CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM

M.TECH - POWER SYSTEMS

(FULL TIME)

I – IV SEMESTERS

SEMESTER I						
Course Code	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
MMA111	PM	Applied Mathematics	3	2	0	4
MPS101	PC	Power Systems Analysis	3	0	0	3
MPS102	PC	Power System Operation & Control	3	0	0	3
MIC105	PC	Advanced Control Theory	3	0	0	3
MPS1E1	PE	ProfessionalElective – I	3	0	0	3
MPS1E2	PE	ProfessionalElective – II	3	0	0	3
Total Number of Contact Hours = 20Total Number of Credits= 19						

SEMESTER II						
Course Code	**Category**	**Course Title**	**L**	**T**	**P**	C
THEORY						
MPS201	PC	Power Systems Dynamics	3	0	0	3
MPS202	PC	Power Systems Transients	3	0	0	3
MPS203	PC	High Voltage DC Transmission	3	0	0	3
MPS2E3	PE	ProfessionalElective – III	3	0	0	3
MPS2E4	PE	ProfessionalElective – IV	3	0	0	3

PRACTICAL						
MPS2L1	PC	Power System simulation Lab	0	0	4	2
Total Number of Contact Hours = 19Total Number of Credits= 17						

SEMESTER – III						
Course Code	**Category**	**Course Title**	**L**	**T**	**P**	**C**
THEORY						
MPS301	PC	Power System Protection	3	2	0	4
MPS3E5	PE	ProfessionalElective – V	3	0	0	3
MPS3E6	OE	Open Elective – I	3	0	0	3
PRACTICAL						
MPS3P1	PR	Project Work Phase – I	0	0	12	6
Total Number of Contact Hours = 23 Total Number of Credits= 16						

SEMESTER – IV						
Course Code	**Category**	**Course Title**	**L**	**T**	**P**	**C**
PRACTICAL						
MPS4P2	PR	Project Work Phase – I	0	0	24	12
Total Number of Contact Hours = 24Total Number of Credits=12						

Total No. of Credits – 64

LIST OF ELECTIVES

S.No	Sub code	Subject Name	L	T	P	C

PROFESSIONAL ELECTIVE (PE) – I						
1.	MPS001	Special Electrical Machines & Controllers	3	0	0	3
2.	MPS002	Electrical Distribution System	3	0	0	3
3.	MPS003	Power System Stability	3	0	0	3
PROFESSIONAL ELECTIVE (PE) – II						
1.	MPS004	Power Quality	3	0	0	3
2.	MPS005	Power System planning and Reliability	3	0	0	3
3.	MPS006	Restructured Power System	3	0	0	3
PROFESSIONAL ELECTIVE (PE) – III						
1	MPS007	High Voltage Engineering	3	0	0	3
2	MPS008	Energy Management and Auditing	3	0	0	3
3	MPS009	Computer methods for Power System Analysis	3	0	0	3
PROFESSIONAL ELECTIVE (PE) – IV						
1	MPS010	Wind Energy Conversion Systems	3	0	0	3
2	MPS011	FACTS Controllers	3	0	0	3
3	MPS012	Distributed Generation and Microgrid	3	0	0	3
PROFESSIONAL ELECTIVE (PE) – V						
1	MPS013	Artificial Intelligence Applications to Power Systems	3	0	0	3
2	MPS014	Neural networks and Fuzzy logic control	3	0	0	3
3	MPS015	Smart Grid	3	0	0	3
OPEN ELECTIVE (OE) – I						
1	MPS016	Solar And Energy Storage Systems	3	0	0	3
2	MPS017	Industrial Power System Analysis And Design	3	0	0	3
3	MPS018	Research Methodology	3	0	0	3

SEMESTER I

MMA111	**APPLIED MATHEMATICS**	**L**	**T**	**P**	**C**
	Total Contact Hours: 60	3	1	0	4
	Prerequisite:UG Mathematics				
	Course Designed by : Dept. of Mathematics				

OBJECTIVES

To apply all taught techniques to unseen problems, and present basic concepts of matrices and ma algebra, linear transformation, vector spaces,Random variable compute and interpret me correlation/covariance ,calculus is major branch of optimization deals with extreme values in cer function spaces.

COURSE OUTCOMES (COs)

CO1	Learn to manipulate matrices and to do matrix algebra, determinants, Eigen values Eigen vectors and to solve the system of linear equations
CO2	Learn to analyze and solve the fundamental problems with prescribed or free boundary conditions in simple cases.
CO3	Learn to understand how signals, systems, inference combine in prototypical tasks of communication, control and signal processing.
CO4	Apply concepts of Probability to solve problems in Electronic Engineering
CO5	Find functional relationship between random inputs and outputs with the use of Random Process Techniques. Find the linearity in Birth and Death Processes with the use of Poisson processes.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H	H	L	M	
	CO2		H	L		
	CO3			H		M
	CO4	M	H			L
	CO5		H	H	M	
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I ADVANCED MATRIX THEORY 9+3

Eigen values using QR transformations generalized eigenvectors – canonical forms, singular valued composition and application – matrix norms and induced norms pseudo inverse – least square approximations.

UNIT II CALCULUS OF VARIATIONS

9+3 Variation and its properties – Euler's Equation – Functional dependent on first and higher order derivatives – functional dependent on functions of several independent variables – constraints in the form of a functional isoperimetric problems – Direct method – Ritz and Kantorovich methods – Boundary value problems.

UNIT III SPECIAL FUNCTIONS 9+3

Series solutions – Bessel's equations – Bessel functions – Recurrence relations generating functions and orthogonal of Bessel's functions of the first kind Legendary's equations, Legendary polynomials – Rodriguez's formula applications to boundary value problems

UNIT IV PROBABILITY 9+3

Probability concepts – Random variables Discrete and continuous dissimulations – Correlations – partial, multiple, rank analysis of variance one way, two way process.

UNIT V RANDOM PROCESS 9+3

Poisson process Gaussian process Markov process-Anti Correlations-Cross correlations – Queuing models – quality control – control charts – tolerance limits.

Total No. of Periods: 60

References:

1. Sankar Rao K: "Introduction to Partial Differential Equations" – Prentice Hall of India, New Delhi 1995.
2. Elsgoth, "Differential Equations and Calculus of Variations" MIR Publishers, Moscow.
3. Grewal B.S. "Higher Engineering Mathematics, Khanna Publications, New Delhi 1989.
4. Androws L.A. "Special Function of Scientist and Engineers"
5. Venkataramn M.K. "higher engineering mathematics, the National Publishing Company, 1990.
6. Narayanan S. Manicasachagam Pillai and Ramaniah G. "Advanced Mathematics for Engineering Students" Vol II and ill, Viswanathan printers Pvt. Ltd., Madras1 1985.
7. Freund J.D. and Miller JR "Probability Statistics for Engineers" Prentice Hall of India, 5th Edition, New Delhi 1994.
8. Gupta and Kapoor V.K. "Fundamentals of Mathematics Statistics" Sultan Chand & Sons, New Delhi.

MPS101	**POWER SYSTEM ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3
	Prerequisite: Power system				

	Course Designed by : Dept. of Electrical & Electronics Engineering

OBJECTIVES

To understand the necessity of load flow studies and short circuit analysis

COURSE OUTCOMES (COs)

CO1	Able to develop mathematical models for analysis.
CO2	Able to select proper methodologies of load flow studies for the power network.
CO3	Able to develop the understanding of contingency Analysis.
CO4	Able to develop programs for power system studies.
CO5	Able to apply concepts of Stability analysis

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H				L
	CO2		H			
	CO3				H	M
	CO4			H		
	CO5		H		M	
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

INTRODUCTION **9**

Balanced 3 phase networks-representation of power system components single line diagram-per unit systems – advantage of per unit system – impedance diagram of per unit system – primitive network.

UNIT II
LOAD FLOW **9**
Network Modeling – Formation of Y bus matrix-Gauss-seidal method-Newton Raphson method-Fast decoupled load flow-convergence criteria and tests-formulation of three phase load problem.

UNIT III
SOLUTION TECHNIQUES **9**
Sparse matrix techniques for large scale system-problems- Gauss elimination method-bifactorisation method.

UNIT IV
SHORT CIRCUIT STUDIES **9**
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 typed solutions.

UNIT V
STABILITY STUDIES **9**
Transient stability analysis-swing equation stability of multi machine system-solution using modified Euler's method and Gauss-Seidal method

Total No. of Periods: 45

REFERENCE BOOKS:

1."Modern Power System Analysis" by Nagrath & Kothari – Tata McGraw Hill Publications 2003.
2."Power System Analysis" by Hadi Saadat – Tat McGraw Hill Publications 2001.
3.Stagg G.Ward, El–Abiad: Computer methods in power system analysis, McGraw Hill ISE, 1986.

MPS102	**POWR SYSTEM OPERATION AND CONTROL**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES To impart learning about the power system controls namely load-frequency AVR control for both single-machine infinite bus system and multimachine systems. and to learn optimal system operation through optimal generation dispatch, unit commitment, hydro -thermal scheduling and pumped storage plant scheduling and their implementation through vari classical methods.

COURSE OUTCOMES (COs)	
CO1	Understand Economic Dispatch Controller and solution of Coordinate equation by itera method
CO2	Understand & model reactive power -voltage interaction and different methods of con for maintaining voltage profile against varying system load
CO3	Understand & model power -frequency dynamics and to design power -freque controller.
CO4	Understand Forecasting of base load and Unit commitment using different methods
CO5	Understand generation and absorption of Reactive power and the methods of volt control

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H				M
	CO2			H	H	
	CO3		H			L
	CO4		H			
	CO5			M		H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

ECONOMIC LOAD DISPATCH **9**

Economic dispatch problem-optimal operation of generators neglecting losses-generator scheduling including losses exact transmission loss formula-coordination equation-Automatic load dispatch

UNIT II

OPTIMAL SYSTEM CONTROL **9**

Optimal load flow solution-optimal scheduling of hydrothermal plant-optimal unit Commitment-Dynamic programming.

UNIT III

AUTOMATIC GENERATIN CONTROL **9**

Review of LFC and economic dispatch control using three modes of control flat frequency tie line control-tie line bias control-AGC implementation-AGC features static and dynamic response of controlled two area systems

UNIT IV

REACTIVE POWER CONTROL **9**

Reactive power control-voltage monitoring-application of voltage regulator-synchronous condenser-transformer taps-static Var compensators-thyristor switched capacitors-thyristor controlled reactors

UNIT V

POWER SYSTEM SECURITY **9**

Factors affecting system security-security levels-contingency analysis-linear sensitivity factors-dc power flow methods-contingency selection-concentric relaxation.

Total No. of Periods: 45

REFERENCE BOOKS:

1.“Electric Energy System Theory” by I. Elgerd – Tata McGraw Hill publication 1999

2.“Power System Voltage Stability” by Taylor-McGraw Hill publications 2000

3.“Power System Analysis by Grainger Stevenson – McGraw hill publications 1989

MIC105	**ADVANCED CONTROL THEORY**	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3
	Prerequisite: Control system				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES To study the analysis of systems using state space model To understand the concept of stability To familiarize the optimal control problem
COURSE OUTCOMES (COs)

CO1	Apply the knowledge of basic and advance control system for design of control systems.
CO2	Understand and able to apply the concepts of state variable analysis for real time applications.
CO3	To apply advanced control theory to practical engineering problems.
CO4	To understand and apply nonlinear systems for real time applications.
CO5	Analyze the concept of stability of nonlinear systems.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		H		M
	CO2		H			
	CO3			M		H
	CO4		H			
	CO5	H			H	
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37^{th}, 38^{th} & 39^{th} Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I **7**

PROPERTIES OF TRANSFER FUNCTION

Impulse response matrices- poles & zeros of transfer function matrices critical frequencies resonance-steady state and dynamic response bandwith-singular value, Analysis-multivariable Nyquist plots.

UNIT II **8**

REVIEW OF STATE MODEL FOR SYSTEMS

State transition matrix & its properties-free and forced response control ability and observability-kalman's Decomposition-Minimal realization.

UNIT III **10**

STATE FEEDBACK AND STATE ESTIMATORS

Single variable case-connection of state feedback and state estimators Compensation design-design concepts-realization of basic compensation-cascade compensation in time domain and frequency domain .

UNIT IV **11**

TYPES OF NON-LINEARITY

Typical examples-phase plane analysis-isoclines method-limit cycles Equation Linearization-Describing function-Describing function analysis of simple non linear systems.

UNIT V **9**

STABILITY CONCEPTS

Equilibrium points-BIBO & Asymptotic stability-direct method of liapnov-variable gradient method of generating liapnov functions-applications to non-linear problems-krasakovskils theorem on global asymptotic stability of non linear systems.

Total No. of Periods: 45

Text Books:

1. Gopal M. Modern control system theory, New age International pvt Ltd, 2002.

References:

1. Nagrath & Gopal, Control system engineering, Wiley & Sons, 1982.
2.Ogata K. 11, Modern control engineering, PHI, 1982.
3.Ogata K.H, State space analysis of control systems, PHI.
4.Tou.J.T. Modern control theory, McGraw hill.

SEMESTER II

	POWER SYSTEM DYNAMICS	**L**	**T**	**P**	**C**
MPS201	Total Contact Hours: 45	3	0	0	3

	Prerequisite: Basics of Electrical Machines
	Course Designed by : Dept of Electrical & Electronics Engineering

OBJECTIVES

To equip students with adequate knowledge of Introduction to steady state transient and dynamic stability of power systems

COURSE OUTCOMES (COs)

CO1	Study about the Steady State Transient and Dynamic Stability Of Power Systems, States of Operation and System Security and its Analysis.
CO2	Know the Voltage And Torque Equations and Modeling Of Induction and synchronous machine.
CO3	To learn and analyze the modeling of power system components .Analysis the Modeling of Prime Mover Control System and Modeling Of Turbines
CO4	To understand analyze the power system stabilizers and dynamics of synchronous machine.
CO5	Study the Sub Synchronous Resonance In Compensated Systems and voltage stability.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H	M	L	M	L
	CO2	M	L	L	M	L
	CO3	M	M	L	M	L
	CO4	H	M	L	H	L
	CO5	H	M	L	H	L
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I 9

POWER SYSTEM STABILITY

Introduction to steady state transient and dynamic stability of power systems-states of operation and system security-analysis of steady state and transient stability-classical methods of solutions-numerical solution-point by point method, equal area criterion-effect of damper winding and governor.

UNITII 9

SYNCRONOUS AND INDUCTION MACHINE MODELLING

Synchronous machine modeling-flux linkage, voltage and torque equations-Park's transformation-transformation of flux linkage, voltage and torque equations-modeling of induction motors-representation in stability studies.

UNIT III 9

MODELLING OF POWER SYSTEM COMPONENTS

Excitation systems-Classification, modeling-prime mover control system-modeling of turbines, speed-governing systems-modeling of transmission line-Static Var compensators-load modeling.

UNIT IV 9

DYNAMICS OF SYNCHRONOUS MACHINES

Synchronous machine model-Application of Models-Small signal analysis-Synchronizing and Damping torque analysis-Power system stabilizers-Structure and tuning of power system stabilizers.

UNITV 9

SUBSYNCHRONOUS RESONANCE AND VOLTAGE STABILITY

Sub synchronous resonance in compensated systems-Counter measures for SSR-Filtering and damping schemes-Voltage stability-Factors affecting voltage instability and collapse-Comparison of Angle and Voltage stability –Analysis and control of voltage instability.

Total No. of Periods: 45

Text Books:

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.

References

1. P.M Anderson and A.A Fouad, "Power System Control and Stability", Iowa State University Press, Ames, Iowa, 1978. MPS202

MPS202	**POWER SYSTEM TRANSIENTS**	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3
	Prerequisite: Protection and Switchgear				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES	
Develop a basic understanding of the transient effect of lightning,faults, and switching on po systems. Provide a basic understanding of the principles used to protect power systemequipm from transients.	
COURSE OUTCOMES (COs)	
CO1	To understand the Source, Effects and Importance of Transients.
CO2	To understand the Forms and Effects of Switching Transients
CO3	To understand the transients in integrated power systems
CO4	Understanding the lumped parameters & travelling waves on transmission lines
CO5	Understanding the Phenomenon of lighting and Protection of Devices from Lighting

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H			H	
	CO2		H			H
	CO3	H				
	CO4		M	H	M	
	CO5	H	H			
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th& 39thMeeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I **5**

INTRODUCTION AND SURVEY

Review of various types of power system transients-effect of transients on power systems-relevance of the study and computation of power system transients.

UNIT II **10**

LIGHTNING SURGES

Electrification of thunder clouds-lightning current surges-lightning current parameters and their values-Stroke to tower and mid span-induced lightning surges.

UNIT III **10**
SWITCHING SURGES
Closing and reclosing of lines-toad rejection-fault initiation-fault clearing-short line faults-Ferro-resonance-isolator switching surges-temporary over voltages-surges on an integrated system-switching-harmonics.

UNIT IV
COMPUTATION OF TRANSIENTS IN CONVERSION EQUIPMENT 10
Traveling wave method Transmission and Reflection of Waves at various junctions-Beweley's Lattice diagram-Eigen value approach-Z-transform –EMTP software.

UNIT V
PROTECTIVE DEVICES AND SYSTEMS **10**
Basic ides about protection-Surge diverters'-Surge absorbers-Ground fault neutralizers-Protection of lines and stations by shielding-Ground wires-Counter poises-Driven rods-Modern lightning arresters-Insulation coordination-protection of alternators-Industrial drive systems.

Total No. of Periods: 45

REFERENCE BOOKS:

1.Allen Greenwood, electrical transients in power systems, willey interscience, New York, 1971.
2.Klaus ragaller, Surges in high voltage networks, Plenum Press, New York, 1980.
3.Diesendorf, W. Over voltages on high voltage systems, reneelaer Bookstore, Troy New York.1971.

MPS203	**HIGH VOLTAGE DC TRANSMISSION**	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3
	Prerequisite: Power Electronics, High Voltage Engineering.				
	Course Designed by : Dept of Electrical & Electronics Engineering				
OBJECTIVES To mould the students to acquire knowledge about HVDC Transmission systems					

COURSE OUTCOMES (COs)	
CO1	To get an idea about modern trends in HVDC Transmission and its application
CO2	To complete analysis of harmonics and basis of protection for HVDC Systems.
CO3	To understand the power flow control on HVDC Transmission system
CO4	To Understand the Operation of the controller for HVDC in worst and normal operations
CO5	To understand the complete operation of HVDC Converter stations

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1					H
	CO2	H	H	H	M	M
	CO3	H	M	M	M	
	CO4	H	M		M	
	CO5		M		M	H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I INRODUCTION 9

Comparison of AC and DC transmission-Types of DC links-components of HVDC systems principal application of DC transmission-merits and demerit of DC transmission-modern trends in DC transmission

UNIT II THYRISTOR CONVERTORS AND ANALYSIS 9

Thyristors-switching and steady state characteristics-valve firing-recent trends-pulse number converter configuration-analysis of Gratez circuit-converter bridge characteristics pulse converter.

UNIT III HVDC SYSTEM CONTROL 9
Desired features of control-converter control characteristics-constant current control extinction angle control-system control-firing angle control Reactive power control

UNIT IV STABILITY ANALYSIS 9
Modeling of converter-DC network and synchronous generator-solution methodology-transient stability improvement using DC link control voltage stability in AC-DC systems control.

UNIT V POWER MODULATION AND HARMONICS 9
Power modulation controls, reactive power modulation. Characteristic harmonics-troubles due to harmonics-harmonic filters.

Total Periods:45

REFERENCES:

1. HVDC Power transmission system-Padiyar K.R. wiley Eastern Pvt. Ltd. 1980.
2. Direct current Transmission-Kimbark, Vol 1., John Wiley, New York, 1971.
3. Computer Modeling of electric Power Systems-Arriliaga J. and Arnald C.P. & Parker B.J., John wiley& Sons, 1983.

MPS2L1	**POWER SYSTEM SIMULATION LAB**	**L**	**T**	**P**	**C**
	Total Contact Hours:45			4	2
	Prerequisite: Power System Analysis				

	Course Designed by : Dept of Electrical & Electronics Engineering

OBJECTIVES

To equip students with adequate knowledge of Short Circuit Analysis Using Matlab Program, Trans Stability Analysis of Single Machine To Infinite Bus System

COURSE OUTCOMES (COs)

CO1	Study the Short Circuit Analysis Using Matlab Program.
CO2	Know about the Load Frequency Dynamics of Single Area Bus System.
CO3	Study of Monopolar operation using HVDC transmission line analyzer.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		H		M
	CO2		H	H		
	CO3	H		H	H	H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

LIST OF EXPERIMENTS:

1. Short Circuit Analysis Using Matlab Program
2. Transient Stability Analysis of Single Machine To Infinite Bus System
3. A Solution to Economic Dispatch in Power System

4. Swing Curve

5. Load Frequency Dynamics of Single Area Bus System

6. Load Frequency Dynamics of Two Area Bus System

7. Analysis of Transmission Line Parameters

8. Study of Monopolar operation using HVDC transmission line analyzer.

9. Study of Bipolar operation using HVDC transmission line analyzer.

10. Study of Earth fault relay using HVDC transmission line analyzer.

11.Study of EMTP Software

REFERENCES

1. Department Lab Manual

SEMESTER III

MPS301	POWER SYSTEM PROTECTION	L	T	P	C
	Total Contact Hours:60	3	1	0	4
	Prerequisite:Basics of power system protection				
	Course Designed by : Dept of Electrical & Electronics Engineering				

OBJECTIVES

- To educate the causes of abnormal operating conditions (faults, lightning and switching surges the apparatus and system.
- To introduce the characteristics and functions of relays and protection schemes
- To impart knowledge on functioning of circuit breakers

COURSE OUTCOMES (COs)

CO1	Ability to understand and analyze power system Equipment protection and their operati
CO2	Ability to apply the over current protection scheme in the power systems
CO3	Able to apply the distance and carrierProtection for Transmission Lines
CO4	Ability to understand and apply bus bar protection schemes in power systems
CO5	Able to apply thenumerical relay and protection schemes

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	M	M			
	CO2	M	M	M		M
	CO3	M	H		M	M
	CO4	M	M		M	
	CO5	H	H		M	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I EQUIPMENT PROTECTION 12

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.

UNIT II OVER CURRENT PROTECTION 12

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.

UNIT III DISTANCE AND CARRIER CURRENT PROTECTION FOR TRANSMISSION LINES 12

Drawback 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 - 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 II.

UNIT IV BUS BAR PROTECTION 12

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.

UNIT V NUMERICAL PROTECTION 12

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.

Total No of periods: 60

REFERENCES

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

ELECTIVES
PROGRAMME ELECTIVE (CE) – I

		L	T	P	C
MPS001	**SPECIAL ELECTRICAL MACHINES AND CONTROLLERS**	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3
	Prerequisite: Basics of Electrical machines				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES

To expose the students to the concepts of various types of special electrical machines and their applications

COURSE OUTCOMES (COs)

CO1	Understand axial and radial air gap of Synchronous Reluctance Motors
CO2	Describe open loop control, closed loop control of stepping motor.
CO3	Analyze microprocessor based controller of Switched Reluctance Motor
CO4	Able to derive the EMF equation, Torque – Speed characteristics Controllers Of Permanent magnet brushless dc motors
CO5	Able to derive EMF equation, Torque – Speed characteristics Controllers of Permanent Magnet Synchronous Motors

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		M		M
	CO2		H		H	
	CO3			H		
	CO4	H	H		M	H
	CO5	H	H	M		M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

SYNCHRONOUS RELUCTANCE MOTORS 9

Constructional features-types-axial and radial air gap motors-operating principle-reluctant torque-phasor diagram-characteristics-Vernier motor.

UNIT II
STEPPING MOTORS **9**
Constructional features-principle of operation-variable reluctance motor Hybridmotor-single and multi stack configurations-theory of torque predictions-linear and non linear analysis-characteristics-drive circuits.

UNIT III
SWITCHED RELUCTANCE MOTORS **9**
Constructional features-principles of operation-torque prediction-power controllers-nonlinear analysis-Microprocessor based control characteristics-computer control.

UNIT IV
PERMANENET MAGNET BRUSHILESS D.C. MOTORS **9**
Principle of operation-Types-Magnetic circuit analysis-EMF and torque equations-Power controllers-Motor characteristics and control.

UNIT V
PERMANENET MAGNET SYNCHRONOUS MOTORS **9**
Principle of operation-EMF and torque equations-reactance –phasor diagram-Power controllers-Converter volt-ampere requirements-Torque speed characteristics-Microprocessor based control.

Total No. of Periods: 45

References:

1. A Nazar and I Boldea, Linear Electric Motors, Theory, Design and Practical applications, Prentice Hall Inc, New/Jersey, 1987.
2. Brushless permanent Magnet and Reluctance Motor Drives-Miller T.J.E. clarendon Press, Oxford. 1989.
3. Permanent Magnet and Brushless DC Motors, Kenjo T. and Naganori S. clarendon Press, Oxford 1989.
4. Stepping Motors and their Microprocessor Control-Kenjo t. clarendon Press Oxford 1989.

	ELECTRICAL DISTRIBUTION SYSTEM	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3

MPS002	Prerequisite: Basics of Transmission and Distribution
	Course Designed by : Dept. of Electrical & Electronics Engineering

OBJECTIVES

To master the complete idea of Electrical Distribution by learning planning strategies, reliab analysis, distribution protection and the voltage control in distribution systems.

COURSE OUTCOMES (COs)

CO1	To learn the structure and operation of Electrical Distribution systems.
CO2	To learn the planning strategies of Electrical Distribution systems.
CO3	To have a clear understanding of reliability analysis.
CO4	To learn the voltage control and its advancements in distribution.
CO5	To learn the protection of feeders, distributors and service mains.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H				M
	CO2		H		H	
	CO3			M		H
	CO4	H				
	CO5		H	L	H	H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-I

INTRODUCTION

Industrial and commercial distribution systems-Energy losses in distribution system –system ground bonding for safety and protection comparison of O/H lines and underground cable system-single phase and three phase unbalanced network model-power flow, short circuit and loss calculations.

UNIT –II
RELIABILITY ANALYSIS 9
Distribution system reliability analysis-reliability concepts –Markov model-distribution network reliability-reliability performance

UNIT-III
DISTRIBUTION SYSTEM PLANNING 9
Distribution system expansion planning-load characteristic-load forecasting-design concepts – optimal location of substation-design of radial lines-solution technique

UNIT-IV
VOLTAGE CONTROL OF DISTRIBUTION SYSTEM 9
Voltage control-Applications of shunt capacitance for loss reduction-Harmonics in the system-static VAR systems-optimization for loss reduction and voltage improvement.

UNIT-V
DISTRIBUTION SYSTEM PROTECTION 9
System protection – requirement – fuses and section analyzers over current. Under voltage and under frequency protection- coordination of protective device.

Total no of periods: 45

References:
Electrical Power systems Planning – Pabka,
Power System Voltage Stability – Taylor,

	POWER SYSTEM STABILITY	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3

MPS003	Prerequisite: Power System Transients
	Course Designed by : Dept. of Electrical & Electronics Engineering

OBJECTIVES

Togivebasicknowledgeaboutthe dynamicmechanismsbehindangleandvoltagestab problemsinelectricpowersystems,includingphysicalphenomenaandmodelingissues.

COURSE OUTCOMES (COs)

CO1	To gain a deep understanding on power system modeling for stability analysis.
CO2	To gain a deep understanding of power system behavior under transient condition.
CO3	Analyze the performance of single and multi-machine systems under transient, steady state and dynamic conditions.
CO4	Analyze the factors effect voltage stability and analysis of factors and solutions of control of voltage instability
CO5	Analyze the various Methods of improving stability

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		H		M
	CO2		H			
	CO3			H		
	CO4		M		H	
	CO5	M		M		H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

POWER SYSTEM STABILITY CONSIDERATIONS 9

Introduction-Stability classifications -rotor angle and voltage stability-synchronous machine representation –classical model-load modeling concepts-modeling of excitation systems-modeling of prime movers.

UNIT II

TRANSIENT STABILITY 9

Swing equation-equal area criterion-solution of swing equation-Numerical methods -Euler method-Runge-Kutta method-critical clearing time and angle-effect of excitation system and governors-Multi machine stability –extended equal area criterion-transient energy function approach.

UNIT III

SMALL SIGNAL STABILITY 9

State space representation – eigen values- modal matrices-small signal stability of single machine infinite bus system – synchronous machine classical model representation-effect of field circuit dynamics-effect of excitation system-small signal stability of multimachine system.

UNIT IV

VOLTAGE STABILITY 9

Generation aspects - transmission system aspects – load aspects – PV curve – QV curve – PQ curve – analysis with static loads – load ability limit - sensitivity analysis-continuation power flow analysis - instability mechanisms-examples.

UNIT V

STABILTY IMPROVEMENT 9

Methods of improving stability – transient stability enhancement – high speed fault clearing – steam turbine fast valving-high speed excitation systems- small signal stability enhancement-power system stabilizers – voltage stability enhancement – reactive power control.

Total No. of Periods: 45

REFERENCE BOOKS:

1.Kundur, P., "Power System Stability and Control", McGraw-Hill International Editions, 1994.
2.Anderson, P.M. and Fouad, A.A., „Power System Control and Stability", Galgotia Publications, New Delhi, 2003.

PROFESSIONAL ELECTIVE (CE) – II

MPS004	POWER QUALITY	L	T	P	C
	Total Contact Hours:45	3	0	0	3
	Prerequisite:				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES

Understandthevariouspower quality phenomena theiroriginandmonitoringandmitigationmethods.Understandtheeffectsofvarious powerqualityphenomenoninvarious equipment.

COURSE OUTCOMES (COs)

CO1	Able to know the severity of power quality problems in distribution system
CO2	Able to understand the analysis of single phase and three phase system
CO3	Able to Conventional load compensation methods
CO4	Able to understand the concepts of load compensation.
CO5	Understanding the basics of FACTS devices.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1			M	H	
	CO2	H				
	CO3					H
	CO4	H			H	
	CO5		H	M		
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I
INTRODUCTION **9**

Introduction – Characterization 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
ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM 9
Single phase linear and non linear loads – single phase sinusoidal, non sinusoidal source – supplying linear and nonlinear load – three phase Balance system – three phase unbalanced system – three phase unbalanced and distorted source supplying non linear loads – concept of pf – three phase three wire – three phase four wire system.

UNIT III
CONVENTIONAL LOAD COMPENSATION METHODS 9
Principle of load compensation and voltage regulation – classical load balancing problem: open loop balancing – closed loop balancing, current balancing – harmonic reduction and voltage sag reduction – analysis of unbalance – instantaneous of real and reactive powers – Extraction of fundamental sequence component from measured.

UNIT IV
LOAD COMPENSATION USING DSTATCOM 9
Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of DSTATCOM – DSTATCOM in Voltage control mode

UNIT V
SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM 9
Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – voltage Restoration – Series Active Filter – Unified power quality conditioner.

Total No of periods: 45

REFERENCE 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. Power Quality - R.C. Duggan
4. Power System Harmonics –A.J. Arrillga
5. Power Electronic Converter Harmonics –Derek A. Paice.

	POWER SYSTEM PLANNING AND RELIABILITY	**L**	**T**	**P**	**C**

MPS005	Total Contact Hours:45	3	0	0	3
	Prerequisite: Basics of Transmission and Distribution				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES

To learn the basic concepts of reliability models, approaches and distribution system planning.

COURSE OUTCOMES (COs)

CO1	Study about the Load growth patterns and their importance in planning.
CO2	Learn about the Probabilistic generation and load models.
CO3	Study the concepts of Fuzzy load flow probabilistic transmission system reliability analysis.
CO4	Study the procedure followed for integrate transmission system planning.
CO5	Learn the Distribution System Protection And Coordination of Protective Devices

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		M		H
	CO2		H		M	H
	CO3	H		H		
	CO4				H	
	CO5		H		H	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

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.

Total No of periods: 45

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

	RESTRUCTURED POWER SYSTEM	L	T	P	C

MPS006	Total Contact Hours:45	3	0	0	3
	Prerequisite: Basics of Power System				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES
To study the complete process of deregulation and restructuring of Power Industry

COURSE OUTCOMES (COs)	
CO1	To learn the issues involving in restructuring and deregulation of Power Network.
CO2	To learn the various fundamentals of Electricity market and its functions.
CO3	To have a clear understanding Congestion management.
CO4	To learn the various fundamentals of Marginal Pricing and Transmission Rights.
CO5	To learn the pricing in different market strategies.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H			H	
	CO2	H	H	M		H
	CO3			M		
	CO4		M			H
	CO5	M			H	
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I
INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY 9
Introduction: Deregulation of power industry, Restructuring process, Issues involved in

deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models

UNIT II
TRANSMISSION CONGESTION MANAGEMENT 9
Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion management – Capacity alleviation method.

UNIT III
LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS 9
Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights – Risk hedging functionality -Simultaneous feasibility test and revenue adequency – FTR issuance process: FTR auction, FTR allocation –– Flow gate rights – FTR and market power

UNIT IV
ANCILLARY SERVICE MANAGEMENT 9
Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service

UNIT V
PRICING OF TRANSMISSION NETWORK 9
Transmission pricing – Principles – Classification – Rolled in transmission pricing methods – Marginal transmission pricing paradigm – Composite pricing paradigm – Merits and demerits of different paradigm.

Total No. of Periods: 45

References:
1. Sally Hunt,” Making competition work in electricity”, , John Willey and Sons Inc. 2002
2. Steven Stoft,” Power system economics: designing markets for electricity”, John Wiley & Sons, 2002.
3. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, “Restructured electrical power systems: operation, trading and volatility” Pub., 2001
4. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen,” Operation of restructured power systems”, Kluwer Academic Pub., 2001.

PROFESSIONAL ELECTIVE (CE) – III

	HIGH VOLTAGE ENGINEERING	**L**	**T**	**P**	**C**

MPS007	Total Contact Hours:45	3	0	0	3
	Prerequisite:				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES

To understand the various types of over voltages in power system , Generation of over voltages protection methods and Measurement of over voltages in laboratories

COURSE OUTCOMES (COs)

CO1	Identify various causes of over voltages, currents and their effects on power system.
CO2	To understand electrical breakdown in gases, solids and liquids
CO3	To understand the generation of high voltages and high currents in power system
CO4	Measurement of over voltages and Generation of over voltages in laboratories.
CO5	To understand the various types of testing of high voltages in power system

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		M		H
	CO2			M		
	CO3	H	H		H	
	CO4		H		M	H
	CO5		H	M		M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th& 39thMeeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

OVER VOLTAGES AND INSULATION COORDINATION **9**

Natural causes of over voltages-lightning phenomena-over voltages due to switching surges-system faults and other abnormal conditions-principles of insulation coordination.

UNIT II

ELECTRICAL BREAKDOWN IN GASES, SOLIDS AND LIQUIDS **9**

Classical gas laws-ionization and decay processes-secondary effects –paschen's law – streamer theory-breakdown in non uniform fields and corona discharges-practical considerations in using gages for insulation purposes-vacuum insulation conduction and breakdown in pure and commercial liquids. Intrinsic break down in solids-electromechanical breakdown –thermal breakdown in composite dielectrics.

UNIT III

GENERATION OF HIGH VOLTAGE AND HIGH CURRENTS **9**

Generation of high dc voltage, alternating voltage,impulse voltage and impulse current.

UNIT-IV

MEASURMENTS OF HIGH VOLTAGE AND HIGH CURRENTS **9**

Measurement of high voltage and high currents- digital technique in high voltage measurements.

UNIT V

HIGH VOLTAGE TESTING **9**

High voltage testing of electrical apparatus power frequency, impulse voltage and dc ,international and Indian standards

Total no of periods: 45

References:

1. M.S.Naidu and V.kamaraju High voltage engineering Tata Mc Graw Hill 2nd edition 1995.
2. Kuffel E and Zaengi. W.S. High voltage engineering fundamentals pargamon press Oxford London 1986

	ENERGY MANAGEMENT AND AUDITING	L	T	P	C

MPS008	Total Contact Hours: 45	3	0	0	3
	Prerequisite:Electrical Machines,Power System.				
	Course Designed by : Dept of Electrical & Electronics Engineering				

OBJECTIVES
To equip the students with Demand meters and energy management and auditing concepts.

COURSE OUTCOMES (COs)

CO1	Study the Designing And Starting An Energy Management Program.
CO2	Understand an Economic models, Time value of money, Utility rate structures and load management.
CO3	Study the Electric motors-Transformers and reactors-Capacitors
CO4	Know about the Demand meters - Paralleling of current transformers and metering techniques.
CO5	To understand the lighting concepts and the effects of harmonics on power quality.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H	M	M	L	M
	CO2	L	L	L	L	M
	CO3	M	M	L	L	L
	CO4	M	L	L	L	L
	CO5	L	M	L	M	L
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I
INTRODUCTION **9**

Need for energy management - energy basics- designing and starting an energy management program – energy accounting -energy monitoring, targeting and reporting- energy audit process.

UNIT II

ENERGY COST AND LOAD MANAGEMENT 9

Important concepts in an economic analysis - Economic models-Time value of money-Utility rate structures- cost of electricity-Loss evaluation- Load management: Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification

UNIT III

ENERGY MANAGEMENT FOR MOTORS & ELECTRICAL EQUIPMENT 9

Systems and equipment- Electric motors-Transformers and reactors-Capacitors and synchronous machines

UNITIV

METERINGFORENERGYMANAGEMENT 9

Relationships between parameters-Units of measure-Typical cost factors- Utility meters - Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters - Metering location vs. requirements- Metering techniques and practical examples

UNIT V

LIGHTING SYSTEMS 9

Concept of lighting systems - The task and the working space -Light sources - Ballasts - Luminaries - Lighting controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality - Cost analysis techniques-Lighting and energy standards

Total No of Periods : 45

Text Books :

1. Reay D.A, Industrial Energy Conservation, first edition, Pergamon Press, 1977.
2. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
3. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.

References :

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006
2. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,. Logman Scientific & Technical, ISBN-0-582-03184, 1990.

MPS009	**COMPUTER METHODS FOR POWER SYSTEM ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3

	Prerequisite:Power System Analysis
	Course Designed by : Dept. of Electrical & Electronics Engineering

OBJECTIVES

- To provide the students in getting basic idea of different computer methods in power systems and to analyze the various methods of Power Flow studies, short circuit analysis and Stability analysis

COURSE OUTCOMES (COs)

CO1	Ability to understand the concepts of Network modeling Conditioning of Y Matrix
CO2	Ability to develop the Sequential Solution Techniques for DC system model
CO3	Ability to conduct short circuit analysis
CO4	Ability to conduct analysis of power system for steady state stability and Transient stability
CO5	Ability to form the contingency constrained optimal power flow .

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H			H	M
	CO2			H		
	CO3		H			H
	CO4		H		H	
	CO5	H		H		M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-I

LOAD FLOW **9**

Network modeling-Conditioning of Y Matrix-Newton Raphson method-Decoupled Newton

Load flow-Convergence criteria and tests –formulation of three phase load flow problem.

UNIT II
AC-DC LOAD FLOW **9**
Formulation of the problem-DC system model-Sequential Solution Techniques –Extension to Multiple and Multi terminal DC systems-DC convergence tolerance-Test systems and Results.

UNIT III
FAULT STUDIES **9**
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 typed solutions.

UNIT IV
STABILITY STUDIES **9**
Transient stability analysis: Swing equation – stability of multi-machine systems –Solution using modified Euler method and gauss-seidal method.

UNIT V
SYSTEM OPTIMISATION **9**
Objectives – strategy for two generator system – generalized strategies – effect of transmission losses-Sensitivity of objective function-formulation of contingency constrained optimal power flow problem.

Total No. of periods: 45

REFERENCE BOOKS:

1.Computer Aided power systems Analysis –M.A. Pai
2.Modem power system analysis-Nagrath & Kothari Tata Mc Graw hill Ltd.,

PROFESSIONAL ELECTIVE (CE) – IV

	WIND ENERGY CONVERSION SYSTEMS	**L**	**T**	**P**	**C**

MPS010	Total Contact Hours: 45	3	0	0	3
	Prerequisite: Electrical Machines, Power system				
	Course Designed by : Dept of Electrical & Electronics Engineering				

OBJECTIVES

To understand and analyze the present and future energy demand of world and nation.

Techniques to exploit the available renewable energy resources such as, wind power effectively.

COURSE OUTCOMES (COs)

CO1	To understand and analyse the basic schemes and components of wind energy conversion system.
CO2	To understand and analyse the design concepts of wind turbines
CO3	To understand the concepts of fixed speed wind energy conversion systems
CO4	To understand the concepts of variable speed, wind energy conversion systems
CO5	To analyze the grid integration issues.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	M	M	L	M	L
	CO2	H	M	L	H	L
	CO3	M	M	L	M	L
	CO4	M	H	L	M	L
	CO5	H	M	L	M	L
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNITI

INTRODUCTION TO WECS 9

Components of WECS-Schemes of WECS-Power obtained from wind- simple momentum theory-power coefficient- Sabinin’s theory- Aerodynamic s 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 9
FIXED SPEED SYSTEMS
Generating Systems- Constant speed constant frequency systems- Choice of Generators- Deciding factors- synchronous Generator- squirrel cage induction Generator- Model Wind turbine rotor-Drive Train Model- Generator model for steady state and Transient Stability analysis.

UNIT-IV 9
VARIABLE SPEED SYSTEMS
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 9
GRID CONNECTED SYSTEMS
Stand alone and Grid connected WECS system – Grid connection Issues- Machine side & Grid Side controllers- WECS in various countries.

Total Periods: 45

TEXT BOOKS:

1. L.L.Freris “Wind Energy Conversion Systems”, Prentice Hall,1990.
2. Ion Boldea, ”Variable Speed Generators”, Taylor & Francis group,2006.

REFERENCE

1. E.W.Golding “The Generation of Electricity by Wind Power:, Redwood burn Ltd., Trowbridge, 1976.
2. S.Heir “Grid Integration of WECS”, Wiley 1998.
3. L.L.Freris “Wind Energy Conversion Systems”, Prentice Hall,1990.
4. Ion Boldea, ”Variable Speed Generators”, Taylor & Francis group,2006.
5. E.W.Golding “The Generation of Electricity by Wind Power:, Redwood burn Ltd., Trowbridge, 1976.
5. S.Heir “Grid Integration of WECS”, Wiley 1998.

	FACTS Controllers	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3

MPS011	Prerequisite: Basics of Power System and Power Electronics
	Course Designed by : Dept. of Electrical & Electronics Engineering

OBJECTIVES

To acquire the knowledge on flexible AC Transmission System and its importance for FAC controllers. To understand the various FACTS controllers operation on FACTS systems.

COURSE OUTCOMES (COs)	
CO1	Analyse uncompensated and compensated AC transmission lines.
CO2	Describe the principle of operation and configuration of SVC .
CO3	Describe the structure, functions and applications of TCSC and GCSC.
CO4	Describe the structure, functions and applications of STATCOM, SSSC, UPFC and IPFC.
CO5	Describe the operation of coordination of controllers

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H				H
	CO2		H	M	H	
	CO3	H	H		H	M
	CO4		H			M
	CO5	H		M	H	
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

INTRODUCTION 9

Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.

UNIT II
STATIC VAR COMPENSATOR (SVC) 9

Configuration of SVC- voltage regulation by SVC- Modeling of SVC for load flow analysis- Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

UNIT III
THYRISTOR & GTO THYRISTOR CONTROLLED SERIES CAPACITORS (TCSC and GCSC) 9

Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of TCSC-GCSC – Modeling of TCSC and GCSC for load flow studies- modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.

UNIT IV
VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)- Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modeling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers(UPFC and IPFC)- Modeling of UPFC and IPFC for load flow and transient stability studies- Applications.

UNIT V
CONTROLLERS AND THEIR COORDINATION 9

FACTS Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.

Total No of Periods: 45

References:

1. A.T.John, “Flexible AC Transmission System”, IEEE,1999.
2. Narain G.Hingorani, Laszio. Gyugyl, “Understanding FACTS Concepts and Technology of Flexible AC Transmission System”, Standard Publishers, Delhi 2001.
3. V. K.Sood, “HVDC and FACTS controllers- Applications of Static Converters in Power System”, 2004, Kluwer Academic Publishers.
4. Mohan Mathur, R., Rajiv. K. Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc.
5. K.R.Padiyar,” FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd., Publishers New Delhi, Reprint 2008,

	DISTRIBUTED GENERATION AND MICROGRID	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3

MPS012	Prerequisite: Power Generation Systems
	Course Designed by : Dept. of Electrical & Electronics Engineering

OBJECTIVES

To grasp basic principles and applications of different distributed generation systems and to study concept of Micro-grid and its configuration

COURSE OUTCOMES (COs)

CO1	Understand the Conventional power generation systems
CO2	Understand that distributed generation systems in microgrids can offer increased reliability and reduced network losses.
CO3	Describe the Impact of grid integration
CO4	Describe the concept of Microgrid and its configuration
CO5	Apply advanced analysis tools in planning and operation of smart grids

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		M		
	CO2		H		H	H
	CO3		H		H	
	CO4	H		M		
	CO5	H		H		M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

INTRODUCTION

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

UNIT II
DISTRIBUTED GENERATIONS 9

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants

UNIT III
IMPACT OF GRID INTEGRATION 9

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

UNIT IV
BASICS OF A MICROGRID 9

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids

UNIT V
CONTROL AND OPERATION OF MICROGRID 9

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.

Total No of Periods: 45

Text books:

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

PROFESSIONAL ELECTIVE (CE) – V

	ARTIFICIAL INTELLIGENCE APPLICATIONS TO	**L**	**T**	**P**	**C**

MPS013	POWER SYSTEMS				
	Total Contact Hours:45	3	0	0	3
	Prerequisite: Basics of Power System				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES

To master the concept of Artificial Intelligence and their usage in various Power System applications.

COURSE OUTCOMES (COs)

CO1	To learn the basic concepts of expert systems and their applications
CO2	To learn the concepts of artificial intelligence systems and their applications
CO3	To master the programming in Artificial Neural Networks
CO4	To use and analyze Artificial intelligence concepts for Power System problems
CO5	To program, trouble shoot the neural network based problems

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		M		H
	CO2		H			
	CO3	M		H		M
	CO4				H	
	CO5		H	H		H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I
INTRODUCTION **9**

Basics of All systems-introduction to expert systems-definitions-architecture- differences-conventional programming.

UNIT II

EXPERT SYSTEMS **9**

Knowledge components-levels of representation-representation schemes-formal and non-formal representation schemes-ES building task-development-knowledge acquisition-typical building process.

UNIT III

INTRODUCION TO NEURAL NETWORKS **9**

Neurobiological model of neurons-basics of ANN-perception-back propagation network-memory models-bi-directional associative memory-hop filed network.

UNIT IV

ARTIFICIAL NEURAL NETWORKS **9**

Theory, architecture and applications of computer propagation network-Boltzmann's network-adaptive resonance theory-introduction to cognitron and neo-cognitron.

UNIT V

APPLICATIONS **9**

Application of expert systems and neural networks to load forecasting, contingency analysis-VAR control and other power system problems.

Total No. of Periods: 45

Reference:

1. Rolston D.W. "Principles of Artificial Intelligence and Expert systems development", McGraw Hill, 1988.
2. Wasserman P.O."Neural Computing", Van Reinhold, 1988.
3. Rich, Elaine, Kevin Knight, "Artificial Intelligence"

MPS014	**NEURAL NETWORKS AND FUZZY LO(CONTROL**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	3	0	0	3

	Prerequisite: Digital Electronics, Basics of set theory
	Course Designed by : Dept of Electrical & Electronics Engineering

OBJECTIVES

To expose the students to the concepts of fuzzy sets and operations.
To provide adequate knowledge about feed forward and back propagation neural networks.
To have sound knowledge about neuron models,learning algorithms and applications.

COURSE OUTCOMES (COs)	
CO1	To understand and analyze the fuzzy sets and fuzzy logic.
CO2	To understand the fuzzy notations,fuzzy controllers and algorithms
CO3	To understand and analyze artificial neural network architecture and algorithms
CO4	To study about self organizing maps ,adaptive resonance theory and network architectur
CO5	To apply the fuzzy and neural network concepts in real time applications image process control system and signal processing.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	L	L	M	M	L
	CO2	M	M	M	M	L
	CO3	M	M	M	M	L
	CO4	M	M	L	M	L
	CO5	H	H	L	M	L
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT – I **9**

FUZZY SETS AND FUZZY SYSTEMS

Fuzzy sets – properties of fuzzy sets – representation of fuzzy sets – operations of fuzzy sets – fuzzy relation – relation composition. Fuzzy system– Rule based fuzzy system – linguistic model –

Singleton model - Relational model – Takagi – Sugeno model – Dynamic fuzzy systems.

UNIT – II **9**

FUZZY CLUSTERING AND FUZZY CONTROL

Basic notations – hard and fuzzy partitions – fuzzy C- means clustering – Gustafson – Kessel algorithm. Knowledge based fuzzy control – Motivation for fuzzy control – fuzzy control as a parameterization of controllers non-linearities – mamadani controller – Takasi - sugeno controller – fuzzy supervisory control.

UNIT – III **9**

ARTIFICIAL NEURAL NETWORKS

Biological neuron – artificial neuron – neuron network architecture – learning – Multilayer neural network – radial based function network. Perception – multilayer perception architecture-Back propagation algorithm and its variant.

UNIT – IV **9**

NETWORK ARCHITECTURES

Hopfield network-kohonen-Self organizing maps – ART I and II, Grossberg nets recurrent network – reinforcement learning.

UNIT – V **9**

CONTROL BASED ON FUZZY AND NEURAL MODELS

Applications of fuzzy logic and neural network to measurement, control, signal processing and image processing.

Total No of Periods: 45

TEXT BOOKS:

1. Laurance Fausett, ”Fundamentals of Neural Network”, Prentice Hall, Englewood Cliffs N-S, 1992.
2. Jacek M. Zurava, Introduction to Aritificial neural system, Jiaco publishing House, Mumbai. 1997.

REFERENCE:

1. Draiankor D. Hellendron H. Reinfrank. M. An introduction to fuzzy control Narosa publishing House. New Delhi 1996.
2. Timothy J- Ross. Fuzzy logic with engineering applications. International editions.

	SMART GRID	**L**	**T**	**P**	**C**
MPE015	Total Contact Hours:45	3	0	0	3

	Prerequisite: FACTS, Power Generation Systems, Transmission and Distributior
	Course Designed by : Dept of Electrical & Electronics Engineering

OBJECTIVES

• To provide students with a working knowledge of fundamentals, design, analysis, and development of Smart Grid, from the basic concepts of power systems to the inherent elements of computational intelligence, communication technology and decision support system.

COURSE OUTCOMES (COs)

CO1	able toUnderstand the fundamental element of the smart grid,
CO2	able toUnderstand the fundamental structure of the power grid
CO3	use simulation tools such as Matlab and Paladin, for power flow analysis, optimization and state estimation
CO4	understand communication, networking, and sensing technologies involved with the smart grid
CO5	Develop computational techniques involved with the smart grid (decision support tools and optimization)

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	M				
	CO2	H	H	H	H	M
	CO3	M	M		M	H
	CO4	M	M	H	M	M
	CO5	H	H	M	M	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient &Self Healing Grid, Present development & International policies in Smart

Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart energy resources,Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control,Fault Detection, Isolation and service restoration, Outage management,High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits,AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Total Periods: 45 Periods

REFERENCES*:*

1. Vehbi C. Güngör, DilanSahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang "Smart Grid – The New and
3. Improved Power Grid: A Survey" , IEEE Transaction on Smart Grids,
4. Stuart Borlase "Smart Grid :Infrastructure, Technology and Solutions",CRC Press 2012.
5. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama,
6. "Smart Grid: Technology and Applications", Wiley.

OPEN ELECTIVE (OE) – I

	SOLAR AND ENERGY STORAGE SYSTEMS	**L**	**T**	**P**	**C**

MPS016	Total Contact Hours:45	3	0	0	3
	Prerequisite: Basics of Renewable Energy Sources				
	Course Designed by : Dept. of Electrical & Electronics Engineering				

OBJECTIVES

To Study about solar modules and PV system design and their applications , grid connected systems and about different energy storage systems

COURSE OUTCOMES (COs)

CO1	To understand the Characteristics of sunlight and solar cells
CO2	To describe the stand alone PV system
CO3	To understand Grid connected PV systems
CO4	To know Energy storage systems
CO5	To describe the Applications of solar systems

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H			M	H
	CO2		H			
	CO3	H		M		H
	CO4		H		H	
	CO5	H		M		H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th& 39thMeeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I
INTRODUCTION **9**

Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection.

UNIT II **9**

STAND ALONE PV SYSTEM

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

UNIT III **9**

GRID CONNECTED PV SYSTEMS

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

UNIT IV **9**

ENERGY STORAGE SYSTEMS

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage

UNIT V **9**

APPLICATIONS

Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

Total No of Periods : 45

References:

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

MPS017	**INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN**	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3
	Prerequisite:				

	Course Designed by : Dept. of Electrical & Electronics Engineering

OBJECTIVES

To analyze the motor starting and power factor correction and to perform computer-aided harmonic and flicker analysis and to design filters.

COURSE OUTCOMES (COs)

CO1	Understand the concept of motor starting methods
CO2	Analyze the power factor correction studies
CO3	Describe the System Model for Computer-Aided Analysis
CO4	Understand the Flicker analysis
CO5	Understand the Ground grid analysis

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H		M		
	CO2		H		H	
	CO3	H		H		M
	CO4				H	
	CO5	H	M	M		H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

MOTOR STARTING STUDIES **9**

Introduction-Evaluation Criteria-Starting Methods-System Data-Voltage Drop Calculations-Calculation of Acceleration time-Motor Starting with Limited-Capacity Generators-Computer-Aided Analysis-Conclusions.

UNIT II

POWER FACTOR CORRECTION STUDIES 9
Introduction-System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis-Voltage Magnification Analysis-Sustained Overvoltages-Switching Surge Analysis-Back-to-Back Switching-Summary and Conclusions.

UNIT III

HARMONIC ANALYSIS 9
Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis-Acceptance Criteria-Harmonic Filters-Harmonic Evaluation-Case Study-Summary and Conclusions.

UNIT IV
FLICKER ANALYSIS 9
Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT V
GROUND GRID ANALYSIS 9
Introduction-Acceptance Criteria-Ground Grid Calculations-Computer-Aided Analysis - Improving the Performance of the Grounding Grids-Conclusions.

Total No of Periods: 45

REFERENCES

1. Ramasamy Natarajan, ”Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2002.

	RESEARCH METHODOLOGY	**L**	**T**	**P**	**C**
	Total Contact Hours:45	3	0	0	3
MPS018	Prerequisite:				

	Course Designed by :
OBJECTIVES	
COURSE OUTCOMES (COs)	
CO1	
CO2	
CO3	
CO4	
CO5	
Mapping of Course Outcomes with Program outcomes (POs) (H/M/L indicates strength of correlation) H-High, M-Medium, L-Low	

1	COs/Pos	a	b	c	d	e
2	CO1					
	CO2					
	CO3					
	CO4					
	CO5					
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I

RESEARCH CONCEPTS **9**

Concepts, meaning, objectives, motivation, types of research, approaches, research (Descriptive research, Conceptual, Theoretical, Applied & Experimental).

Formulation of Research Task – Literature Review, Importance & Methods, Sources, quantification of Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task.

UNIT II

MATHEMATICAL MODELING AND SIMULATION 9

Concepts of modeling, Classification of Mathematical Models, Modeling with Ordinary differentialEquations, Difference Equations, Partial Differential equations, Graphs, Simulation, Process offormulation of Model based on Simulation.

UNIT III

EXPERIMENTAL MODELING 9

Definition of Experimental Design, Examples, Single factor Experiments, Guidelines for designing experiments. Process Optimization and Designed experiments, Methods for study of response surface, determining optimum combination of factors, Taguchi approach to parameter design.

UNIT IV

ANALYSIS OF RESULTS 9

Parametric and Non-parametric, descriptive and Inferential data, types of data, collection of data (normal distribution, calculation of correlation coefficient), processing, analysis, error analysis, different methods, analysis of variance, significance of variance, analysis of covariance, multiple regression, testing linearity and non-linearity of model.

UNIT V

REPORT WRITING 9

Types of reports, layout of research report, interpretation of results, style manual, layout and format, style of writing, typing, references, tables, figures, conclusion, appendices.

Total No of Periods: 45

TEXT BOOKS

1. Willktnsion K. L, Bhandarkar P. L, „Formulation of Hypothesis", Himalaya Publication.
2. Schank Fr., „Theories of Engineering Experiments", Tata Mc Graw Hill Publication.

REFERENCE BOOKS

1. Douglas Montgomary, „Design of Experiments", Statistical Consulting Services, 1990.
2. Douglas H. W. Allan, „Statistical Quality Control: An Introduction for Management", Reinhold Pub Corp, 1959.
3. Cochran and Cocks, „Experimental Design", John Willy & Sons.
4. John W. Besr and James V. Kahn, „Research in Education", PHI Publication.
5. Adler and Granovky, „Optimization of Engineering Experiments", Meer Publication
6. S. S. Rao, „Optimization Theory and Application", Wiley Eastern Ltd., New Delhi, 1996.