	VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN (Autonomous Institution Affiliated to Anna University, Chennai) Elayampalayam, Tiruchengode – 637 205				
Programme	**M.E.**	Programme Code	**202**	Regulation	**2013**
Department	**POWER SYSTEMS ENGINEERING / ELECTRICAL AND ELECTRONICS ENGINEERING**			Semester	**I**

CURRICULUM

(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
	THEORY							
P13MA102	Applied Mathematics	3	1	0	4	50	50	100
P13PS101	Advanced Power Electronic Circuits	3	0	0	3	50	50	100
P13PS102	Electrical Transients in Power Systems	3	0	0	3	50	50	100
P13PS103	Linear and Nonlinear System Theory	3	0	0	3	50	50	100
P13PS104	Computer Methods in Power System Analysis	3	1	0	4	50	50	100
-	Elective I	3	0	0	3	50	50	100
	PRACTICAL							
P13PS105	Power System Simulation Laboratory - I	0	0	3	2	50	50	100
				Total Credits	**22**	**350**	**350**	**700**

CA - Continuous Assessment, ESE - End Semester Examination

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Programme	**M.E.**	Programme Code	**202**	Regulation	**2013**
Department	**POWER SYSTEMS ENGINEERING / ELECTRICAL AND ELECTRONICS ENGINEERING**			Semester	**II**

CURRICULUM

(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
THEORY								
P13PS206	Flexible AC Transmission Systems	3	0	0	3	50	50	100
P13PS207	Power System Dynamics and Control	3	0	0	3	50	50	100
P13PS208	Power Quality	3	0	0	3	50	50	100
P13PS209	Restructured Power System	3	0	0	3	50	50	100
-	Elective II	3	0	0	3	50	50	100
-	Elective III	3	0	0	3	50	50	100
PRACTICAL								
P13PS210	Power System Simulation Laboratory -II	0	0	3	2	50	50	100
	Total Credits				**20**	**350**	**350**	**700**

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CURRICULUM
(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
THEORY								
-	Elective IV	3	0	0	3	50	50	100
-	Elective V	3	0	0	3	50	50	100
-	Elective VI	3	0	0	3	50	50	100
PRACTICAL								
P13PS311	Project Phase - I	0	0	12	6	50	50	100
				Total Credits	**15**	**200**	**200**	**400**

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Programme	**M.E.**	Programme Code	**202**	Regulation	**2013**
Department	**POWER SYSTEMS ENGINEERING / ELECTRICAL AND ELECTRONICS ENGINEERING**			Semester	**IV**

CURRICULUM
(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
PRACTICAL								
P13PS412	Project Phase - II	0	0	24	12	50	50	100
Total Credits					**12**	**50**	**50**	**100**

CA - Continuous Assessment, ESE - End Semester Examination

Cumulative Course Credit: 69

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CURRICULUM

(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
	LIST OF ELECTIVES							
P13PSE01	Industrial Control Electronics	3	0	0	3	50	50	100
P13PSE02	Analysis of Inverters	3	0	0	3	50	50	100
P13PSE03	Renewable Power Generation Technologies	3	0	0	3	50	50	100
P13PSE04	Power System Planning and Reliability	3	0	0	3	50	50	100
P13PSE05	EHV AC Transmission	3	0	0	3	50	50	100
P13PSE06	Modeling And Analysis Of Electrical Machines	3	0	0	3	50	50	100
P13PSE07	Advanced Power System Protection	3	0	0	3	50	50	100
P13PSE08	Computer Relaying and Wide Area Measurement Systems	3	0	0	3	50	50	100
P13PSE09	Smart Grid Technologies	3	0	0	3	50	50	100
P13PSE10	Distributed Generation and Micro-Grids	3	0	0	3	50	50	100
P13PSE11	Control Design Techniques for Power Electronic Systems	3	0	0	3	50	50	100
P13PSE12	Energy Auditing and Management	3	0	0	3	50	50	100
P13PSE13	Electrical Distribution Systems	3	0	0	3	50	50	100
P13PSE14	Intelligent Systems And Control	3	0	0	3	50	50	100
P13PSE15	Power Electronic Drives	3	0	0	3	50	50	100

P13PSE16	High Voltage Dc Transmission	3	0	0	3	50	50	100
P13MAE01	Optimization Techniques	3	0	0	3	50	50	100

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CURRICULUM (Applicable to the students admitted from the academic year 2013 - 2014 onwards)					

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13MA102	**Applied Mathematics**	3	1	0	4	**50**	**50**	**100**

Objective	• One Dimensional random variables, Testing the hypothesis • Linear programming, Computational methods in Engineering and Various Queuing models.		
Unit – I	**ONE DIMENSIONAL RANDOM VARIABLE**	Periods	**09**
Random Variables- Probability Function-Moments-Moment Generating Function & their Properties- Binomial, Poisson, Geometric, Uniform, Exponential Distributions			
Unit – II	**TESTING OF HYPOTHESIS**	Periods	**09**
Basic Definitions:- (Population, Sampling, Tests of Significance, Testing a Hypothesis, Null Hypothesis, Alternative Hypothesis, Level of Significance, Types of Errors) – Testing of Hypothesis using : 't'-Test , 'F'-Test , Chi Square Test (ψ^2) - Test for Independence of Attributes & Goodness of Fit			
Unit – III	**LINEAR PROGRAMMING**	Periods	**09**
Formulation-Graphical solution-Simplex Method -Transportation and Assignment problems			
Unit – IV	**DYNAMIC PROGRAMMING**	Periods	**09**
Dynamic Programming-principle of optimality-forward and backward recursion-DP Applications (Cargo loading method only)-Problems of dimensionality			
Unit – V	**QUEUING MODELS**	Periods	**09**
Introduction-Markovian Models: M/M/1**:** infinite capacity-M/M/C**:** infinite capacity-M/M/1**:** finite capacity – M/M/C**:** finite capacity, Little's formula			
		Total Periods	**45**
References			

1.	B.V.Ramana – 'Higher Engineering Mathematics', by Tata Mc Graw Hill Publishing Pvt Ltd – New Delhi, 2008th Edition.
2.	Taha, H.a., Operations Research: An Introduction, seventh Edition, Person Education edition, Asia, New Delhi (2002).
3.	Moon,T.K.,Sterling,W.C.,Mathematical methods and algorithms for signal processing,Pearson Education,2000
4.	Donald Gross and carl M.Harris, Fundamentals of queuing theory,2nd edition, john Wiley and Sons,New York(1985)
5.	Richard Johnson,Miller&freund's probability and statistics for engineers,7th edition, Prentice-Hall of india,private Ltd.,New Delhi(2007)

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Department	**POWER SYSTEMS ENGINEERING / ELECTRICAL AND ELECTRONICS ENGINEERING**			Semester	**I**

CURRICULUM

(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS101	**Advanced Power Electronic Circuits**	3	0	0	3	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • Providing the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation. • Required skills to derive the criteria for the design of power converters starting from basic fundamental		
Unit – I		Periods	**09**
Special Inverter Topologies - Current Source Inverter. Ideal Single Phase CSI operation, analysis and waveforms - Analysis of Single Phase Capacitor Commutated CSI. Series Inverters .Analysis of Series Inverters .Modified Series Inverter. Three Phase Series Inverter - Analysis using MATLAB			
Unit – II		Periods	**09**
Switched Mode Rectifier - Operation of Single/Three Phase bilateral Bridges in Rectifier Mode. Control Principles. Control of the DC Side Voltage. Single phase and three phase boost type APFC and control, Three phase utility inter phases and control-Analysis using MATLAB			
Unit – III		Periods	**09**
Buck, Boost, Buck-Boost SMPS Topologies. Basic Operation- Waveforms - modes of operation – Output voltage ripple Push-Pull and Forward Converter Topologies - Basic Operation .Waveforms - Voltage Mode Control. Half and Full Bridge Converters .Basic Operation and Waveforms- Fly back Converter. Discontinuous mode operation. Waveforms Control - Continuous Mode Operation Waveforms - Analysis using MATLAB			
Unit – IV		Periods	**09**
Introduction to Resonant Converters .Classification of Resonant Converters. Basic Resonant Circuit Concepts. Load Resonant Converter. Resonant Switch Converter. Zero Voltage Switching Clamped Voltage Topologies. Resonant DC Link Inverters with Zero Voltage Switching. High Frequency Link Integral Half Cycle Converter-, Analysis using MATLAB			
Unit – V		Periods	**09**
Principle and operation - Single phase and three phase cyclo converters – multi-level inverters. - matrix converters – Z source inverter-Analysis using MATLAB			
		Total Periods	**45**

References	
1.	Ned Mohan et.al, “Power electronics : converters, applications and design” , John Wiley and Sons
2.	Rashid, “Power Electronics”, Prentice Hall India 2007.
3.	G.K. Dubey et.al ,“Thyristorised Power Controllers” ,Wiley Eastern Ltd., 2005, 06.
4.	G.K. Dubey & C.R. Kasaravada ,“Power Electronics & McGraw Hill., Drives” Tata 1993.
5.	Dewan & Straughen, “Power Semiconductor Circuits", John Wiley & Sons., 1997

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CURRICULUM
(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS102	**Electrical Transients in Power Systems**	3	0	0	3	**50**	**50**	**100**

Objective

- To make the students familiar with the theoretical basis for various forms of over voltages such as lighting strokes, surges, switching transients etc.,
- Introduce some of the protection measures against over voltages .

Unit – I		Periods	**09**

Transients in electric power systems – Internal and external causes of over voltages –-Lightning strokes – Mathematical model to represent lightning, Travelling waves in transmission lines – Circuits with distributed constants – Wave equations – Reflection and refraction of travelling waves – Travelling waves at different line terminations

Unit – II		Periods	**09**

Switching transients – double frequency transients – abnormal switching transients –Transients in switching a three phase reactor - three phase capacitor

Unit – III		Periods	**09**

Voltage distribution in transformer winding – voltage surges-transformers – generators and motors - Transient parameter values for transformers, reactors, generators and transmission lines

Unit – IV		Periods	**09**

Basic ideas about protection – surge diverters-surge absorbers - protection of lines and stations Modern lighting arrestors - Insulation coordination - Protection of alternators and industrial drive systems.

Unit – V		Periods	**09**

Generation of high AC and DC-impulse voltages, currents - measurement using spheregaps-peak voltmeters - potential dividers and CRO

	Total Periods	**45**

References

1. Allen Greenwood, ‘Electrical transients in power systems’, Wiley Interscience, 1991.
2. Bewley, L.V., ‘Travelling waves on Transmission systems’, Dover publications, New York, 1963
3. Gallaghar, P.J. and Pearman, A.J., 'High voltage measurement, Testing and Design', John Wiley and sons, New York, 2001.

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CURRICULUM (Applicable to the students admitted from the academic year 2013 - 2014 onwards)					

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS103	**Linear and Nonlinear System Theory**	3	0	0	3	**50**	**50**	**100**

Objective	• Modeling and representing systems in state variable form • Model concepts and design of state and output feedback controllers and estimators		
Unit – I	**PHYSICAL SYSTEMS AND STATE ASSIGNMENT SYSTEMS**	Periods	**09**
Electrical, mechanical, Hydraulic, Pneumatic, Thermal Systems – Modelling of some typical systems like DC machines- Inverted Pendulum-Analysis using MATLAB			
Unit – II	**STATE SPACE ANALYSIS**	Periods	**09**
Realisation of state models: Non-uniqueness – minimal realization – Balanced realization – Solution of State equations – State Transition matrix and its properties – Free and Forced Responses – Properties: Controllability and Observability – Stabilisability and Detectability – Kalman decomposition-Analysis using MATLAB.			
Unit – III	**MIMO SYSTEMS – FREQUENCY DOMAIN SPECIFICATIONS**	Periods	**09**
Properties of transfer functions – Impulse response matrices – poles and zeros of transfer function matrices – critical frequencies – Resonance – Steady State and dynamic response – Bandwidth – Nyquist plots – Singular Value Analysis- Analysis using MATLAB.			
Unit – IV	**NONLINEAR SYSTEMS**	Periods	**09**
Types of Nonlinearity – Typical examples – Equivalent linearization – Phase plane analysis – Limit cycles – Describing Functions – Analysis using Describing functions – Jump resonance- Analysis using MATLAB			
Unit – V	**STABILITY**	Periods	**09**
Stability concepts – equilibrium points – BIBO and asymptotic stability – Direct method of Liapnov – Application to non linear problems – Frequency domain stability criteria – Papov's method and its extensions-, Analysis using MATLAB			
		Total Periods	**45**

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.

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CURRICULUM (Applicable to the students admitted from the academic year 2013 - 2014 onwards)					

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS104	**Computer Methods in Power System Analysis**	3	1	0	4	**50**	**50**	**100**

Objective	• Modeling the power system under steady state operating condition. • Modeling and analyses the transient behavior of power system when it is subjected to a fault.		
Unit – I		Periods	**12**
Modern Power System- Power in Single Phase AC Circuits- Complex Power- Power Balance and Power Factor Correction- Balanced Three Phase Circuits- Computer's Role in Power System Studies. Power system Network Matrices: Graph of a Power system Network- Incidence Matrices -Primitive Network -Network Equations and Network Matrices- Bus Admittance Matrix, Analysis using MATLAB.			
Unit – II		Periods	**12**
Y_{Bus} Formulation- Solution of Nonlinear Algebraic Equations- Power Flow Analysis: Gauss –Seidel method - Newton Raphson Method- Decoupled And Fast Decoupled Methods- Line flows And Losses- DC Load flow- Optimal Power Flow: Solution of the Optimal Power Flow-Linear Sensitivity Analysis and Programming Methods- Security-Constrained Optimal Power flow- Analysis using ETAP & MATLAB.			
Unit – III		Periods	**12**
Bus Impedance Matrix [Z_{bus}] -Direct Building of [Z_{bus}]- Contingency Analysis, Multiple line Contingency and Line Outage(Single, Two and Tie Line)- Computerized Fault Analysis: Symmetrical and Unsymmetrical Short Circuit Analysis, Analysis using ETAP & MATLAB.			
Unit – IV		Periods	**12**
Characteristics of Power Generation Units - Unit Commitment: Spinning Reserve- Thermal Unit Constraints- Solution Methods. Hydrothermal Coordination: Plant Models and Scheduling Problem - Pumped Storage Hydro plants- Dynamic and Linear Programming Solution- Economic Dispatch of Thermal Units and Methods of Solution.			
Unit – V		Periods	**12**
Power System Security: Factors Affecting Security - Linear Sensitivity Factors- AC Power Flow Methods- State Estimation: Maximum Likelihoon Weighted Least squares Estimation- State Estimation of an AC Network- State Estimation from Non Linear Measurement – Bad Data in Measurement Vector- Application of Power System State Estimation- Load Forecasting and Techniques – Estimation of Average and Trend Terms of Deterministic part of load.			
		Total Periods	**60**

References	
1.	A.J. Wood, B.F. Wollenberg, "Power Generation, Operation and Control", John Wiley & Sons, New York, 2010.
2.	Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", PHI Learning Private Limited, NewDelhi, 2012.
3.	N.V.Ramana,"Power System Analysis", Dorlig Kindersley (India)Pvt. Ltd., 2012.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS105	**Power System Simulation Laboratory - I**	0	0	3	2	**50**	**50**	**100**

Objective	• Acquire skills of using computer packages MATLAB coding and SIMULINK in power electronics and power system studies.

1. Solution of simultaneous Algebraic equations by
   - Gauss-Elimination
   - Crout's method
   - Cholesky method
2. Solution of Simultaneous differential equations by
   - RK-4
   - Modified Euler's method
3. Formation of Ybus using two dimensional arrays by inspection method
4. Formation of Ybus using Sparsity Technique
5. Load flow by Gauss Seidel, Newton Raphson and Fast Decoupled methods using
   - Two-dimensional arrays
   - Sparsity techniques
   - MATLAB
6. AC/DC load flow study
7. NR-load flow study with FACTS

Total Periods	**45**

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CURRICULUM

(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS206	**Flexible AC Transmission Systems**	3	0	0	3	**50**	**50**	**100**

Objective	• To analyze variety of high power-electronic controllers for active and reactive power in transmission lines. • To model different FACTS controllers, form a basis for selecting a particular controller for a given application		
Unit – I		Periods	**09**
Fundamentals of ac power transmission - transmission problems and needs - emergence of FACTS-FACTS control considerations - FACTS controllers			
Unit – II		Periods	**09**
Principles of shunt compensation – Variable Impedance type & switching converter type -Static Synchronous Compensator (STATCOM) configuration - characteristics and control			
Unit – III		Periods	**09**
Principles of static series compensation using GCSC, TCSC and TSSC – applications - Static Synchronous Series Compensator (SSSC)			
Unit – IV		Periods	**09**
Principles of operation - Steady state model and characteristics of a static voltage regulators and phase shifters - power circuit configurations			
Unit – V		Periods	**09**
UPFC - Principles of operation and characteristics - independent active and reactive power flow control - comparison of UPFC with the controlled series compensators and phase shifters			
		Total Periods	**45**

References

1.	Song, Y.H. and Allan T. Johns, "Flexible AC Transmission Systems (FACTS)", Institution of Electrical Engineers Press, London, 1999.
2.	Hingorani ,L.Gyugyi, "Concepts and Technology of Flexible AC Transmission System", IEEE Press New York, 2000 ISBN –078033 4588.
3.	Mohan Mathur R. and Rajiv K.Varma , "Thyristor - based FACTS controllers for Electrical Transmission systems", IEEE press, Wiley Inter science, 2002.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS207	**Power System Dynamics and Control**	3	0	0	3	**50**	**50**	**100**

Objective

At the end of the course the students would be exposed to fundamental knowledge in

- Modeling of synchronous machine, the excitation system and speed-governing controllers.
- Transient stability simulation of multi machine power system

Unit – I		Periods	**09**

Power System Operation and Control. Stability Problems faced by Power Systems. Impact on Power System Operation and Control. Concept of Equilibria, Small and Large Disturbance Stability. Example: Single Machine Infinite Bus System. Modal Analysis of Linear Systems. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff Systems.

Unit – II		Periods	**09**

Physical Characteristics. Rotor Position Dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. ETAP Programs: Short Circuit Transient Analysis of a Synchronous Machine. Synchronous Machine Connected to Infinite Bus.

Unit – III		Periods	**09**

Physical Characteristics and Models. Control system components. Excitation System Controllers. Prime Mover Control Systems. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Other Subsystems - HVDC, protection systems.

Unit – IV		Periods	**09**

Single Machine Infinite Bus System. Multi-machine Systems. Stability of Relative Motion. Frequency Stability: Centre of Inertia Motion. Concept of Load Sharing: Governors. Single Machine Load Bus System: Voltage Stability. Torsional Oscillations

Unit – V		Periods	**09**

Transient Stability Program. Small Signal Analysis Program.EMTP Programs.Real-Time Simulators.Planning Measures.Stabilizing Controllers (Power System Stabilizers).Operational Measures- Preventive Control. Emergency Control

	Total Periods	**45**

References	
1.	K.R.Padiyar," Power System Dynamics Stability & Control", 2nd Edition, B.S. Publications, Hyderabad, 2002.
2.	P.Kundur, "Power System Stability and Control", McGraw Hill Inc, New York,1995
3.	P.Sauer & M.A.Pai, "Power System Dynamics & Stability", Prentice Hall, 1997.

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CURRICULUM
(Applicable to the students admitted from the academic year 2013 - 2014 onwards)

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS208	**Power Quality**	3	0	0	3	**50**	**50**	**100**

Objective	• Understanding the various power quality issues. • Understanding the conventional compensation techniques used for power factor Correction and load voltage regulation.		
Unit – I		Periods	**09**
Electric power quality phenomena- IEC and IEEE definitions - power quality disturbances- voltage fluctuations-transients-unbalance-waveform distortion-power frequency variations.			
Unit – II		Periods	**09**
Voltage variations, Voltage sags and short interruptions – flicker- longer duration variations - sources – range and impact on sensitive circuits-standards – solutions and mitigations – equipment and techniques.			
Unit – III		Periods	**09**
Transients – origin and classifications – Capacitor switching transient – lightning-load switching – impact on users – protection – mitigation- Analysis using ETAP & MATLAB.			
Unit – IV		Periods	**09**
Harmonics – sources – definitions & standards – impacts - calculation and simulation – harmonic power flow - mitigation and control techniques – filtering – passive and active- Analysis using ETAP & MATLAB			
Unit – V		Periods	**09**
Power Quality conditioners – shunt and series compensators-DStatcom-Dynamic voltage restorer-unified power quality conditioners-case studies- Analysis using ETAP & MATLAB			
		Total Periods	**45**

References

1.	Heydt, G.T., 'Electric Power Quality', Stars in a Circle Publications, Indiana, 2nd edition 1994.
2.	Bollen, M.H.J., 'Understanding Power Quality Problems: Voltage sags and interruptions', IEEE Press, New York, 2000.
3.	Arrillaga, J, Watson, N.R., Chen, S., 'Power System Quality Assessment', Wiley, New York, 2000.

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CURRICULUM
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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS209	**Restructured Power System**	3	0	0	3	**50**	**50**	**100**

Objective	• To provide in-depth understanding of operation of deregulated electricity market systems • To enable students to analyze various types of electricity market operational and control issues using new mathematical models		
Unit – I		Periods	**09**
Introduction – Deregulation – Different entities in Deregulated Electric markets – Background to deregulation and the current situation around the world – Benefits from competitive electricity market – After – effects of Deregulation – Review of Economic Load dispatch problem (ELD) – Recent development in ELD- Optimal power flow (OPF) as a basic tool – OPF model, examples – characteristic features of OPF – Unit commitment (UC) – basic model.			
Unit – II		Periods	**09**
additional issues – Formation of power pools – The Energy Brokerage system- Role of the independent system operator (ISO) – structure of UK and Nordic electricity sector deregulation – Operational planning activities of ISO – ISO in pool and bilateral markets – Operational planning activities of a Genco – Genco in pool and bilateral markets.			
Unit – III		Periods	**09**
Market participation issues – UC in Deregulated environment – Competitive bidding- Power wheeling – Transmission open access – types of transmission services in open access – Cost components in transmission – Pricing of power transactions, and embedded cost based transmission pricing.			
Unit – IV		Periods	**09**
Incremental cost based transmission based transmission pricing – transmission open access and pricing mechanisms in various countries – United kingdom, Chile and Sweden- Developments in international transmission pricing in Europe – security management in deregulated environment.			
Unit – V		Periods	**09**
Scheduling of spinning reserves, interruptible load options for security management – Congestion management in deregulation, economic instruments for handling congestion.			
		Total Periods	**45**

References	
1.	Kankar Bhattacharya, Math H.J.Bollen, Jaap E.Daader, "Operation of restructured power systems, Kluwer academic publishers" , USA, first Edition, 2001.
2.	G.Zaccour, "Deregulation of Electric utilities", Kluwar Academic Publisher, 1998.
3.	Marjia IIic, Francisco Galiana and Lester fink, "Power systems restructuring engineering and economics" , Kulwer academic Publishers, 1998.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PS210	**Power System Simulation Laboratory -II**	0	0	3	2	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • Acquire skills of using computer packages MATLAB coding and SIMULINK in power electronics and power system studies. • Acquire skills of using ETAP software for power system studies.

1. Simulation of Single Area and Two Area Systems using Matlab Package.
2. Study of load frequency control problem of (i) uncontrolled and (ii) controlled cases
3. Economic Dispatch of (i) Thermal Units and (ii) Thermal Plants using Conventional and ANN and GA algorithms
4. MVAR Compensation studies on normal and heavily loaded power systems using Mi-power package
5. Contingency evaluation and analysis of power system
6. Development of single line diagram of power system components
7. State estimation of power systems.

Total Periods	**45**

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE01	**Industrial Control Electronics**	3	0	0	3	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • Control and applications of various electronic equipments to the industries		
Unit – I		Periods	**09**
Review of switching regulators and switch mode power supplies, Uninterrupted power supplies- off-line and on-line topologies-Analysis of UPS topologies, solid state circuit breakers, solid-state tap-changing of transformer			
Unit – II		Periods	**09**
Analog Controllers - Proportional controllers, Proportional – Integral controllers, PID controllers, derivative overrun, integral windup, cascaded control, Feed forward control, Digital control schemes, control algorithms, programmable logic controllers			
Unit – III		Periods	**09**
Signal conditioners-Instrumentation amplifiers – voltage to current, current to voltage, voltage to frequency, frequency to voltage converters; Isolation circuits – cabling; magnetic and electro static shielding and grounding			
Unit – IV		Periods	**09**
Opto-Electronic devices and control , electronic circuits for photo-electric switches-output signals for photo-electric controls; Applications of opto-isolation, interrupter modules and photo sensors; Fibre-optics; Bar code equipment, application of barcode in industry			
Unit – V		Periods	**09**
Stepper motors – types, operation, control and applications; servo motors- types, operation, control and applications – servo motor controllers – servo amplifiers – linear motor applications-selection of servo motor.			
		Total Periods	**45**

References

1.	Michael Jacob, ‘Industrial Control Electronics – Applications and Design’, Prentice Hall,1995.
2.	Thomas E. Kissell, ‘Industrial Electronics’, Prentice Hall India, 2003
3.	James Maas, ‘Industrial Electronics’, Prentice Hall, 1995.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE02	**Analysis of Inverters**	3	0	0	3	**50**	**50**	**100**

Objective	• Designing and analyzing the different types of inverters. • Working of advanced types of inverters such as multilevel inverters and resonant inverters. • Switching techniques and basic topologies of DC-AC converters.		
Unit – I		Periods	**09**
Introduction to self commutated switches : MOSFET and IGBT - 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- Analysis using MATLAB.			
Unit – II		Periods	**09**
180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques- Analysis using MATLAB			
Unit – III		Periods	**09**
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- Analysis using MATLAB.			
Unit – IV		Periods	**09**
Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters- Analysis using MATLAB			
Unit – V		Periods	**09**
Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters-Analysis using MATLAB			
		Total Periods	**45**

References	
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.
3.	Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education, Second Edition, 2003.

<table>
<tr><td rowspan="1"></td><td colspan="4">VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
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Elayampalayam, Tiruchengode – 637 205</td><td></td></tr>
<tr><td>Programme</td><td>M.E.</td><td>Programme Code</td><td>202</td><td>Regulation</td><td>2013</td></tr>
<tr><td>Department</td><td colspan="3">POWER SYSTEMS ENGINEERING / ELECTRICAL AND ELECTRONICS ENGINEERING</td><td>Semester</td><td>-</td></tr>
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(Applicable to the students admitted from the academic year 2013 - 2014 onwards)</td></tr>
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<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods Per Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ESE</td><td>Total</td></tr>
<tr><td>P13PSE03</td><td>Renewable Power Generation Technologies</td><td>3</td><td>0</td><td>0</td><td>3</td><td>50</td><td>50</td><td>100</td></tr>
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Objective

At the end of the course the students would be exposed to fundamental knowledge in

- To aware of various forms of renewable energy
- To understand in detail the wind energy conversion system and photovoltaic conversion system

Unit – I		Periods	**09**

Sun and Earth-Basic Characteristics of solar radiation-angle of sunrays on solar collector- Photovoltaic cell-characteristics-equivalent circuit-Photovoltaic modules and arrays

Unit – II		Periods	**09**

PV Systems-Design of PV systems-Standalone system with DC and AC loads with and without battery storage-Grid connected PV systems-Maximum Power Point Tracking

Unit – III		Periods	**09**

Wind energy – energy in the wind – aerodynamics - rotor types – forces developed by blades - Aerodynamic models – braking systems – tower - control and monitoring system - design considerations-power curve - power speed characteristics-choice of electrical generators

Unit – IV		Periods	**09**

Wind turbine generator systems-fixed speed induction generator-performance analysis-semi variable speed induction generator-variable speed induction generators with full and partial rated power converter topologies -isolated systems-self excited induction generator-permanent magnet alternator -performance analysis

Unit – V		Periods	**09**

Hybrid energy systems-wind-diesel system-wind-PV system-micro hydro-PV system-biomass-PV-diesel system-geothermal-tidal and OTEC systems

	Total Periods	**45**

References

1. Chetan Singh Solanki, 'Solar Photovoltaics-Fundamentals, Technologies and Applications',PHI Learning Pvt. Ltd., New Delhi, 2011
2. Van Overstraeton and Mertens R.P., 'Physics, Technology and use of Photovoltaics', Adam Hilger, Bristol, 1996.
3. John F.Walker & Jenkins. N, 'Wind energy Technology', John Wiley and sons, Chichester, UK, 1997.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE04	**Power System Planning and Reliability**	3	0	0	3	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • To acquire skills in planning and building reliable power system.		
Unit – I		Periods	**09**
Objectives of planning – Long and short term planning - Load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting –total forecasting – annual and monthly peak demand forecasting			
Unit – II		Periods	**09**
Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique. Generator system reliability analysis –probability models for generators unit and loads – reliability analysis of isolated and interconnected system – generator system cost analysis – corporate model – energy transfer and off peak loading			
Unit – III		Periods	**09**
Transmission system reliability model analysis – average interruption rate - LOLP method -frequency and duration method			
Unit – IV		Periods	**09**
Two plant single load system - two plant two load system-load forecasting uncertainlyinterconnections benefits			
Unit – V		Periods	**09**
Introduction to system modes of failure – the loss of load approach – frequency & durationapproach – spare value assessment – multiple bridge equivalents			
		Total Periods	**45**

References

1.	Sullivan, R.L., 'Power System Planning', Heber Hill, 1987.
2.	Roy Billington, 'Power System Reliability Evaluation', Gordan & Breach Scain Publishers,1990.
3.	Eodrenyi, J., 'Reliability modelling in Electric Power System' JohnWiley, 1980.M.Tech. – Power Systems

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE05	**EHV AC Transmission**	3	0	0	3	**50**	**50**	**100**

Objective	• Understanding of the different aspects of Extra High Voltage. • A.C. and D.C. Transmission system design and Analysis.		
Unit – I		Periods	**09**
Standard transmission voltages – different configurations of EHV and UHV lines – average values of line equipment parameters – power handling capacity and line loss – costs of transmission lines and– mechanical considerations in line performance.			
Unit – II		Periods	**09**
Calculation of resistance, inductance and capacitance for multi-conductor lines – calculation of sequence inductances and capacitances – line parameters for different modes of propagation – resistance and inductance of ground return, numerical example involving a typical 400/220kV line using line constant program- Analysis using MATLAB.			
Unit – III		Periods	**09**
Charge-potential relations for multi-conductor lines – surface voltage gradient on conductors – gradient factors and their use – distribution of voltage gradient on sub conductors of bundle - voltage gradients on conductors in the presence of ground wires on towers - Analysis using ETAP			
Unit – IV		Periods	**09**
Power losses and audible losses: I^2R loss and corona loss - audible noise generation and characteristics - limits for audible noise - Day-Night equivalent noise level- radio interference**:** corona pulse generation and properties - limits for radio interference fields.			
Unit – V		Periods	**09**
Effect of EHV line on heavy vehicles - calculation of electrostatic field of AC lines- effect of high field on humans, animals, and plants - measurement of electrostatic fields - electrostatic Induction in un energized circuit of a D/C line - induced voltages in insulated ground wires - electromagnetic interference.			
		Total Periods	**45**

References	
1.	Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, Second Edition, New Age International Pvt. Ltd., 1990.
2.	Power Engineer’s Handbook, Revised and Enlarged 6th Edition, TNEB Engineers’ Association, October 2002.
3.	Microtran Power System Analysis Corporation, Microtran Reference Manual, Vancouver Canada.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE06	**Modeling And Analysis Of Electrical Machines**	3	0	0	3	**50**	**50**	**100**

Objective	• To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems. • To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.		
Unit – I		Periods	**09**
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		Periods	**09**
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		Periods	**09**
Voltage and toque equations – dynamic characteristics of permanent magnet and shunt DC motors – state equations - solution of dynamic characteristic by Laplace transformation.			
Unit – IV		Periods	**09**
Voltage and toque equations – transformation for rotor circuits – voltage and toque 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		Periods	**09**
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.			
		Total Periods	**45**

References	
1.	Charles Kingsley,Jr., A.E. Fitzgerald, "Stephen D.Umans, 'Electric Machinery", Tata Mcgraw Hill,6ht Edition, 2003.
2.	Paul C.Krause, OlegWasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", IEEE Press, Second Edition.
3.	R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India, 2001.

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CURRICULUM (Applicable to the students admitted from the academic year 2013 - 2014 onwards)					

Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE07	**Advanced Power System Protection**	3	0	0	3	**50**	**50**	**100**

Objective	• To facilitate the students understand the basic concepts and recent trends in power system protection. • To enable the students design and work with the concepts of digital and numerical relaying		
Unit – I		Periods	**09**
General philosophy of protection - Classification and Characteristic function of various protective relays-basic relay elements and relay terminology - Development of relaying scheme			
Unit – II		Periods	**09**
Digital Protection of power system apparatus – protection of generators – Transformer protection – magnetizing inrush current – Application and connection of transformer differential relays – transformer over current protection			
Unit – III		Periods	**09**
Bus bar protection - line protection - distance protection–long EHV line protection – Power line carrier protection			
Unit – IV		Periods	**09**
Reactor protection – Protection of boosters - capacitors in an interconnected power system			
Unit – V		Periods	**09**
Digital signal processing – digital filtering in protection relays - numeric protection – testing digital filtering in protection relays – digital data transmission – relay hardware – relay algorithms - Concepts of modern coordinated control system			
		Total Periods	**45**

References	
1.	Lewis Blackburn, J., ‘Protective Relaying – Principles and Applications’, Marcel Dekkar, INC, New York, 2006.
2.	The Electricity Training Association, ‘Power System Protection Vol1-4’, The IEE, U.K., 2005.
3.	C. Russeil Mason, ‘The art and Science of Protective Relaying’, GE Publishers, 1962.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE08	**Computer Relaying and Wide Area Measurement Systems**	3	0	0	3	**50**	**50**	**100**

Objective	• To understand the operating principles of a computer relays and wide area measurement systems and to learn about main classification of relay types		
Unit – I		Periods	**09**
Historical background - Expected benefits – computer relay architecture - Analog to digital converters - Anti-aliasing filters - Substation computer hierarchy - Fourier series Exponential fourier series - Sine and cosine fourier series – Phasor			
Unit – II		Periods	**09**
Walsh functions - Fourier transforms - discrete fourier transform - Random processes - Filtering of random processes - Kalman filtering - Digital filters - Windows and windowing, - Linear phase Approximation - filter synthesis – Wavelets - Elements of artificial intelligence			
Unit – III		Periods	**09**
Introduction - Phasor representation of sinusoids - Fourier series and Fourier transform and DFT Phasor representation - Phasor Estimation of Nominal Frequency Signals - Formulas for updating phasors – Non recursive updates – Recursive updates – Frequency Estimation			
Unit – IV		Periods	**09**
A generic PMU - The global positioning system - Hierarchy for phasor measurement systems, - Functional requirements of PMUs and PDCs - Transient Response of Phasor Measurement Units-of instrument transformers, filters, during electromagnetic transients - Transient response during power swings			
Unit – V		Periods	**09**
State Estimation - History, Operator's load flow - weighted least square least square, -Linear weighted least squares - Nonlinear weighted least squares - Static state estimation - State estimation with Phasors measurements - linear state estimation - Adaptive protection - Differential and distance protection of transmission lines – Adaptive protection – Adaptive out-of-step protection			
		Total Periods	**45**

References

1.	A.G. Phadke, J.S. Thorp, 'Computer Relaying for Power Systems', John Wiley and Sons Ltd., ResearchStudies Press Limited,2nd Edition,2009
2.	A.G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE09	**Smart Grid Technologies**	3	0	0	3	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure. • To get familiarized with the power quality management issues in Smart Grid.		
Unit – I		Periods	**09**
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		Periods	**09**
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		Periods	**09**
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		Periods	**09**
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		Periods	**09**
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**

References	
1.	Stuart Borlase ‘SmartGrid: Infrastructure, Technology and Solutions’,CRC Press 2012.
2.	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technologyand Applications’, Wiley, 2012.
3.	Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang ‘Smart Grid – The New and Improved Power Grid: A Survey’, IEEETransactionon Smart Grids.

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		L	T	P	C	CA	ESE	Total
P13PSE10	**Distributed Generation and Micro-Grids**	3	0	0	3	**50**	**50**	**100**

Objective	• To understand the planning and operational issues related to Distributed Generation and Micro-grids • To design a micro-grid taking into consideration the planning and operational issues of the Distributed Generators to be connected in the system.		
Unit – I		Periods	**09**
Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, and Planning of DGs – Siting and sizing of DGs – optimal placement of DG sources in distribution systems.			
Unit – II		Periods	**09**
Grid integration of DGs – Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG units. Energy storage elements: Batteries, ultra-capacitors, flywheels.			
Unit – III		Periods	**09**
Technical impacts of DGs – Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems.			
Unit – IV		Periods	**09**
Economic and control aspects of DGs –Market facts, issues and challenges - Limitations of DGs. Voltage control techniques, Reactive power control, Harmonics, Power quality issues. Reliability of DG based systems – Steady-state and Dynamic analysis			
Unit – V		Periods	**09**
Introduction to micro-grids – Types of micro-grids – autonomous and non-autonomous grids – Sizing of micro-grids- modeling & analysis- Micro-grids with multiple DGs – Micro-grids with power electronic interfacing units. Transients in micro-grids - Protection of micro-grids – Case studies.			
		Total Periods	**45**

References	
1.	H. Lee Willis, Walter G. Scott,’Distributed Power Generation – Planning and Evaluation’, Marcel DeckerPress, 2000.
2.	M.Godoy Simoes, Felix A.Farret, ’Renewable Energy Systems – Design and Analysis with Induction Generators’,CRC press.
3.	F. Katiraei, M.R. Iravani, ‘Transients of a Micro-Grid System with Multiple Distributed Energy Resources’, International Conference on Power Systems Transients (IPST’05) in Montreal, Canada

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE11	**Control Design Techniques for Power Electronic Systems**	3	0	0	3	**50**	**50**	**100**

Objective	• To study the application of modern control theory to power electronic converters and drives. • To study about modern controller design techniques for power converters		
Unit – I		Periods	**09**
Review of basic control theory – control design techniques such as P, PI,PID and lead lag compensator design. Review of state space control design approach – state feedback controller and observer design.			
Unit – II		Periods	**09**
Control of DC-DC converters. State space modeling of Buck, Buck-Boost, Cuk, Sepic, Zeta Converters. Equilibrium analysis and closed loop voltage regulations using state feedback controllers and sliding mode controllers.			
Unit – III		Periods	**09**
Control of rectifiers. State space modeling of single phase and three phase rectifiers. State feedback controllers and observer design for output voltage regulation for nonlinear loads. Analysis of continuous and discontinuous mode of operation.			
Unit – IV		Periods	**09**
Modelling of Brushless DC motors and its speed regulations – State space model, sensorless speed control of BLDC motor and Sliding mode control design for BLDC motor. Modelling and control of switched reluctance motor.			
Unit – V		Periods	**09**
Modeling of multi input DC-DC converters and its application to renewable energy. Output voltage regulation of Multi input DC-DC converter using state feedback controllers.			
		Total Periods	**45**

References

1.	Sira -Ramirez, R. Silva Ortigoza, 'Control Design Techniques in Power Electronics Devices', Springer, 2006.
2.	Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, 'Sliding mode control of switching Power Converters', CRC Press, 2011
3.	Ion Boldea and S.ANasar, 'Electric drives', CRC Press, 2005

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		L	T	P	C	CA	ESE	Total
P13PSE12	**Energy Auditing and Management**	3	0	0	3	**50**	**50**	**100**

Objective	• To emphasize the energy management on various electrical equipments and metering. • To illustrate the energy management in lighting systems and cogeneration		
Unit – I		Periods	**09**
Basics of Energy – Need for energy management – energy accounting- energy monitoring, targeting and reporting-energy audit process			
Unit – II		Periods	**09**
Energy management for electric motors – Transformer and reactors-capacitors and synchronous machines, energy management by cogeneration –forms of cogeneration – feasibilityof cogeneration – electrical interconnection			
Unit – III		Periods	**09**
Energy management in lighting systems – task and the working space - light sources – ballasts – lighting controls – optimizing lighting energy – power factor and effect of harmonics, lighting and energystandards			
Unit – IV		Periods	**09**
Metering for energy management – units of measure - utility meters – demand meters – paralleling of current transformers – instrument transformer burdens – multitasking solid state meters, metering location vs requirements, metering techniques and practical examples			
Unit – V		Periods	**09**
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 energymanagement – economic justification			
		Total Periods	**45**

References	
1.	Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, ‘Guide to Energy Management’, 5th Edition, The Fairmont Press, Inc., 2006
2.	Amit K. Tyagi, ‘Handbook on Energy Audits and Management’, The Energy and Resources Institute, 2003
3.	IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE13	**Electrical Distribution Systems**	3	0	0	3	**50**	**50**	**100**

Objective	• To explain the principles of design and operation of electric distribution feeders and other components • To make the students to understand the distribution system expansion planning and reliability analysis procedures		
Unit – I		Periods	**09**
Industrial and commercial distribution systems – Energy losses in distribution system – system ground for safety and protection – comparison of O/H lines and under ground cable system . Network model – power flow - short circuit and loss calculations.			
Unit – II		Periods	**09**
Distribution system - reliability analysis – reliability concepts – Markov model – distribution network reliability – reliability performance.			
Unit – III		Periods	**09**
Distribution system expansion - planning – load characteristics – load forecasting – design concepts – optimal location of substation – design of radial lines – solution technique.			
Unit – IV		Periods	**09**
Voltage control – Application of shunt capacitance for loss reduction – Harmonics in the system – static VAR systems – loss reduction and voltage improvement.			
Unit – V		Periods	**09**
System protection – requirement – fuses and section analyzers-over current - Under voltage and under frequency protection – coordination of protective device.			
		Total Periods	**45**

References

1.	Pabla, A.S., ‘Electrical Power Distribution System’, 5th edition,Tata McGraw hill, 2011.
2.	Tuvar Goner, ‘Electrical Power Distribution System Engineering’, McGraw hill, 2008.
3.	Sterling, M.J.H., ‘Power System Control’, Peter Peregrinus, 1986

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE14	**Intelligent Systems And Control**	3	0	0	3	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • Fuzzy logic model and Neural network interconnection systems.		
Unit – I		Periods	**09**
Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems- Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron.			
Unit – II		Periods	**09**
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-- Analysis using MATLAB-Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning.			
Unit – III		Periods	**09**
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.			
Unit – IV		Periods	**09**
Fuzzy logic control for nonlinear time-delay system-Analysis using MATLAB- 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 and-colony search techniques for solving optimization problems - Analysis using MATLAB- GA application to power system optimization problem.			
Unit – V		Periods	**09**
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.			
		Total Periods	**45**

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.

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		L	T	P	C	CA	ESE	Total
P13PSE15	**Power Electronic Drives**	3	0	0	3	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • To introduce basic concepts of load and drive interaction, speed control concepts of ac and dc drives, speed reversal, regenerative braking aspects, design methodology. • To analyse, simulate and evaluate performance of variable speed drives.		
Unit – I		Periods	**09**
Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive.			
Unit – II		Periods	**09**
Conventional methods of D.C.motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation			
Unit – III		Periods	**09**
Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers. PV fed DC drives.			
Unit – IV		Periods	**09**
Conventional methods of induction motor speed control. Solid state controllers for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motors. Voltage source and Current source inverter fed induction motor drives			
Unit – V		Periods	**09**
Speed control of synchronous motors, field oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines.			
		Total Periods	**45**

References

1.	P.C Sen, ‘Thyristor DC Drives’, John Wiley and Sons, New York, 1991.
2.	R.Krishnan, ‘Electric Motor Drives – Modeling, Analysis and Control’, Prentice-Hall of India Pvt Ltd., New Delhi, 2003.
3.	Bimal K.Bose, ‘Modern Power Electronics and AC Drives’, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003

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Course Code	Course Name	Periods Per Week			Credit	Maximum Marks		
		L	T	P	C	CA	ESE	Total
P13PSE16	**High Voltage Dc Transmission**	3	0	0	3	**50**	**50**	**100**

Objective	• To analyze the HVDC circuits and develop exquisite interest to work in the area of HVDC transmission		
Unit – I		Periods	**09**
Introduction to HVDC transmission, Comparison between HVAC and HVDC systems -economic, technical and reliability, limitations, choice of best topology for HVDC converters, types of HVDC links - monopolar, bipolar and homopolar links, Rectifier operation of Graetz circuit with and without overlap			
Unit – II		Periods	**09**
Inverter operation – analysis with and without overlap. Equivalent circuit model, Combined characteristics of HVDC system, basic means of control - desired features of control, power reversal			
Unit – III		Periods	**09**
Basic controllers - Constant Ignition Angle, Constant Current and Constant Extinction Advance angle control, power control, high level controllers. Converter faults - misfire, arc through, commutation failure. D.C. Reactor design - voltage and current oscillations.			
Unit – IV		Periods	**09**
Protection issues in HVDC – DC Circuit breakers, over voltage and over current protection. Characteristic and uncharacteristic harmonics - troubles due to harmonics – harmonic filters - active and passive filters - Reactive power control of converters			
Unit – V		Periods	**09**
Interaction between ac and dc systems. Recent trends in HVDC - VSC based HVDC – Multiterminal HVDC systems and Hybrid HVDC systems. Back to back thyristor converter system.			
		Total Periods	**45**

References

1.	Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.
2.	S.Rao, 'EHV-AC, HVDC Transmission and Distribution Engineering', Khanna Publications,3rd Edition, 2012.
3.	S.Kamakshaiah and V.Kamaraju, 'HVDC Transmission', 1st Edition, Tata McGraw Hill,2011.

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		L	T	P	C	CA	ESE	Total
P13MAE01	**Optimization Techniques**	3	0	0	3	**50**	**50**	**100**

Objective	At the end of the course the students would be exposed to fundamental knowledge in • To learn essential optimization techniques for applying to day to day problems. • Optimization techniques they can apply to engineering and other problems		
Unit – I		Periods	**09**
Linear programming – formulation - Graphical and simplex methods - Big-M method -Two phase method - Dual simplex method - Primal Dual problems			
Unit – II		Periods	**09**
Unconstrained one dimensional optimization techniques - Necessary and sufficient conditions – Unrestricted search methods - Fibonacci and golden section method -Quadratic Interpolation methods, cubic interpolation and direct root methods			
Unit – III		Periods	**09**
Unconstrained n dimensional optimization techniques – direct search methods – Random search – pattern search and Rosen brock's hill climbing method - Descent methods -Steepest descent, conjugate gradient, quasi - Newton method			
Unit – IV		Periods	**09**
Constrained optimization Techniques - Necessary and sufficient conditions – Equality and inequality constraints - Kuhn-Tucker conditions - Gradient projection method - cutting plane method - penalty function method			
Unit – V		Periods	**09**
Dynamic programming - principle of optimality - recursive equation approach -application to shortest route, cargo - loading, allocation and production schedule problems			
		Total Periods	**45**

References

1.	Rao S.S., 'Optimization: Theory and Application' Wiley Eastern Press, 2nd edition 1984.
2.	Taha,H.A., Operations Research –An Introduction,Prentice Hall of India,2003
3.	Fox, R.L., 'Optimization methods for Engineering Design', Addition Wiely, 1981.