about different advanced compensating devices like shunt and series compensators
2. To get knowledge about transient behavior using compensating devices.

UNIT I INTRODUCTION 9

FACTS-a toolkit, Basic concepts of Static VAR compensator, Resonance damper, Thyristor controlled series capacitor, Static condenser, Phase angle regulator, and other controllers.

UNIT II SERIES COMPENSATION SCHEMES 9

Sub-Synchronous resonance, Torsional interaction, torsional torque, Compensation of conventional, ASC, NGH damping schemes, Modelling and control of thyristor controlled series compensators.

UNIT III UNIFIED POWER FLOW CONTROL 9

Introduction, Implementation of power flow control using conventional thyristors, Unified power flow concept, Implementation of unified power flow controller.

UNIT IV DESIGN OF FACTS CONTROLLERS 9

Approximate multi-model decomposition, Variable structure FACTS controllers for Power system transient stability, Non-linear variable-structure control, variable structure series capacitor control, and variable structure resistor control.

UNIT V STATIC VAR COMPENSATION 9

Basic concepts, Thyristor controlled reactor (TCR), Thyristors switched reactor (TSR), Thyristor switched capacitor (TSC), saturated reactor (SR), Fixed Capacitor (FC).

L = 45 T=15 TOTAL = 60

REFERENCES

1. Narin G.Hingorani, " Flexible AC Transmission ", IEEE Spectrum, April 1993,pp 40-45.
2. Narin G. Hingorani, " High Power Electronics and Flexible AC Transmission Systems IEEE High Power Engineering Review, 1998.
3. Narin G.Hingorani, " Power Electronics in Electric Utilities : Role of Power Electronics infuture power systems ", Proc. of IEEE, Vol.76, no.4, April 1988.
4. Einar V.Larsen, Juan J. Sanchez-Gasca, Joe H.Chow, " Concepts for design of FACTS Controllers to damp power swings ", IEEE Trans On Power Systems, Vol.10, No.2, May 1995.
5. Gyugyi L., " Unified power flow control concept for flexible AC transmission ", IEEE Proc-C Vol.139, No.4, July 1992.

PPD705 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION

Common to M.TECH(PED)/M.TECH(EC)

L	T	P	C
3	1	0	4

OBJECTIVE

1. To get an idea about power converters used in transmission grid
2. To get an idea about HVDC power controlling.

OUTCOME

1. To gain the knowledge about power converters used in transmission grid
2. To gain the knowledge about HVDC power controlling.

UNIT I DC POWER TRANSMISSION TECHNOLOGY 9

Introduction-comparison of AC and DC transmission application of DC transmission - description of DC transmission system planning for HVDC transmission-modern trends in DC transmission.

UNIT II ANALYSIS OF HVDC CONVERTERS 9

Pulse number, choice of converter configuration-simplified analysis of Graetz circuit-converter bridge characteristics - characteristics of a twelve pulse converter-detailed analysis of converters.

UNIT III CONVERTER AND HVDC SYSTEM CONTROL 9

General principles of DC link control-converter control characteristics-system control hierarchy-firing angle control-current and extinction angle control-starting and stopping of DC link-power control-higher level controllers-telecommunication requirements.

UNIT IV HARMONICS AND FILTERS **9**

Introduction-generation of harmonics-design of AC filters-DC filters-carrier frequency and RI noise.

UNIT V SIMULATION OF HVDC SYSTEMS **9**

Introduction-system simulation: Philosophy and tools-HVDC system simulation-modeling of HVDC systems for digital dynamic simulation.

L = 45 T=15 TOTAL = 60

REFERENCES

1. Padiyar, K.R., "HVDC Power Transmission System", Wiley Eastern Limited, New Delhi 1990. First edition.
2. Edward Wilson Kimbark, "Direct Current Transmission", Vol.I, Wiley interscience, New York, London, Sydney, 1971.
3. Rakosh Das Begamudre, Extra high voltage AC transmission engineering New Age International (P) Ltd., New Delhi, 1990.
4. Arrillaga, J., High Voltage direct current transmission, Peter Pregrinus, London, 1983.

PPD707 POWER QUALITY
(COMMON TO M.TECH (PED) / M.TECH (EC)

L	T	P	C
3	1	0	4

Objective

To provide the knowledge about improving quality techniques in power supply under Linear and non linear loads.

Outcome

Gain the knowledge about improving quality techniques in power supply under linear and non linear loads.

UNIT I INTRODUCTION **9**

Introduction - Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves - power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage - Power quality standards.

UNIT II NON-LINEAR LOADS **9**

Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

UNIT III MEASUREMENT AND ANALYSIS METHODS **9**

Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error - Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods: Laplace's, Fourier and Hartley transform - The Walsh Transform - Wavelet Transform.

UNIT IV ANALYSIS AND CONVENTIONAL MITIGATION METHODS 9

Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On-line extraction of fundamental sequence components from measured samples - Harmonic indices - Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

UNIT V POWER QUALITY IMPROVEMENT 9

Utility-Customer interface -Harmonic filters: passive, Active and hybrid filters -Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC -control strategies: P-Q theory, Synchronous detection method - Custom power park -Status of application of custom power devices.

L = 45 T = 15 TOTAL = 60

TEXT BOOKS

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition)
3. R. C. Dugan,M. F. McGranaghan, S. Santoso, H. W. Beaty, Electric Power Systems Quality, 2nd edition, McGraw-Hill Companies Inc., New York, 2003.
4. Power system harmonics -A.J. Arrillga
5. Power electronic converter harmonics -Derek A. Paice.

PPS701 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

L	T	P	C
3	1	0	4

Objective

To provide the knowledge about discrete numerical solutions to various electromagnetic Field models and configurations.

Outcome

To get an idea about various numerical solutions for various electromagnetic field models and configurations.

UNIT I INTRODUCTION 9

Review of basic field theory - electric and magnetic fields - Maxwell's equations - Laplace, Poisson and Helmoltz equations - principle of energy conversion - force/torque calculation - Electro thermal formulation.

UNIT II SOLUTION OF FIELD EQUATIONS I 9

Limitations of the conventional design procedure, need for the field analysis based design, problem definition, solution by analytical methods-direct integration method - variable separable method - method of images, solution by numerical methods- Finite Difference Method.

UNIT III SOLUTION OF FIELD EQUATIONS II 9

Finite element method (FEM) - Differential/ integral functions - Variational method - Energy minimization - Discretisation - Shape functions -Stiffness matrix -1D and 2D planar and axial symmetry problem.

UNIT IV FIELD COMPUTATION FOR BASIC CONFIGURATIONS 9

Computation of electric and magnetic field intensities- Capacitance and Inductance - Force, Torque, Energy for basic configurations.

UNIT V DESIGN APPLICATIONS 9

Insulators- Bushings - Cylindrical magnetic actuators - Transformers - Rotating machines.

L = 45 T = 15 TOTAL =60

REFERENCES

1. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.
2. Nathan Ida, Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer- Verlage, 1992.
3. Nicola Biyanchi , "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. S.J Salon, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai, India
5. User manuals of MAGNET, MAXWELL & ANSYS software.
6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, 1983.

PPS702 ANALYSIS OF ELECTRICAL MACHINES

L	T	P	C
3	1	0	4

Objective

To provide the basic idea about modeling of different machines and their analysis under steady state and transient conditions.

Outcome

To get a knowledge about modeling of different machines and their analysis under Steady state and transient conditions.

UNIT I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 9

General expression of stored magnetic energy, co-energy and force/ torque - example using single and doubly excited system -Calculation of air gap mmf and per phase machine inductance using physical machine data.

UNIT II REFERENCE FRAME THEORY 9

Static and rotating reference frames - transformation of variables - reference frames - transformation between reference frames - transformation of a balanced set -balanced steady state phasor and voltage equations - variables observed from several frames of reference.

UNIT III DC MACHINES 9

Voltage and toque equations - dynamic characteristics of permanent magnet and shunt DC motors - state equations - solution of dynamic characteristic by Laplace transformation.

UNIT IV INDUCTION MACHINES 9

Voltage and toque equations - transformation for rotor circuits - voltage and torque equations in reference frame variables - analysis of steady state operation - free acceleration characteristics - dynamic performance for load and torque variations - dynamic performance for three phase fault - computer simulation in arbitrary reference frame.

UNIT V SYNCHRONOUS MACHINES 9

Voltage and Torque Equation - voltage Equation in arbitrary reference frame and rotor reference frame - Park equations - rotor angle and angle between rotor - steady state analysis - dynamic performances for torque variations- dynamic performance for three phase fault - transient stability limit - critical clearing time - computer simulation.

L = 45 T = 15 TOTAL = 60

TEXT BOOKS

1. Paul C.Krause, OlegWasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", IEEE Press, Second Edition.
2. R.Krishnan, "Electric Motor Drives, Modeling, Analysis and Control" , Prentice Hall of India, 2002.

REFERENCES

1. Samuel Seely, " Eletomechanical Energy Conversion", Tata McGraw Hill Publishing Company,
2. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition, 1992.

PPS703 POWER SYSTEM PLANNING AND RELIABILITY

L	T	P	C
3	1	0	4

Objective

To provide the basic knowledge about advanced controlling techniques for reliable Power flow.

Outcome

To gain knowledge about advanced controlling techniques for reliable Power flow.

UNIT I LOAD FORECASTING 9

Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

UNIT II GENERATION SYSTEM RELIABILITY ANALYSIS 9

Probabilistic generation and load models- Determination of LOLP and expected value of demand not served -Determination of reliability of iso and interconnected generation systems.

UNIT III TRANSMISSION SYSTEM RELIABILITY ANALYSIS 9

Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.

UNIT IV EXPANSION PLANNING 9

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

UNIT V DISTRIBUTION SYSTEM PLANNING OVERVIEW 9

Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices.

L = 45 T = 15 TOTAL = 60

REFERENCES:

1. Proceeding of work shop on energy systems planning & manufacturing CI.
2. R.L .Sullivan, " Power System Planning",.

3. Roy Billinton and Allan Ronald, "Power System Reliability."

4. Turan Gonen, Electric power distribution system Engineering 'McGraw Hill,1986.

PPS704 ADVANCED POWER SYSTEM DYNAMICS

L	T	P	C
3	1	0	4

Objective

To provide the basic idea about advanced synchronous machine models under transient and Steady state conditions and with resonance effects.

Outcome

To gain the knowledge about advanced synchronous machine models under transient and Steady state conditions and with resonance effects.

UNIT I TRANSIENT STABILITY ANALYSIS [1,2,3] 9

Review of numerical integration methods: Euler and Fourth Order Runge-Kutta methods, Numerical stability and implicit methods, Simulation of Power System Dynamic response: Structure of Power system Model, Synchronous machine representation: equations of motion, rotor circuit equations, stator voltage equations, Thevenin's and Norton's equivalent circuits, Excitation system representation, Transmission network and load representation, Overall system equations and their solution: Partitioned - Explicit and Simultaneous-implicit approaches, treatment of discontinuities, Simplified Transient Stability Simulation using implicit integration method.

UNIT II SUBSYNCHRONOUS OSCILLATIONS [1] 9

Introduction - Turbine Generator Torsional Characteristics: Shaft system model - Examples of torsional characteristics - Torsional Interaction with Power System Controls: Interaction with generator excitation controls - Interaction with speed governors - Interaction with nearby DC converters.

UNIT III SUBSYSNCHRONOUS RESONANCE (SSR) [1,4] 9

Subsysnchronous Resonance (SSR): Characteristics of series -Compensated transmission systems - Self-excitation due to induction generator effect - Torsional interaction resulting in SSR - Analytical Methods - Numerical examples illustrating instability of subsynchronous oscillations - Impact of Network-Switching Disturbances: Steady-state switching - Successive network-Switching disturbances - Torsional Interaction Between Closely Coupled Units; time-domain simulation of subsynchronous resonance - EMTP with detailed synchronous machine model

UNIT IV TRANSMISSION, GENERATION AND LOAD ASPECTS OF VOLTAGE STABILITY ANALYSIS [5] 9

Review of transmission aspects - Generation Aspects: Review of synchronous machine theory - Voltage and frequency controllers - Limiting devices affecting voltage stability - Voltage-reactive power characteristics of synchronous generators - Capability curves - Effect of machine limitation on deliverable power - Load Aspects - Voltage dependence of loads - Load restoration dynamics - Induction motors - Load tap changers - Thermostatic load recovery - General aggregate load models.

UNIT V ENHANCEMENT OF TRANSIENT STABILITY AND COUNTER MEASURES FOR SUBSYNCHRONOUS RESONANCE [1] 9

Principle behind transient stability enhancement methods: high-speed fault clearing, reduction of transmission system reactance, regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit-breakers, single-pole switching, fast-valving, high-speed excitation systems; NGH damper scheme.

L = 45 T = 15 TOTAL = 60

REFERENCES

1. P. Kundur, Power System Stability and Control, McGraw-Hill, 1993.
2. H.W. Dommel and N.Sato, "Fast Transient Stability Solutions," IEEE Trans., Vol.PAS-91, pp, 1643-1650, July/August 1972.
3. AU Power Lab Laboratory Manuals, Anna University, pp : 7-1 to 7-12, May 2004.
4. H. W. Dommel, EMTP THEORY BOOK, Microtran Power System Analysis Corporation, Second Edition, 1996.
5. T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwer publishers,1998.

PPS705 WIND ENERGY CONVERSION SYSTEMS
Common to M.TECH(EC)

L	T	P	C
3	1	0	4

OBJECTIVE

To introduce the principle of wind turbines and wind energy conversion stems.

OUTCOME

To gain the knowledge about wind energy conversion that connected to the grid.

UNIT I INTRODUCTION 9

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

UNIT II WIND TURBINES 9

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

UNIT III FIXED SPEED SYSTEMS 9

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model-Generator model for Steady state and Transient stability analysis.

UNIT IV VARIABLE SPEED SYSTEMS **9**

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.

UNIT V GRID CONNECTED SYSTEMS **9**

Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries.

L = 45 T = 15 TOTAL = 60

REFERENCES

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,1976.
4. S.Heir "Grid Integration of WECS", Wiley 1998.

PPS706 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS
Common to M.TECH(EC)

L	T	P	C
3	1	0	4

OBJECTIVE

1. To provide an idea about usage of power electronics for renewable energy systems.
2. To provide idea about controlling and storage of non conventional energy using power electronics

OUTCOME

1. To gain the knowledge about power electronics utility in renewable energy systems
2. To gain the knowledge about controlling and storage of non conventional energy using power electronics.

UNIT I INTRODUCTION **9**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION **9**

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III POWER CONVERTERS 9

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS 9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

L = 45 T = 15 TOTAL = 60

REFERENCES:

1. Rashid .M. H "Power electronics Hand book", Academic press, 2001.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
5. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.