Nagar Yuwak Shikshan Sanstha's
Yeshwantrao Chavan College of Engineering
(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)
Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering
SoE & Syllabus 2014
7 & 8 Semester
Electrical Engineering

Updated on June,2020

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B.E. SCHEME OF EXAMINATION 2014

(Revised Scheme of Examination w.e.f. 2020-21 onward)

SoE No. EL-101

Electrical Engineering

Sl.No.	Sub Code	Subject	CONTACT HOURS				Credits	% Weightage			ESE Duration
			L	T	P	Total		MSEs*	TA**	ESE	
SEVENTH SEMESTER											
1	EL1401	High Voltage Engineering	3	0	0	3	3	30	30	40	3 Hrs
2	EL1402	**Lab. :** High Voltage Engineering	0	0	2	2	1		60	40	
3	EL1403	Computer Applications in Electrical Engg	3	1	0	4	4	30	30	40	3 Hrs
4	EL1404	**Lab.:** Computer Applications in Electrical Engg	0	0	2	2	1		60	40	
5	**Prof. Elective II**		3	0	0	3	3	30	30	40	3 Hrs
	EL1410	PE II: FACTS Devices									
	EL1427	PE II:Artificial Intelligence based Systems									
	EL1431	PE II:Advanced Control System									
6	EL1432	Electrical Distribution Power System	3	0	0	3	3	30	30	40	3 Hrs
7	EL1405	**Lab.:** Simulations in Power System	0	0	2	2	1		60	40	
8	EL1406	Industrial Training / CRT	0	0	0	0	2		100		
9	EL1407	Project Phase I	0	0	4	4	4		60	40	
TOTAL			**12**	**1**	**10**	**23**	**22**				

EIGHTH SEMESTER											
1	EL1416	Switchgear and Protection	3	0	0	3	3	30	30	40	
2	EL1433	Renewable Energy Sources	3	0	0	3	3	30	30	40	
3	EL1434	**Lab. :**Renewable Energy Sources	0	0	2	2	1		60	40	
4	**Prof. Elective III**		3	0	0	3	3	30	30	40	
	EL1411	PE III : Advanced Electrical Drives									
	EL1422	PE III : Power System Operation and Control									
	EL1435	PE III : Fundamentals of Power Quality									
5	**Prof. Elective IV**		3	0	0	3	3	30	30	40	
	EL1424	PE IV : EHVAC-HVDC Transmission									
	EL1425	PE IV : Electrical Power Utilization									
	EL1436	PE IV : Fundamentals of Smart Grid									
	EL1437	PE IV : Electric Vehicles									
6	EL1417	**Lab.:** Switchgear and Protection	0	0	2	2	1		60	40	
7	EL1418	**Lab.:** Substation Design	0	0	4	4	2		60	40	
8	EL1419	**Lab.:** Comprehensive Viva-voce	0	0	0	0	3			100	
9	EL1430	Extra Curricular Activities / Competitive Exam.	0	0	0	0	2		100		
10	EL1420	Project Phase II	0	0	8	8	8		60	40	
TOTAL			**12**	**0**	**16**	28	**29**				

*** MSEs = 3 MSEs of 15 Marks each will be conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

TA ** = for Theory : 20 marks on lecture quizzes, 8 marks on assignments, 2 marks on class performance

TA = for Practical : MSPA will be 15 marks each**

Chairperson	**Version**	**1.00**	**Applicable for AY 2019-20 Onwards**
Dean (Acad. Matters)	**Date of Release**	**Nov 2019**	

7th Semester

EL1401	High Voltage Engineering	L= 3	T=0	P=0	Credits=3

Course Objective	Course Outcomes
	The student will be able to understand the 1) Breakdown process of dielectrics including the gas, liquid and solid state dielectrics and solids explaining the physical process of breakdown - based on the Townsend, Paschen's law, Streamer theory. 2) Mechanism of lighting, characteristics of switching over voltages and protection of transmission lines with various types of lightening arresters. 3) Phenomenon of travelling waves on HV transmission line which may be incident, reflected, transmitted, attenuated or distorted during propagation. 4) Generation of high DC and AC Voltages, high impulse voltages, switching surges and impulse current.. 5) Measurement of high AC and DC voltages, impulse voltage, high frequency and impulse current. 6) Non destructive and high voltage testing of electrical apparatus.
Mapped Program Outcomes: b,d,f,j	

UNIT-1: **Breakdown Mechanism in Dielectrics**

Ionisation process : Townsend's criterion for breakdown, Break-down in electro-negative gases, Time -lag for breakdown, Streamer theory for breakdown in gases, Paschen's law, Breakdown in non-uniform fields, corona discharges and introduction of corona, post breakdown phenomenon and applications, practical considerations in using gases for insulation purposes, vacuum insulation, liquid as insulators, conduction and breakdown in pure and commercial liquids. Intrinsic electromechanical and thermal breakdown. Breakdown of solid dielectric in practice, breakdown in composite dielectric.

UNIT-2: **Lightning and switching over voltages**

Mechanism of lightning types of strokes, parameter and characteristics of lightning strokes, characteristics of switching surges; power frequency over voltages, control of over voltages due to switching. Protection of lines by ground wire, protection by Lightning Arrester (LA), gap type and gapless LA, selection of LA ratings, Surge absorbers.

UNIT-3: Travelling Waves and Insulation Co-ordination

Travelling waves on transmission lines, classifications of lines, attenuation and distortion of travelling waves, reflection and transmission of waves, behaviour of rectangular waves at transition points. Introduction to insulation co-ordination and associated terms, impulse wave-form, introduction to Basic Insulation Level (BIL), Reduced BIL and Switching Impulse Level (SIL).

7th Semester

EL1401	**High Voltage Engineering**	**L= 3**	**T=0**	**P=0**	**Credits=3**

UNIT-4: Generation of High Voltage and Currents

Generation of High D.C. voltages by rectifiers, voltage doubler and multiplier circuits (Derivation not required) electrostatic machines. Generation of high ac voltage by cascade transformers, resonant transformers. Generation of high impulse voltages: Standard impulse wave shapes, analyses of model and commercial impulse generation circuits, waveshape control, Marx Circuit, tripping and control of impulse generation, generation of switching surges, generation of impulse current.

UNIT-5: Measurement of High Voltage and Current

Measurement of high AC and DC voltages by micro ammeter, generating voltmeters, resistance and capacitance potential dividers, series impedance voltmeter, Capacitive Voltage Transformer (CVT), Magnetic type potential transformers, electrostatic voltmeter, peak reading AC voltmeters, sphere gap arrangement, measurement of impulse voltage by potential dividers and peak reading voltmeters. Measurement of High AC/DC currents: Measurement of high frequency and impulse current by resistive shunts (Bifiliar strip shunt only).

UNIT-6: Non Destructive and High Voltage Testing of Electrical Apparatus

Non-destructive testing : Measurement of DC Resistivity, measurement of dielectric constant and loss-factor (low and power frequency only), Schering bridge for high voltage circuits, for high dissipation factor for three terminal measurements, transformer ratio arm bridges, partial discharge measurements by straight detector, balance detectors, calibration of detectors, discharge detection in power cables. High voltage testing: Testing of insulators, bushings, isolators, circuit breakers, cables, transformers, lightning arresters and power capacitors.

Text books:

SN	Name	Edition	Author	Publisher
1	EHV AC Transmission	2nd	Begamudre	New Age international Publisher
2	High Voltage Engineering	3rd -2006	M. S. Naidu and V. Kamaraju	Mc GrawHill Publisher
3	High Voltage Engineering	1st -1994	C.L. Wadhwa	New Age international Publisher

Reference books:				
1	Advances In High Voltage Engineering		M.Haddat and Warne	

7th Semester

EL1402	Lab. : High Voltage Engineering	L= 0	T=0	P=2	Credits=1

Mapped PO: b,c,f,i,j

Course Outcomes:

1) The main equipment in high voltage laboratory like HV transformer, sphere gap, control panel of transformer, cascade transformer and impulse voltage generator.
2) To measure the breakdown voltage between sphere gap, string insulator, pin insulator, puncture voltage and transformer oil.
3) To Measure Resistivity, Dielectric constant, tan δ of Oil Sample in Laboratory by using Three Terminal Oil Test Cell.
4) To Measure the condition of corona gap and horn gap which is applied generally in substation and transmission line during fault condition.
5) To observe the waveform in the CRO and measure the breakdown voltage between cascade transformer, impulse voltage generator (MARX circuit).
6) General study of cable fault locator.

Following practical based on Syllabus can be performed.

1) Study of High Voltage Laboratory Equipments.
2) Calibration of Panel Voltmeter by Sphere Gap.
3) Study of Corona.
4) Study of Movement of arc in horn gap.
5) Flash over voltage test: 11 kV pin type insulator.
6) Determination of string efficiency of suspension insulator.
7) Determination of breakdown voltage for transformer oil sample.
8) Determination of breakdown voltage for solid insulator.
9) Study of Cable Fault locator.
10) Measurement of Resistivity of Transformer oil.
11) Measurement of dielectric constant of transformer oil.
12) Measurement of Loss Angle of transformer oil.
13) Study of 100 kV AC/ 140 kV DC test set and calibration of Panel Voltmeter by Sphere gap.
14) Study of 150 kV, 225 Joules Impulse Generator and test on Pin type Insulator.

7th Semester

EL1403	Computer Applications in Electrical Engineering	L= 3	T=1	P=0	Credits=4

Course Objectives	Course Outcomes
This subject exposes the students to mathematical foundational concepts necessary in the field of Electrical Engineering such as 1) Load flow 2) Short circuit studies 3) Transient stability studies	1) Study of basics of incidence, network matrices and graph theory. 2) Formation of algorithms of bus impedance and bus admittance for single phase network. 3) Algorithm for formation of 3 phase bus impedance matrices without mutual coupling. 4) Calculations to find fault current and voltages for 3 phase network considering different types of fault. 5) Modelling and transient stability studies using different numerical methods with elementary computer programming. 6) Different methods of load flow studies.
PO:a,b,c,d,e,f,g,h,i,j	

UNIT-1: **Incidence and network matrices**
Incidence and network matrices: - Graph incidence Matrices, Primitive network, formation of network matrices by singular transformations.

UNIT-2: **Algorithm for single phase network**
Algorithm for formation of Bus Impedance and Bus Admittance matrix for system without mutual coupling.

UNIT-3: Three Phase Networks
Three Phase Networks: - Three phase balance network elements with balanced and unbalanced excitation incidence and network matrices for three phase element Algorithm for formation of three phase bus impedance matrices without mutual coupling.

UNIT-4: Short circuit studies
Short circuit studies: Three phase network short circuit calculations using bus impendence matrix for balanced and unbalanced faults. Computer programme for short circuit studies on simple system.

UNIT-5: Transient stability studies
Transient stability studies: Modelling of synchronous machine, power system network for transient stability studies. Numerical solution of swing equation by modified Euler and Runge Kutta 4th order method. Elementary computer programme for the transient stability study.

UNIT-6: Load Flow Studies
Load Flow Studies: Power system load flow equation, solution technique: Gauss Seidal , Newton Raphson and fast decoupled technique with and without (voltage) control buses. Representation of tap changing and phase shifting transformers. Elementary load flow programmes.

Text Books:

SN	TITLE	EDITION	AUTHOR	PUBLICATION
1	Computer Methods in Power Systems	1st 1968	Stag and El – Abiad	Mc Graw Hill
2	Elements of Power System Analysis	1982	William D.Stevenson	Mc Graw Hill

Reference Books

SN	TITLE	EDITION	AUTHOR	PUBLICATION
1	Computer Analysis in Power System	1982	R.N.Dhar	Mc Graw Hill
2	Modern Power System Analysis	3rd-2006	D.P.Kothari and I.J.Nagrath	TMH

7th Semester

EL1404	Lab.: Computer Applications in Electrical Engineering	L= 0	T=0	P=2	Credits=1

Course Outcomes:

The students will be able to understand
1. Basics of programming.
2. Write and debug programs for some power system problems.
3. Develop a skill of lifelong learning to solve Electrical problems by programming

Mapped PO: a,b,c,d,g,i,j

List of Experiments:

1. Write a program to find Bus Incidence Matrix.
2. Write a program to find Basic Cutset, Basic Closed Loop, Branch path incidence matrix.
3. Write a program to obtain Y_{bus} by Singular Transformation.
4. Write a program to find Z_{bus} by building algorithm method.
5. Write a program to obtain Y_{bus} by building algorithm method.
6. Write a program to determine fault current & faulted bus voltage for three phase to ground fault.
7. Write a program to determine fault current & faulted bus voltage for single phase to ground fault.
8. Write a program to plot swing curve by using Euler's method

7th Semester

EL1410	PE II: FACTS Devices	L= 3	T=0	P=0	Credits=3

Course Objectives	Course Outcomes
To understand the problems and constraints related with stability of large interconnected systems and to study their solutions using different FACTS Controllers, Shunt (SVC,STATCOM),Series (TCSC,GCSC,SSSC),Series Shunt(UPFC),Series Series(IPFC)	1) Concepts of FACTS, importance of controllable parameters in power system and benefits of FACTS controllers. 2) Design and implementation of shunt compensator with different control strategies. 3) Structure, operating principle and characteristics of different series controllers along with their implementation and applications. 4) Structure and operation of voltage and phase angle regulator in power system. 5) Combined series –shunt controllers with various operating modes. 6) Causes, effects, remedies and mitigation techniques for various power quality problems. 7) Concepts of FACTS, importance of controllable parameters in power system and benefits of FACTS controllers. **Mapped PO:a,b,c,d,f,j**

UNIT-1: **Flexible AC Transmission Systems (FACTS)**
FACTS concept and General System Consideration, Transmission interconnections, Flow of power in an AC System, factors affecting the Loading Capability, power flow and Dynamic Stability Consideration of Interconnected Transmission. Importance of controllable Parameters, FACTS Controller. HVDC and FACTS.

UNIT-2: **Static shunt compensators**
SVC and STATCOM, Objectives of Shunt Compensation, Methods of Controllable Var Generation, Static Var Compensators SVC and STATCOM,Control scheme for SVC and STATCOM ,Comparison between STATCOM and Static Var System (SVS).

UNIT-3: Static Series Compensators
GCSC, TSSC, TCSC and SSSC, Objectives of series Compensation, Variable Impedance Type Series compensators, Switching Converter Type Series Compensators, Control Schemes for GCSC,TSSC,TCSC and SSSC, External (System) Control for Series Reactive Compensators

UNIT-4: Static Voltage and Phase Angle Regulators
TCVR and TCPAR, Objectives of Voltage and phase angle regulators, Approaches to Thyristor Controlled Voltage Regulators (TCVR) and Thyristor Controlled Phase Angle Regulators (TCPAR), Switching Converter- Based Voltage and Phase Angle regulators, Hybrid Phase Angle Regulators.

UNIT-5: Shunt-Series Compensators:UPFC
Shunt series Compensators UPFC, Operating modes of UPFC, Basic control system for P and Q control, Comparison of UPFC to Series Compensators and Phase angle regulators.

UNIT 6: **Other FACTS Controllers**

Series –series compensators IPFC,Basic structure and operation,Thyristor controlled braking resistor

7th Semester

EL1410	PE II: FACTS Devices	L= 3	T=0	P=0	Credits=3

Text books:

1	Understanding FACTS	2001	Naryan G Hingorani and Laszlo Gyigyi	Standard Publishers
2	FACTS : Controllers in Power Transmission & Distribution	1st Edition, 2007	K. R. Padiyar	New Age International
3	Thyristor based FACTS controller for electrical transmission systems	1st Edition 2002	R. Mohan Mathur, Rajiv K Verma	Wiley

Reference books:				
1	Flexible AC Transmission System [FACTS]		Edited by Yong Hua Song and Johns	IEEE Press

7th Semester

EL1427	**PE II: Artificial Intelligence based Systems**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Learning Objectives	Learning Outcomes
Student will understand The concept of fuzzy logic and neural network The basic concepts and mathematical models of fuzzy and neural network are covered	The student will be able to understand the 1) Basic principles of Fuzzy logic, its need and formulate and solve fuzzy logic based decision making problems. 2) Design aspects of fuzzy control. 3) Principles of neural networks, its need and solve classification and pattern recognition problems 4) Concepts of recurrent associative memories. 5) Basics of Neural network based control systems.

Mapped program outcmes: a,b,c,d,h,j

UNIT-1: **Introduction:-**
Fundamental concepts of fuzzy systems
1. Fuzzy sets, Approximate reasoning Representing set of rules.
2. Fuzzy knowledge based (FKBC) parameters. Introduction rule and data base inference engine, choice of fuzzification and defuzzification processes.

UNIT-2: **Nonlinear fuzzy control**
Introduction, Control problem, FKBC as nonlinear transfer element, types of FKBC.

UNIT-3: Adaptive Fuzzy control
Introduction, design and performance evaluation, main approach to design.

UNIT-4: Artificial Neural Network
1. Fundamental concept of ANN.
2. Model of artificial neural network (ANN), Learning & adaptation learning rules.

Feed forward networks:
Classification Model, features & decision, regions, Minimum distance classification, perceptron, delta learning rules for multi perceptron layer, generalized learning rules, back propagation algorithm, back propagation training, learning factors.

UNIT-5: Recurrent networks
Mathematical foundation of discrete time & gradient type Hopfield networks, transient response & relaxation modeling.

UNIT-6: Associative memories, self-organizing networks and Neural Control

Basic concept & recurrent associative memory, Bi-directional associative memory, Hamming net & MAXNET Unsupervised learning of clusters, , feature mapping, self-organizing feature maps, Basics of Neural Network Control, Predictive Control.

7th Semester

EL1427	**PE II: Artificial Intelligence based Systems**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Text Books

1	Introduction of Artificial Neural Networks	1992	Jacek Zurada	JPH
2	An Introduction to Fuzzy Control	2010	D. Drianko	Springer
3	Design of Neural Networks	2nd edition	Hagen,Demuth,Beale	Cengage Learning,ISBN-10:0-9717321-1-6,ISBN-13:978-0-9717321-1-7

Reference Books:				
1	Neural Network & Fuzzy Systems	1992	Bart Kosko	Prentice Hall of India
2	Neural Networks	2009	Simon Haykin	(Maxwell) Macmillan Canada Inc.) Comprehensive Foundation
3	Fuzzy sets: Uncertainty & information	1988	Klir & Folger	Prentice Hall of India
4	MATLAB Toolbox			

7th Semester

EL1431	PE II:Advanced Control System	L= 3	T=0	P=0	Credits=3

Course Objective	Course Outcomes
This subject elaborate concept of compensation in control system. Compensation design is explained. Optimal control and sample data control system is also discussed in this subject	1) Concept of lag and lead compensator design in time and frequency domain. 2) State variable approach with solution of state models and concepts of controllability, observability and state variable feedback. 3) Optimal control problems with transfer function approach. 4) Introduction of nonlinear system and stability analysis using describing function approach. 5) Phase plane method for stability analysis using isocline and delta methods. 6) Introduction of sample data control system, Stability analysis with Z transforms and solution of discrete time systems.

Mapped program outcomes	a	b	c	d	f	h	j

UNIT-1: **Compensation**
Compensation: - Review of performance Analysis of type O, type 1 & type 2 systems. Need for compensation. Performance Analysis of Compensators in time & frequency domain, Bode Plots and Design of Compensators.

UNIT-2: Design of PID Controller:
Fixed configuration design, theory of PI, PD and PID control in time domain and frequency domain, Zeigler Nichol's method of PID tuning.

UNIT-3: State variable Feedback
Design by State variable Feedback: Review of state variable representations. Solution of state equation Controllability & observability, Design of State Feedback.

UNIT-4 : Non Linear control system (NLCS)
Non Linear Control System: Types of non-linearities, characteristics of NLCS. Inherent & intentional non-linearities. Describing function method for Analysis Describing functions of some common non-linearities. Stability analysis. Limit cycles & stability of limit cycles.

UNIT-5 : Phase -Plane Method
Phase -Plane Method:Singular points stability from nature of singular points Construction of trajectory by Isocline and Delta Method Computation of time.

UNIT-6: Sample Data control System (SDCS)
Sample Data control System; - Representation of SDCS, Sample and Hold Circuit Z-Transform, Inverse Z-Transform & solution of difference equation "Z" & "S" domain relationship. Stability by Bi-linear transformation & Jury's test. Discretization of continuous time state equation.

Text books:				
1	Control Systems Analysis	4th edition	2008	I.J.Nagrath,M.Gopal
2	Modern Control Theory			M.Gopal

Reference books:			
Control Systems			Kutsohiko Ogata
Automatic Control Systems	Seventh Edition		B C..Kuo
Modern Control System		2003	B.C.Kuo
Optimal Control			Kirk

		1.01	Nov. 2017	Applicable for AY 2017-18 Onwards
Chairperson	Dean (Acad. Matters)	Version	Date of Release	

7th Semester

EL1432	Electrical Distribution Power System	L= 3	T=0	P=0	Credits=3

Course Objectives	Course Outcomes
Student will be able to understand the various Aspects of distribution system **Mapped Program Outcomes: a,b,d,f,j**	The student will be able to understand the 1) The factors which affect the performance of distribution system, nature of load, its growth and forecasting. 2) Types of feeders, its loading, causes of unbalance, fault isolation, System restoration. 3) Distribution line parameter, supports and the causes and effects of voltage drop in distribution line 4) Different method Reactive power compensation Benefits of power factor improvement. 5) To decide optimal location of substation 6) Problems with existing distribution systems and function of substation automation system

UNIT-1: **Load Forecasting**
Introduction, Explanation of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor, load & load characteristics, load and load duration curve, relation between load and loss factor, load curve and diversified demand, load modeling,load growth and forecasting.

UNIT-2: **Distribution Feeders:**
Introduction, Primary and secondary distribution, Radial and loop types, Distribution substation location and planning, Feeder loading and voltage drop considerations, Voltage drop in feeder with different loading, Engineering considerations for voltage levels and loading, causes of unbalance and unequal drops, common faults in feeders, fault location, fault isolation, restoration.

UNIT-3: Overhead lines and Cables
Introduction, Line parameters, Overhead lines, insulators and supports, cables, Insulation resistance, Voltage drop and power loss in conductors, voltage drop in ac single phase distribution system, voltage drop computation based on load density, voltage drop in underground cable distribution.

UNIT-4: Reactive power compensation and applications of capacitors
Introduction, advantages and benefits of power factor improvement, power factor improvement using capacitors: mathematical calculations, location of capacitors, application of capacitor banks for power factor improvement, sub harmonic oscillations and ferro resonance due to capacitor banks, optimum power factor for distribution system.

UNIT-5: Substation & Metering, instrumentation & Tariffs
Introduction, substation types, substation components, equipment and layouts, substation location and size, Grounding, earth connection and earthing system, measurement of power, measurement of energy, maximum demand and trivector meter, automatic meter reading (AMR), AMR systems, substation instrumentation, tariffs and billing.

UNIT-6: Distribution automation (DA) & SCADA
Problems with existing distribution systems, need for distribution automation, distribution automation, feeder automation, communication requirements for DA. Remote terminal unit (RTU), Block diagram of SCADA, Components of SCADA, Functions of SCADA, SCADA applied to distribution automation, Advantages of DA through SCADA,DA integration mechanisms, Functions of substations automation systems, state and trends of substation automation.

7th Semester

EL1432	Electrical Distribution Power System	L= 3	T=0	P=0	Credits=3

Text books				
1	Electrical power Distribution Systems	2009	V. Kama Raju	Tata Mcgraw Hill Education Private Ltd., New Delhi
2	A Text Book of Electric Power Distribution Automation	1st Edition, 2010	Dr. M. K. Khedkar And Dr. G. M. Dhole,.	University Science Press

Reference books:				
1	Electric Power Distribution	4th edition, 1997	A.S.Pabla	Tata Mc Graw-Hill Publishing Company
2	Electrical Distribution System	1st Edition,2013	Dr.H.P.Inamdar	Electrotech Publication

7th Semester

EL1405	Lab.: Simulations in Power System	L= 0	T=0	P=2	Credits=1

Students shall be able to understand practically the

1) Use of MATLAB tools for realizing the power system problems and solutions.
2) Implementation of the distribution and transmission systems with various loads and its effects.
3) Application of capacitor bank for voltage regulation, power factor improvement and for mitigating other power quality problems.
4) Effects of faults on the power system.
5) Calculation of different powers, power factor and other power system parameters.

Mapped Program Outcomes	a	b	c	d	g	h	j

SN	TITLE
1	To study analysis of active and reactive power of distribution system
2	Analysis of power factor of distribution system
3	Analysis of harmonic distortion in distribution system
4	Analysis of transient condition of system when circuit breaker is at load side
5	Voltage regulation of non-stiff distribution system
6	To study shunt capacitor compensation
7	To study Ferranti effect
8	Use of surge arrestor in transmission system

Text books:				
1	Power System Analysis	2nd Edition, 2002	Hadi Saddat	Mc GrawHill
2	MATLAB Programming for Engineers	2nd Edition, 2002	S. J. Chapman	Bookware Companion Series, Thomson Brooks/Cole, Thomson Asia Pte. Ltd., Singapore
3	MATLAB and Simulink for Engineers	1st Edition, 2012	Agam Kumar Tyagi	Oxford University Press
4	MATLAB and its applications in Engineering	2009	R. K. Bansal, A. K. Goel and M. K. Sharma	Pearson Education

Reference books:		
1	Matlab Simulink manual	Mathwork
2	Sim Power system toolbox manual	Mathwork

7th Semester

EL1406	**Industrial Training / CRT**	**L= 0**	**T=0**	**P=4**	**Credits=3**

7th Semester

EL1407	**Project Phase-I**	**L= 0**	**T=0**	**P=4**	**Credits=4**

8th Semester

EL1416	Switchgear and Protection	L= 3	T=0	P=0	Credits=3

Course Objective	Course Outcomes
Students will understand 1.The theory and applications of the main components used in power system Protection. 2.Tthe protection systems used for electric machines, transformers, bus bars, Transmission lines. 3. The theory, construction, and applications of main types of circuit breakers. 4. To design the feasible protection systems needed for each main part of a power system. **Mapped Program Outcomes : a,b,c,d,e,f,g,h,i,j**	The student will be able to understand the 1) Fundamentals of protection system. 2) Overcurrent protection for medium voltage line with overcurrent and directional Overcurrent relay. 3) Theory of distance protection 4) Concept of static relays and circuit breakers 5) Application of different types of transformer And busbar protection in industry. 6) Application of different types of generator and Induction motor protection in industry.

UNIT-1: **Introduction**

General Philosophy of Protective Relaying:- Protective Zones. Primary Protection, Back up protection. Primary and Local Back Up. Selectivity, Fuse (wire and HRC).

UNIT-2: **Overcurrent Protection**

Medium voltage Line Protection: Overcurrent relaying, directional overcurrent relays.

UNIT-3: Distance protection

High voltage line Protection: - Distance relays, carrier distance schemes, Unit carrier schemes.

UNIT-4: Static relays:

Introduction to static relays: Comparison of static and electro-mechanical relays, two input amplitude and phase comparators and their duality, Generation of various distance relay characteristics using above comparators.
Circuit breakers

Switchgear : Circuit breakers Arc interruption theory, recovery and Restriking voltage ,RRRV, breaking of inductive & capacitive currents, C. B. rating, different media of arc interruption, overview of oil circuit breakers, Air blast, SF6 and vacuum breakers.

UNIT-5: Equipment Protection

Equipment Protection: Principles of differential relaying, protection, transformers and busbars by differential relaying and other relays. Miniature circuit breakers, moulded case circuit breaker, release, earth leakage circuit breaker.

UNIT-6: Equipment Protection

Protection of Generators & Induction Motors.

8th Semester

EL1416	**Switchgear and Protection**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Text Books				
1	Protection and Switchgear	2012	R.P.Maheshwari, Nilesh G.Chothani, Bhavesh Bhalija	Oxford University Press
2	Switchgear and Protection	2003	S.R.Bhide and Y.G. Paithankar	PHI
3	Power System Protection and Switchgear	2007	Badri Ram	TMH.
4	Switchgear and Protection	**1990**	S. S. Rao Khanna	
Reference books				
1	The Art and science of protective relaying	**1992**	Russel, Mason	Wiley Eastern
2	Computer relaying for power system	2009	Arun G. Phadke and JamesThorpe	S John Wiley

8th Semester

EL1433	**Renewable Energy Sources**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Course Objectives	Course Outcomes

UNIT-1
Introduction
Introduction to Renewable Energy Sources, Primary and Secondary Energy Sources, Comparison of Conventional and Non-Conventional Energy Sources, Prospects of RES in global and Indian Context, Introduction to Energy from Bio – mass, Geothermal Energy, MHD Power Generation

UNIT-2
Solar radiation & its Measurement
Solar constant, Solar radiation at earth's surface, Beam and Diffused Solar Radiation, Insolation, Attenuation of Beam Radiation, Absorption and Scattering, solar radiation geometry, Day Length, Local Solar Time, solar radiation measurement, estimation of average solar radiation, solar radiation on tilted surfaces, Numericals
Solar Energy Collectors
Physical principles of the conversion of solar radiation into heat, flat plate collectors, transmissivity of cover systems, energy balance equation and collector efficiency, concentrating collectors, comparison of concentrating and flat plate collectors, selective absorber coatings, Numericals on Flat Plate Collectors only

UNIT-3
Applications of Solar Energy
Photovoltaic solar energy conversion:- Introduction, Equivalent Structure of PV cell, Series – Parallel combination, Partial shading, Introduction to DC – DC converter, solar MPPT, Grid converters and control
Introduction and working principle of **Solar ponds,** Solar water heating, solar thermal heat conversion, solar pumping, solar cooking

UNIT-4:Wind Energy
Basic principles of wind energy conversion, Power in the wind, Numericals based on Power Calculations, Lift and Drag, site selection considerations, basic components of wind energy conversion systems (WECS), classification of WEC systems, Wind Energy Collectors, Horizontal and Vertical Axis Wind Machines and their comparison (No Numerical or Derivative or Analytical part), generating system,

UNIT-5: Applications of Wind Energy
Application of wind energy, On – land and off – shore applications, Stand alone and Grid Connected Applications, Fixed (Single speed and Two speed) and variable speed (Wound rotor, SCIG) wind turbines, Introduction to soft starters, Reduced and full capacity converters and wind MPPT, Introduction to control mechanism

8th Semester

EL1433	Renewable Energy Sources	L= 3	T=0	P=0	Credits=3

UNIT-6: Ocean and Tides

Energy from oceans

Ocean thermal electric conversion (OTEC), Claud& Anderson cycles, evaporators, Bio-fouling, hybrid cycle.

Energy from tides

Introduction, basic principles of tidal power, components of tidal power plants, operation methods of utilization of tidal energy, Single and Double Basin Arrangement, estimation of energy & power in simple single basin tidal system, advantages and limitations of tidal power generations, Numericals on Single Basin Systems only

8th Semester

Energy & power from waves

Introduction to Wave energy conversion devices, Floats, High Level Reservoir Wave Machine, Dolphin type Wave power machine

Small scale hydroelectric power generation

Introduction, Classification of Small Hydro Power Stations depending upon capacity and head, Turbines and Generators for Small Scale Hydro Electric Power Generation, Advantages and limitations

Text books:

SN	TITLE	YEAR	AUTHOR	PUBLICATION
1	Non – Conventional Energy Sources, 5th edition, 10th Reprint	2013	G. D. Rai	Khanna Publisher, New Delhi
2	Solar Photovoltaic's: Fundamentals, Technologies and Applications	2011	Chetan Singh Solanki	PHI Learning Publications, 2nd Edition
3	Non-conventional Energy Resources	2006	B. H. Khan	Tata McGraw Hill

Reference Books:

SN	TITLE	YEAR	AUTHOR	PUBLICATION
1	Solar Energy : Principles of Thermal collection and storage	1994	S. P. Sukhatme and J. K. Nayak	Mcgraw Hill Publishing Company Limited, New Delhi
2	Energy Technology :Nonconventional, Renewable and Conventional		S. Rao and B.B. Parulekar	Khanna Publisher, New Delhi
3	Wind and Solar Power System		M. R. Patel	CRC Press, New York.

8th Semester

EL1434	**Lab. :Renewable Energy Sources**	**L= 0**	**T=0**	**P=2**	**Credits=1**

Practical's will be based on Syllabus:

1) To plot V-I characteristics of a single PV module.
2) To plot V-I characteristics of a series connected PV modules.
3) To plot V-I characteristics of a parallel connected PV modules
4) To study the effect of tilt angle on power output of module.
5) To study the effect of shadow on power output of solar PV module.
6) To study the solar based battery charger
7) To study the wind based battery charger
8) To study the hybrid wind and solar based charger
9) To study the biogas generation plant model set up at YCCE Campus
10) To study the box type solar cooker
11) To study solar water heater in natural convection and force convection mode
12) Study of Hydroelectric Power Plant
13) To design home solar PV system.

It is expected to conduct 8 to 10 experiments in a session

8th Semester

EL1411	PE III : Advanced Electrical Drives	L= 3	T=0	P=0	Credits=3

Course Objective	Course Outcomes
1) To study the converter and Chopper control of DC drives. 2) To study the semiconductor based control of Induction and Synchronous motors. 3) To learn the basics of Switched reluctance motor and Brushless DC motor. 4) To Study the non-conventional and renewable energy based drives .	The student will be able to understand the 1) Dynamics of Electrical drives and its energy conservation. 2) Various control techniques for DC Drives and study of current harmonics. 3) Induction motor drives and its variable frequency control using scalar and vector control 4) Starting,braking and control of synchronous motor drives using various power electronic devices. 5) Various special motors like BLDC,Stepper motor ,switched reluctance motor. 6) Control of traction motor by using Semiconductor Converter Controller

Mapped Program Outcomes	a	b	c	d	e	f	i	j

UNIT-1: Introduction to Electric Drives
Dynamics of electric drives and control of electric drives. Energy conservation in electric drives.

UNIT-2: D.C. Drives
Controlled rectifier fed D.C. drives, single phase and three phase rectifier control of Separately excited D.C. motor; Dual Converter control of separately excited D.C. motor; Power factor, supply harmonics and ripples in motor current; Chopper controlled of separately excited dc motor; chopper control of series motor; source current harmonics.

UNIT-3: Induction Motor Drives
Stator voltage control, V/f control, static rotor resistance control, slip power recovery schemes, variable frequency control using voltage source inverter. Current sources inverter and cyclo converter, Introduction to vector control of Induction motor.

UNIT-4: Synchronous Motor Drives
Starting and Braking of Synchronous motor; variable frequency control; self-controlled synchronous motor drive employing load commutated thyristor inverter , Introduction of Cyclo-converter control of Synchronous motor; starting of large synchronous motors.

UNIT-5: Special Motors Drives
Brush less dc motor, stepper motor switched reluctance motor drives and eddy current drives. Introduction to solar and battery powered drives.

UNIT-6: Traction Drives
DC and AC traction drives, semiconductor converter controlled Drives; 25 KV AC traction using semi conductor converter controlled DC motor; DC traction using semiconductor chopper controlled dc motors; polyphase AC motors for traction drives.

8th Semester

EL1411	PE III : Advanced Electrical Drives	L= 3	T=0	P=0	Credits=3

Text Books

1	Fudamentals of Electric drives	2nd Edition	G. K.Dubey	Narosa Publications
2	Modern Electric Traction	2003	H.Pratap	Dhanpatrai & Company
3	Electric drives concepts and applications	2005	V.Subramaniam	Tata McGraw Hill
4	Electric Motor Drives	2001	R. Krishnan	Prentice Hall India

Reference books:				
1	Electrical Machines Drives and Power Systems	6th edition 2008	Theodore Wildi	Pearson Education

8th Semester

EL1422	**PE III : Power System Operation and Control**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Course Objectives	Course Outcomes
The student will understand the economic aspects of power system operation, methods of power frequency control, economic dispatch control, reactive power control and voltage control.	The students will able to understand 1) System characteristics curves and concept of load dispatching. 2) Concept of load forecasting and unit commitment. 3) Load frequency control of single area and two area network. 4) Theory of economic load dispatch and solution with iterative method. 5) Control of reactive power and compensation equipment used for transmission line. 6) Theory of voltage control and different methods of voltage control.

Mapped Program Outcomes	a	b	j

UNIT-1: **Economic Aspects**
Introduction, system load characteristics curves-chronological load curves-load duration curves-energy time curves load factor utilization factor-diversity factor- coincidence factor- demand factor- reserve requirements installed reserve- spinning reserve- cold reserve- hot reserve – operational restrictions, load dispatching.

UNIT-2: **Pre requisite of Load Dispatching**
Load forecasting- components of system load- classification of base load- forecasting of the base load by method of least square fit introduction to unit commitments unit commitment using priority ordering.

UNIT-3: Load Frequency Control (LFC)
Introduction, necessity of maintaining frequency constant, Load frequency Control, Governor Characteristics of single Generator, Adjustment of Governor Characteristic of Parallel Operating Unit, LFC (P-f control) Q-V Control, Generator Controller (P-f control & Q-V controllers), P-f control versus Q-V control, Dynamic Interaction between P-F and Q-V Loops, Speed-Governing System, Control Area Concept, Incremental Power Balance of Control Area, Requirements of the Control Strategy, Integral control, Concept of two area.

UNIT-4: Economic Dispatch Control
Incremental cost curve- co-ordination equations with loss included (No derivation of B_{mn} coefficient) solution of co-ordination equations using B_{mn} co-efficient by iteration method Base point & participation factors- Economic dispatch controller added to LFC.

UNIT-5: Reactive Power Control
Introduction, objective of load compensation, theory of load compensation, uncompensated transmission line, compensated transmission line, shunt compensator, series compensator, basic relationship for power flow control, Sub synchronous resonance, comparison of different types of compensating equipment for transmission systems,

UNIT-6: Voltage Control
Introduction, necessity of voltage control, generation and absorption of reactive power, location of voltage control equipment, methods of voltage control, rating of synchronous phase modifier.

8th Semester

EL1422	PE III : Power System Operation and Control	L= 3	T=0	P=0	Credits=3

Text Books:				
1	Power System Operation and control		S. Sivanagarju and G. Srinivasan	Pearson Publisher
2	Power System Stability and control		P. Kundur	TMH Publisher
3	Electrical Power system		C. L. Wadhwa	
4	Economic Operation of power system studies		L. K. Kirchmayer	Wiley Eastern India, New Delhi
5	Power System Analysis Operation and Control	3rd Edition, 2010	Abhijit Chakrabarti, Sunita Halder	PHI Learning Pvt. Ltd.

Reference books:				
1	Power Generation, Operation and control	2nd Edition	A. J. Wood and B.F. Woolenberg	John Wiley & Sons

8th Semester

EL1435	**PE III : Fundamentals of Power Quality**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Course Objectives	Course Outcomes
Students will understand the various power quality issues, harmonics, filter designs and power quality improvements using custom power devices.	The students will able to understand 1) Various power quality issues, their causes and impacts on customer equipments. 2) The classification of voltage sags, effect of fault on voltage sag and impact of voltage sag on different instrument. 3) The causes of harmonics, effects and solutions to mitigate harmonics in system. 4) Working of passive, active and hybrid power filters and will able to design the filters. 5) Different voltage sag detection methods, reference theory, network configuring theory. 6) Working, control strategies and applications of different custom power devices

Mapped Program Outcomes	a	b	c

UNIT-1: **Overview and definition of power quality**
Overview and definition of power quality (PQ): Sources of pollution and regulations, Power quality problems: rapid voltage fluctuations voltage unbalance, Voltage dips and voltage swells, Short duration outages, long duration variations, power acceptability curves.

UNIT-2: **Voltage sag analysis**
Definitions Voltage sag analysis: Sag caused by motor starting, Sag caused by utility fault clearing, Sag magnitude and duration calculations, RMS voltage, calculation in single phase systems, Computers, AC and DC drives etc. performance in presence of sag.

UNIT-3: Harmonics
Harmonic Distortion: Power system harmonics: Harmonic analysis, Harmonic sources and their effects, the static converters, Transformer magnetization and non – linearities, Arc furnaces, Fluorescent lighting. Introduction to power converters, Fourier analysis, Total harmonic distortion, rms & average value calculation, Effects of harmonic distortion and Flickers.

UNIT-4: Filter Design
Filters: passive filters, active filters, hybrid filter design and working principles.

UNIT-5: Analysis and Conventional Mitigation Methods
Analysis: Extraction of fundamental sequence components, reference theories, voltage sag reduction, harmonic reduction, introduction to network configuring devices.

Unit 6: **Power Quality Improvement using custom power devices** Custom Power Devices: Introduction to custom power devices, Dynamic Voltage Restorer (DVR) ,
Distribution Static Compensator (DSTATCOM) and Unified Power Quality Conditioner (UPQC), Control strategies, status of application of custom power devices.

8th Semester

EL1435	**PE III : Fundamentals of Power Quality**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Text books:				
1	Electrica Power Systems Quality	2nd edition.	R. C. Dugan, M. F. Mcgranaghan	McGraw-Hill
2	Power Quality		C. Sankaran	CRC Press
3	Understanding Power Quality Problems: Voltage sag and interruptions	2002	M. H. Bollen	John Willey

Reference books:				
1	Power System Harmonics	2nd edition, 2003	J. S. Arillaga	Wiley
2	Power Quality Enhancement using custom power devices	2002	Arindam Ghosh	Kluwer Academic Publishers

8th Semester

EL1424	PE IV : EHVAC-HVDC Transmission	L= 3	T=0	P=0	Credits=3

Course Objectives	Course Outcomes
The student will understand the various aspects of transmission system, systems for power flow control, design parameters of filters and layout of HVDC power plant	The student will be able to understand the 1. Power handling capacity and concept of voltage gradient of EHVAC Transmission systems 2. Electrostatic and electromagnetic fields and corona effect. 3. The configuration, design and comparison of EHVAC-HVDC Transmission systems and analysis of HVDC power transmission. 4. Control of HVDC Converter. 5. Design of Harmonic filters and reactive power configuration. 6. The HVDC Circuit breaker and concept of HVDC substation protection .

Mapped Program Outcomes	a	b	c	f	j

UNIT-1: P**ower handling and voltage gradient**
1) Power handling capacities of EHV AC transmission lines.
2) Voltages gradients: Electric field of point charge, sphere gap line-charge. Single and three phase lines, and bundled conductors. Maxwell's potentials coefficients.

UNIT-2: **Electrostatic and electromagnetic fields of EHV lines & corona**
1) Electrostatic and electromagnetic fields of EHV lines, electric shock and Threshold current , calculation of electrostatic field of A.C. lines (3 phase single and double circuit lines only). Effect of high electrostatic field.
2) Corona: Types, critical disruptive voltages, Factors affecting corona, Methods for reducing corona power loss (empirical formula), corona current waveform, audible noise and radio interference.

UNIT-3: HVDC Power transmission
DC Power transmission technology: Introduction, comparison of AC and DC Transmission, application of DC transmission, Description of DC transmission system, configuration, planning for HVDC transmission, types of DC link. Introduction to HVDC light, Earth electrode and earth returns. Introduction, objectives, location and configuration, resistance of electrodes, means of reducing earth electrode resistance.

UNIT-4: Analysis of HVDC converters
Analysis of HVDC converters: Pulse number, choice of converter configuration, simplified Graetz circuit, converter bridge characteristics, characteristics of twelve pulse converter Power flow control in HVDC system :- Constant current. Constant voltage, constant ignition and excitation angle control, control characteristics.

UNIT-5: Harmonic Filters &Reactive power compensation
Harmonic Filters :- Introduction, Filters, surge capacitors and damping circuits, shunt filters, series filters, AC filters, design of AC filters and tuned filters, double frequency and damped filters, cost considerations and ratings.
Harmonics on D.C side of converters. DC Harmonics filters. - Reactive power requirement of HVDC converters, substations.

UNIT-6: HVDC circuit breakers
HVDC circuit breakers: - Introduction, construction and principle of operation. Interruption of DC current, application of MRTB, Type of HVDC circuit breaker, capability and characteristics of HVDC circuit breakers

8th Semester

EL1424	PE IV : EHVAC-HVDC Transmission	L= 3	T=0	P=0	Credits=3

Text books:					
1	EHV AC & HVDC Transmission & Distribution	**3rd-2006**	S. Rao	Khanna	
	EHV AC Transmission	2nd	Begamudre	New Age international Publisher	
2	Power system Stability and Control	**2nd - 2006**	P. Kundur	Publisher	
3	HVDC Transmission Systems		J. Arrilaga	**Publisher**	
Reference books:					
1	HVDC Power Transmission System	**1st-2002**	K.R. Padiyar	Publisher	

8th Semester

EL1425	PE IV : Electrical Power Utilization	L= 3	T=0	P=0	Credits=3

Course Objectives	Course Outcomes
Student will understand. The knowledge about energy utilization .The application of electrical energy such as lightning, heating welding, fans and pumps.	The student on completion will be able to understand 1) Types of electric heating techniques, their field of application, relative advantages and limitations. 2) Types of electric welding techniques, their field of application, relative advantages and limitations, defects in welding, new advancements in welding technology. 3) Basic concepts of illumination, various types of lamps along with their light characteristic and field of application. They will be able to design illumination system for various criterions. 4) Basic refrigeration cycle, VCRS and VARS, various types of air conditioning systems and its use as per requirement. 5) Difference between fans and blowers with respect to its characteristics , various energy saving methods to be used. They can classify pumps with respect to its characteristic and field of application. 6) Classification of compressors, application of compressors as per requirement of compressed air. They will understand basics of DG system, its major components, working under different conditions and energy saving opportunities in DG system

Mapped Program Outcomes	a	c	d	e	f	i	j

UNIT-1: **Electric Heating**
Introduction, Advantages of electric heating, modes of heat transfer, methods of electric heating, resistance heating, arc heating, arc furnaces, induction heating, dielectric heating, infrared and radiant heating.

UNIT-2: **Electric Welding:**
Definition, welding process, resistance electric welding, electric arc welding, submerged arc welding, MIG welding, Ultrasonic welding, laser beam welding, welding of various metals, underwater welding, defects in welding, testing of welding joints.

UNIT-3: Illumination :
Nature of light, terms used in illumination, solid angle, laws of illumination, polar curves, Colour Rendering Index (CRI), types of lamps, luminaries, Design of illumination systems, indoor lighting systems, factory lighting, outdoor lighting design, flood lighting, street lighting, energy saving in lighting systems.

UNIT-4: Refrigeration & Air conditioning:
Terminology, refrigeration cycle, refrigeration systems (Vapor compression, vapor absorption), domestic refrigerator, water cooler, desert cooler.
Air conditioning: Factors involved in air conditioning, comfort air conditioning, industrial air conditioning, effective Temperature, summer / winter air conditioning systems, types of air conditioning systems, room air conditioning, and central air conditioning.

8th Semester

EL1425	PE IV : Electrical Power Utilization	L= 3	T=0	P=0	Credits=3

UNIT-5: Fans & Pumps:
Fans and Blowers: Fan types, fan performance evaluation & efficient system operation, fan design & selection criteria, flow control strategies, fan performance assessment, energy saving opportunities.
Pumps: Pump types, system characteristics. Pump curves, factors affecting pump performance, efficient pumping system operation, flow control strategies, energy conservation opportunities in pumping system.

UNIT-6: Compressors and DG Sets:
Compressors: Compressor types, Compressor efficiency, Compressed air system components.
Diesel Generating Systems: Introduction, selection and installation factors, operational factors, energy performance assessment in DG sets, energy saving measures for DG sets.

Text books:				
1	Utilization of Electric Energy		E. Openshaw Taylor	Orient Longman
2	Utilization of Electric Power & Electric Traction		J.B. Gupta	Kataria & Sons
3	Art and Science of Utilization of Electrical Energy		H Partap	Dhanpat Rai & Sons, Delhi
4	Utilisation of Electrical power	1st Edition, 2006	R. K. Rajput	Laxmi Publications Pvt. Ltd.

Reference books:				
1	Guide book for National Certification Examination for Energy Managers and Energy Auditors			Bureau of Energy Efficiency
2	Utilization of Electrical Power		Dr N. V. Suryanarayana	Wiley Eastern Ltd, New Age International

8th Semester

EL1436	**PE IV : Fundamentals of Smart Grid**	**L= 3**	**T=0**	**P=0**	**Credits=3**

Course Objectives	Course Outcomes

UNIT-1: **Introduction to Smart Grid :**
Introduction to smart grid, Comparison between Present grid and Smart grid, Motivation for use of smartgrid, computation intelligence, Communication Standards, Environment and Economics

UNIT-2: **: Power System Enhancement**
Power System enhancement using smart grid, Energy Independence and Security, General view of the Smart grid market drivers, Function and role of stakeholder, Smart grid based performance measures, Functions of smart grid components

UNIT-3 :**Smartgrid Communications :**
Communication and measurement, Monitoring, PMU, Smart meters, Measurement technologies, GIS and Google mapping tools, multi agent technology, microgrid and smartgrid comparison.

UNIT-4: Performance Analysis Tools for Smartgrid Design
Congestion management effect, load flow for smart grid design, Static Security assessment (SSA) and contingencies, Contingencies and their classification, contingency studies for smart grid.

UNIT-5 : Computational Tools for Smartgrid Design
Introduction to computational tools, Decision support Tools (DS), Hybridizing optimization techniques and applications to the smartgrid, Computational Challenges.

UNIT-6: Renewable Energy and Storage :
Sustainable energy options for the smartgrid, Penetration and variability issues associated with sustainable energy technology, Demand-response issue,

Text books:

	TITLE	YEAR	AUTHOR	PUBLICATION
1	Smart Grid: Fundamentals of Design and Analysis		James Momoh	Wiley
2	Smart Grid: Technology and Applications	March 2012	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama	Wiley

Reference books:

1	Smart Grid: Technology and Applications	March 2012	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama	Wiley

8th Semester

EL1417	Lab.: Switchgear and Protection	L= 0	T=0	P=2	Credits=1

Mapped Program Outcomes	a	b	c	d	e	g	j

Course outcomes:

The students will be able to understand

7. Relay setting and co-ordination of relay.
8. Secondary injection testing and setting of relays.
9. Recent tools in protection system

List of Practicals:

1) To plot the characteristic of IDMT relay ICM 21N.
2) To plot the characteristic of directional relay with calculation of maximum torque angle.
3) To plot the characteristic of reactance relay.
4) To plot the characteristic of impedance relay.
5) To plot the characteristic of fuse wire.
6) To study the differential protection of single phase transformer.
7) To plot characteristics of numerical relay MC61C.
8) To study the undercurrent & overcurrent relay.
9) To study the harmonic restraint effect on differential relay.
10) To plot the characteristic of earth fault relay.
11) To study undervoltage relay.
12) To study air circuit breaker.
13) Study of MICOM P430
14) To plot characteristics of MCB
15) To study operation of BMR
16) To study operation of ELCB
17) Study of (quasar) intelligent panel meter
18) Study of relay test set

8th Semester

EL1418	Lab.: Substation Design	L= 0	T=0	P=2	Credits=1

Course Objectives	Course Outcomes
The student will understand different aspects of substation design that is layout drawing, earthing Drawing, lighting drawing and cable wiring.	The students will be able to understand 1. Single line diagram of substation with rating of different equipments, types of relays required and their settings 2. Draw plan of equipments and panels mounted in a substation. 3. Design earthing system of a substation.

Mapped Program Outcomes	a	b	c	f	g	h	i	j

Practical based on following topics may be performed.

1) One Line diagram

2) Switchyard and control panel layout for 132 and 11 kV substation.
3) Lighting layout of substation and switchyard.

4) Substation earthing.

Text books:

1	Handbook of Electrical Power Distribution	2nd Edition	Gorti Ramamurthy	University Press
2	Electric Power Distribution	4th edition, 1997	A.S. Pabla	Tata Mc Graw-Hill Publishing Company

8th Semester

EL1419	**Comprehensive Viva-voce**	**L= 0**	**T=0**	**P=0**	**Credits=3**

8th Semester

EL1430	**Extra-Curricular Activities / Competitive Exam**	**L= 0**	**T=0**	**P=0**	**Credits=2**

8th Semester

EL1420	**Project Phase-II**	**L= 0**	**T=0**	**P=8**	**Credits=8**