YESHWANTRAO CHAVAN COLLEGE OF ENGINEERING
B.E. (Electrical Engineering)
SCHEME OF EXAMINATION

Sl.No.	Sub. Code	Subject	L	T	P	Total Contact Hours	Credits	% Weightage				ESE Duration
								MSE - I	MSE - II	TA	ESE	
VII Semester												
1	EL401	High Voltage Engineering	3	0	0		3	15	15	10	60	3 Hrs
5	EL402	High Voltage Engineering Lab	0	0	2		1			40	60	
	EL403	Computer Applications in Electrical Engg	3	1	0		4	15	15	10	60	3 Hrs
	EL404	Computer Applications in Electrical Engg Lab.	0	0	2		1			40	60	
2		**Prof. Elective 2**	4	0	0		4	15	15	10	60	3 Hrs
4		Free Elective 2	4	0	0		4	15	15	10	60	3 Hrs
6	EL405	Simulations in Power System	0	0	2		1			40	60	
8	EL406	Training	0	0	0		3			100		
9	EL407	Project Phase 1	0	0	4		4			40	60	
10	EL408	Seminar 2	0	0	2		1			100		
Total			**14**	**1**	**12**	**27**	**26**					

	EL409	PE2:Optimisation Technique	4	0	0		4	15	15	10	60	
	EL410	PE2: FACTS Devices	4	0	0		4	15	15	10	60	
	EL411	PE2:Electrical Drives - II	4	0	0		4	15	15	10	60	

	CV418	FE 2 : Elements of Earthquake Engineering	4	0	0	4	4	15	15	10	60	
	CV419	FE2 : Air Pollution & Solid Waste Management	4	0	0	4	4	15	15	10	60	
	ET411	FE2 : Soft Computing	4	0	0	4	4	15	15	10	60	3 Hrs
	ET412	FE2 : Industrial Instrumentation	4	0	0	4	4	15	15	10	60	3 Hrs
	ME429	FE 2 : Total Quality Management	4	0	0	4	4	15	15	10	60	
	ME430	FE 2 : Reliability Engineering	4	0	0	4	4	15	15	10	60	
	EE411	FE 2 :Fuzzy Logic & Neural Network	4	0	0	4	4	15	15	10	60	
	EE429	FE 2 :Basic of Analog and Digital Communication Systems	4	0	0	4	4	15	15	10	60	
	CT411	FE2:Multimedia and Animation	4	0	0	4	4	15	15	10	60	100
	CT412	FE2:Current Trends and Technologies	4	0	0	4	4	15	15	10	60	100
	IT408	FE2: Applications of Computer Networking	4	0	0	4	4	15	15	10	60	3 Hrs
VIII Semester												
1	EL416	Switchgear and Protection	3	0	0		3	15	15	10	60	3 Hrs
		Prof. Elective 3	3	0	0		3	15	15	10	60	3 Hrs
3		**Prof. Elective 4**	3	0	0		3	15	15	10	60	3 Hrs
4		**Prof. Elective 5**	3	0	0		3	15	15	10	60	3 Hrs
5	EL417	Switchgear and Protection	0	0	2		1			40	60	
6	EL418	Substation Design	0	0	4		4			40	60	
7	EL419	Comprehensive Viva-voce	0	0	0		3			40	60	
8		Extra Curricular Activies / Competative Exam.	0	0	0		2			100		
9	EL420	Project Phase 2	0	0	6		6			40	60	
Total			**12**	**0**	**12**	**24**	**28**					

	EL421	PE3:Power Quality Conditioning and Monitoring	3	0	0		3	15	15	10	60	
	EL422	PE3:Power System Operation and Control	3	0	0		3	15	15	10	60	
	EL423	PE3:Transients in Power System	3	0	0		3	15	15	10	60	

	EL424	PE4: EHVAC-HVDC Transmission	3	0	0		3	15	15	10	60	
	EL425	PE4: Electrical Power Utilization	3	0	0		3	15	15	10	60	
	EL426	PE4: Digital Signal Processing	3	0	0		3	15	15	10	60	

	EL427	PE5: Artificial Intelligence based Systems	3	0	0		3	15	15	10	60	
	EL428	PE5: Power Plant Instrumentation	3	0	0		3	15	15	10	60	
	EL429	PE5: Electrical Distribution System	3	0	0		3	15	15	10	60	

Chairperson		**Date of Release**	May 2013	**Applicable for**
Dean (Acad. Matt.)		**Version**	**1.03**	**AY2013-14 Onword**

EL401/EL703	High Voltage Engineering	L= 3	T=0	P=0	Credits=3

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Objectives: The demand for the generation and transmission of large amounts of electric power today necessitates in transmission at extra high voltages. It provides all the latest information on insulating material , breakdown phenomenon, overvoltage and testing techniques, It is also useful for self study by engineers in the field of electricity utilities and in the design, development and testing of electrical apparatus, transmission line hardware, particle acceleration etc.

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

Ionisation process : Townsend's criterion for B.D, 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 B.D. in Pure and commercial liquids. Intrinsic electromechanical and thermal Breakdown. Breakdown of solid dielectric in practice, B.D. in composite dielectric.

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

Mechanism of lighting types of strokes, parameter and characteristics of lighting strokes, characteristics of switching surges; power frequency over voltages, control of overvoltage due to switching. Protection of lines by ground wire, protection by lightning Arrester, gap type and gapless L.A. selection of L.A. ratings, Surges absorbers.

UNIT-3 :Travelling waves and insulation co-ordination

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

UNIT-4: Generation of high voltage and currents

Generation of High D.C. voltages by rectifiers, voltage doubler and multiplier circuits (Derivations of expression 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 devices, 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 devices and peak reading voltmeters. Measurement of High AC/DC currents: Measurement of high frequency and impulse current by resistive shunts (Bifilar 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 charging circuits, for high dissipation factor for three terminal measurements, transformer ratio arm bridges, partial discharge measurements by straight detector by 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.

EL401/EL703	High Voltage Engineering	L= 3	T=0	P=0	Credits=3

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Text books:				
1	High Voltage Engineering		**K. R. Padiyar**	
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
	EHV AC Transmission	**2nd**	Begamudre	New Age international Publisher

Reference books:				
1	Advances In high Voltage Engineering		M. Haddad and Warne	

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EL402/EL704	High Voltage Engineering	L=0	T=0	P=2	Credits=1

Evaluation Scheme (% Weightage)	TA	ESE	Total	ESE Duration
	40	60	100	--

Following practical based on above 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 (ε_r)of transformer oil.
12) Measurement of loss of angle of transformer oil (tan δ).

Department of Electrical Engineering
Semester VII

EL401/EL703	High Voltage Engineering	L= 3	T=0	P=0	Credits=3
PO/PSPO – a, b, c, e, h, i, k, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Students will understand • breakdown mechanism in solid liquid and gaseous medium • lightening and switching over voltages and insulation coordination. • different methods of generation and measurement of high voltage and currents in laboratory • different methods of non destructive and High Voltage testing of apparatus.	Students has understood • breakdown mechanism in solid liquid and gaseous medium • lightening and switching overvoltage and insulation coordination • different methods of generation and measurement of high voltage and currents in laboratory • different methods of non destructive and High Voltage testing of apparatus.

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).

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).

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Dean (Acad. Matters)		Version	1.00	

EL401/EL703	High Voltage Engineering	L= 3	T=0	P=0	Credits=3
PO/PSPO – a, b, c, e, h, i, k, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

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:				
	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	

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EL402	High Voltage Engineering Lab.	L=0	T=0	P=2	Credits=1

Evaluation Scheme (% Weightage)	TA	ESE	Total	ESE Duration
	40	60	100	02 Hours

Following practical based on above 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.

EL403/EL801	Computer Applications in Electrical Engineering	L=3	T=1	P=0	Credits=4
PO/PSPO – a, b, c, e, h, i, k, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
This subject exposes students to the mathematical foundational concepts that are necessary in the field of electrical engineering such as a) Load flow. b) Short Circuit studies. c) Transient Stability Studies.	• Determine Bus Impedance & Admittance matrix (required for Load flow & Short circuit Studies) by graphically, Inspection & building algorithm. • Load flow study of a power system by Newton-Raphson & Gauss-Seidal Iterative Method. • Short circuit studies. • Transient stability by using Eulersodified Eulers & RK-4 order differential method.

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 4^{th} 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:				
1	Computer Methods in Power Systems	**1st 1968**	Stag and El – abiad	Mc Graw Hill
2	Elements of Power System analysis	**1982**	Willim D. Stevenson	Mc Graw Hill
3	Computer analysis of power system	**1982**	R. N. Dhar	Mc Graw Hill
	Modern power system analysis	**3rd-2006**	D.P. Kothari and I.J.Nagrath	TMH

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EL404/EL802	Computer Applications in Electrical Engineering	L=0	T=0	P=2	Credits=1

Evaluation Scheme (% Weightage)	TA	ESE	Total	ESE Duration
	40	60	100	--

1. Write a program to plot the transient response of 2nd order RLC network
2. Write a program to find bus incidence matrix
3. Write a program to find B C K matrix
4. Write a program for Z_{bus} by building algorithm method.
5. Find Y_{bus} by i) Inspection.
   ii) Building algorithm.
   iii) Singular transformation
   for a given system.
6. Write flow chart & program in C to plot swing curve (t v/s δ) using step by step method.
7. Write flow chart & program in C to plot swing curve (t v/s δ) using step by Euler's method.
8. To calculate the change in power handling capacity of transmission line with change in parameters or change in distance.
9. To find I_f and V_f and other bus voltages for LG fault.
10. To find I_f and V_f and other bus voltages for LLG fault.

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EL405/EL803	Simulations in Power System	L=0	T=0	P=2	Credits=1

Evaluation Scheme (% Weightage)	TA	ESE	Total	ESE Duration
	40	60	100	02 Hours

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

EL409/EL711	Optimization Technique	L=4	T=0	P=0	Credits=4
PO/PSPO – a, b, d, e, h, i, j, k					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Students will learn the concept of optimization, classical optimization techniques and linear and nonlinear method of optimization.	The student on completion will be able to understand • Concept of optimization • Classical Optimization Techniques • Linear Programming • Storage classes • Nonlinear programming

UNIT-1:- **Introduction**
Concept of optimization, Statement of optimization problem, classification of optimization problems, optimization techniques.

UNIT-2: **Classical Optimization Techniques**
Single variable optimizations, multivariable optimization with no constraints and equality & inequality constraints, solution using Lagrangian multipliers, Kunh – Tucker Conditions.

UNIT-3:- Linear Programming (Simplex method)
Application of linear programming. Standard form & geometry of linear programming problems, definitions & theorems, solution of system of linear simultaneous equations, pivotal reduction of a general system of equations, simplex algorithm.

UNIT-4:- Nonlinear programming I
One dimensional minimization methods: Introduction, unimodal functions, elimination methods, direct root methods.

UNIT-5:- Nonlinear programming II
Unconstrained optimizations techniques : Introduction, Direct search methods, Random & grid search methods, Powell's method, Indirect search method, Cauchy's method, Fletcher – Reaves method, Newton's method.

UNIT-6:- Nonlinear programming III
Constrained optimizations techniques: Introduction, characteristics of constrained problem, sequential linear programming, Zoutendijk's method of feasible directions, Rosen's gradient projection method. Introduction to software for optimization techniques, (TORA), Introduction to GA)

Text Books :-

S.N.	Name	Edition	Author	Publisher
1	Engineering Optimization: Theory & practice	Fourth Edition	S.S. Rao	John Willey Publication
2	Operations Research: An Introduction	Eighth Edition	Taha, H.A	Prentice Hall of India

Reference Books

S.N.	Name	Edition	Author	Publisher
1	Engineering Optimization : Methods and Applications	Second Edition (Wiley India Edition)	A.Ravindran, K. M. Ragsdell, G. V. Reklaitis	John Wiley Publication

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EL410/EL712	Flexible AC Transmission Systems (FACTS)	L= 4	T=0	P=0	Credits=4
PO/PSPO – a, c, e, h, i, j, k, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning 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) .	A student who successfully fulfills the course requirements will be able to demonstrate the • Ability to understand and identify the problems and constraints with stability of large interconnected system. • Ability to understand different types of converters, regulators and compensators

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.

UNIT-2: **Static shunt compensators**
SVC and STATCOM, Objectives of shunt Compensation, Methods of Controllable var Generation, Static var Compensators 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, 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 : Combined Compensators
Combined Compensators(UPFC,IPFC) Operating modes of UPFC, Multifunctional and Generalized FACTS controllers, Sub-synchronous resonance, NGH-SSR damping scheme

UNIT-6: Harmonic effects and Solutions
Harmonic: Causes, effects, Passive filters. Introduction to active filters (Shunt , series and hybrid)
Introduction to power quality conditioner. (DSTATCOM, DVR, UPQC).

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

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EL411/EL713	Electrical Drives-II	L=4	T=0	P=0	Credits=4
PO/PSPO – a, e, m					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning 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.	1) The student will be able to work with confidence on the drives used in the Industry. 2) The students can carry research on the newer Switched Reluctance motor and Brushless DC motor.

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

Text books:				
1	Fudamenta1s 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

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EL412/EL810	Electrical Energy Audit and Safety	L= 4	T=0	P=0	Credits=4
PO/PSPO – a, b, d, f, h, l, m					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Students will understand the various aspects of energy management audit monitoring and safety.	The student on completion will be able to Understand • Energy Scenario • Basics of Energy and its various forms • Energy Management & Audit • Energy Monitoring and Targeting • Global environmental concerns • Electrical Safety

UNIT-1: **Energy Scenario**
Commercial and Non-commercial energy, primary energy sources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance. Re-structuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features, Salient Features of Electricity Act 2003.

UNIT-2: **Basics of Energy and its various forms**
Electricity basics- DC & AC currents, electricity tariff, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT-3 : **Energy Management & Audit**
Definition, need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

UNIT-4: Energy Monitoring and Targeting
Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM).

UNIT-5 : Global environmental concerns
United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon fund (PCF).

UNIT-6: Electrical Safety
Primary hazards associated with electricity. control measures and safety-related work practices to minimize the risk associated with electrical hazards. response procedures in the event of electrical shock or fire.

Text books:				
1	Principles of Energy Conservation	1991	Archie, W Culp	McGraw Hill
2	Energy management handbook	8th Edition	Wayne C. Turner	John Wiley and Sons
3	Bureau of Energy Efficiency Study material for Energy Managers & Auditors Examination	**--**	---	Bureau of Energy Efficiency www.beeindia.in
Reference books:				
1	Handbook on Energy Audits and Management		Amit Kumar Tyagi	TERI

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Department of Electrical Engineering
Semester VII

EL413/EL811	Utilisation of Electrical Energy	L= 4	T=0	P=0	Credits=4

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
To understand the basic principle of electrical heating, welding, illumination, refrigeration and air conditioning, fans, pumps, compressors and digi sets.	The student on completion will be able to Understand the application of electrical energy in • Electric Heating • Electric Welding • Illumination • Refrigeration & Air conditioning • Fans & Pumps • Compressors and DG Sets

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UNIT-1: **Electric Heating**

i) Electric Heating : Types and methods of electrical heating, advantages of electrically produced heat, type
ii) s & application of electric heating equipments, transfer of heat.
iii) Resistance Ovens : General constructions, design of heating elements, efficiency & losses, radiant heating.
iv) Induction heating: Core type & core less induction furnace, indirect induction oven, medium and high frequency eddy - current heating.
v) Dielectric heating: Principle and application.
vi) Arc furnace : Direct & indirect arc furnace, power supply, characteristics & control.

UNIT-2: **Electric Welding:**

i) Importance, Advantages & Disadvantages of welding, classification of welding processes.
ii) Resistance welding, Butt welding, Spot welding, Projection welding, Seam welding.
iii) Electric arc welding: carbon arc welding, metal arc welding, submerged arc welding, Stainless Steel welding
iv) Ultrasonic welding, electron beam welding, laser beam welding.

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.

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:

Diesel Generating Systems: Introduction, selection and installation factors, operational factors, energy performance assessment in DG sets, energy saving measures for DG sets.

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EL413/EL811	Utilisation of Electrical Energy	L= 4	T=0	P=0	Credits=4

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Text books:				
1	Utilization of Electric Energy	1st Edition, 2006	E. Openshaw Taylor	Orient Longman
2	Utilization of Electric Power & Electric Traction	Edition, 2009	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

Department of Electrical Engineering
Semester VIII

EL416/EL816	Switchgear and Protection	L= 3	T=0	P=0	Credits=3
PO/PSPO – a, b, c, e, i, j , m					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Students will understand • the theory and applications of the main components used in power system protection. • the protection systems used for electric machines, transformers, bus bars, transmission lines. • the theory, construction, and applications of main types of circuit breakers. • to design the feasible protection systems needed for each main part of a power system	At the completion of the subject, students will be able to perform the following tasks: • Theory & application of main components used in power system protection. • Protection systems used for electric machines, transformers, bus bars, transmission lines. • Theory, construction, and applications of main types of circuit breakers. • Design the protection systems needed for each main part of a power system

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.

Text books:				
1	Switchgear and Protection	**1990**	S. S. Rao	Khanna
2	Switchgear and Protection	**2006**	Bhide and Paithankar	PHI
3	Power System Protection and Swithgear	**1st 1999**	Badri Ram	TMH.

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 James S. Thorpe	John Wiley

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EL417/EL817	Switchgear and Protection	L=0	T=0	P=2	Credits=1

Evaluation Scheme (% Weightage)	TA	ESE	Total	ESE Duration
	40	60	100	02 Hours

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

EL418/EL818	Substation Design	L=0	T=0	P=4	Credits=4

Evaluation Scheme (% Weightage)	TA	ESE	Total	ESE Duration
	40	60	100	--

Learning Objectives	Learning Outcomes
The student will understand different aspects of substation design that is layout drawing, earthing drawing, lighting drawing and cable wiring.	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.

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

EL421/EL807	Power Quality Conditioning and Monitoring	L= 3	T=0	P=0	Credits=3
PO/PSPO – a, e, h, i, j, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Students will understand the various power quality issues, harmonics, filter designs and power quality improvements using custom power devices.	The student on completion will be able to Understand • Overview and definition of power quality • Voltage sag analysis • Harmonics • Filter Design • Analysis and Conventional Mitigation Methods • Power Quality Improvement using custom power devices

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.

Text books:				
1	Electrical 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

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EL422/EL808	Power System Operation and Control	L= 3	T=0	P=0	Credits=3
PO/PSPO – a, b, e, i, j, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning 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 student on completion will be able to Understand • Economic Aspects • Pre requisite of Load Dispatching • Load Frequency Control (LFC) • Economic Dispatch Control • Reactive Power Control • Voltage Control

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, LFC (P-f control & Q-V control). LFC control of a single area static & dynamic analysis of uncontrolled system proportional plus integral control of a single area LFC control of two area system uncontrolled case static & dynamic response Tie line with frequency bias control 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.

Text Book :				
1	Power System Operation and control		S. Sivanagarjuand G. Srinivasan	Pearson Publisher
2	Power System Stability and control		P. Kundur	TMH Publisher
3	Elecric 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

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EL423/EL809	Transients in Power System	L= 3	T=0	P=0	Credits=3
PO/PSPO – a, e, i, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Student will learn the causes of transients in power system, switching transients, overvoltage due to lightening and travelling waves.	The student on completion will be able to Understand • Causes of Transients in Power systems • Abnormal Switching Transients • Three Phase Circuit transients • Traveling waves • Lightning • Protection

UNIT-1: **Introduction**
Transients in Power systems: Simple switching transients, Circuit closing and recovery transients, Arcing grounds, double frequency transients, Damping, resistance switching.

UNIT-2: **Abnormal Switching Transients**
Abnormal Switching Transients:, Current chopping, Capacitance switching, Ferro-resonance, Transformer magnetizing inrush currents, re-striking phenomenon and its effects on recovery voltage.

UNIT-3 : **Three Phase Circuit transients**
Transient in three phase circuits: Switching of three phase transformers, effect of types of neutral connection, three phase capacitance switching, Symmetrical component method of analysis of three phase switching transients, effect of open conductors.

UNIT-4: Traveling waves
Traveling Waves: Traveling waves in transmission lines, reflection and refraction of waves, Typical cases of effects of line terminators, Equivalent circuit for traveling wave studies, Forked line, Reactive termination, Bewley lattice diagram, multi conductor systems.

UNIT-5 : Lightning
Lightning: Lightning phenomenon, over voltage due to lightning, lightning arrestors.

UNIT-6: Protection
Protection against transients: Protection of power systems against transient over-voltage due to switching and lightning, surge diverters, surge capacitors, and reactors, Overhead ground wires, Insulation Coordination, Computer aids to calculate transient (EMTP).

Text books:				
1	Electrical Power System	5th Edition 2009	C. L. Wadhawa	New Age International
2	Power System analysis	2008	I. J. Nagrath & D. P. Kothari	PHI, India

Reference books:				
1	Electrical Transients in Power Systems	2 edition 1994	Allan Greenwood	Wiley Interscience
2	Power System Transients: Statistical Approach	**2002**	C. S. Indulakar and D. P.Kothari	PHI publisher

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EL424/EL822	EHVAC – HVDC Transmission	L=3	T=0	P=0	Credits=3
PO/PSPO – a, c, e, h, i, j, k, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Students will understand various aspects of Transmission systems, controlling systems for power flow controls, design parameters of filters and Layout of HVDC power plant	On Successful Completion of the course the Student will be able to demonstrate the following task: • Power handling capacity of different Transmission systems • Electrostatic and electromagnetic fields and corona • The differences between AC and DC Transmission systems. • Different controlling systems for power flow controls.(Voltage control, current control.) • The knowledge of design parameters of AC filters as well as DC filters and Reactive power compensation • Overall knowledge about the layout of HVDC power plant.

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, Mangoldt Formula.

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, troubles caused by earth current and remedies.

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.
1) Reactive power compensation: - Reactive power requirement of HVDC converters, substations.

UNIT-6: HVDC circuit breakers
1) 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 .
2) HVDC Substation protection against short-circuits : Introduction , fault clearing, protective zones, HVDC line pole protections (fault clearing and re-energizing).

EL424/EL822	EHVAC – HVDC Transmission	L=3	T=0	P=0	Credits=3
PO/PSPO – a, c, e, h, i, j, k, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

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

EL425/EL823	Electrical Power Utilisation	L=3	T=0	P=0	Credits=3
PO/PSPO – c, e, h, i, k, l, m					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Student will understand The knowledge about energy utilization The application of electrical energy such as lighting, heating, welding, fans and pumps.	The student on completion will be able to understand the basics of electrical power utilization in various applications.

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.

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

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EL426/EL824	Digital Signal Processing	L=3	T=0	P=0	Credits=3
PO/PSPO – a, b, c, e, i, k					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Student will understand the various transform methods and design of signles in discrete time and frequency domain.	The student on completion will be able to understand • Discrete Time Signals and systems • Frequency Domain Representation • Z-transform • Discrete Design technique • Design Fourier transform

UNIT-1: **Discrete Time Signals and systems**
Discrete Time Signals, Discrete Time Systems, Linearity, causality, stability, static/dynamic. Time invariance/Time variance, classification of Discrete Time Systems, Linear convolution, circular convolution, Auto correlation. Linear constant coefficient difference equations, sampling theorem and sampling process, reconstruction of sampling data, convolution.

UNIT-2: **Frequency Domain Representation**
Frequency Domain Representation of discrete time signals and systems. Fourier Transform of discrete time signals. Properties of discrete time Fourier transform.

UNIT-3 Z-transform
The Z-transform definition, Z-transform properties, Inverse Z-transform using contour Integration, complex convolution theorem, Parseval's unilateral Z-transform, stability interpretation using Jury's array.

UNIT-4:LTI systems
Transform Analysis of LTI systems and structures for discrete time systems, Frequency response of LTI systems, relationship between magnitude and phase, all pass systems, minimum phase system, linear system with generalized linear phase.
Block diagram representation and signal flow graph representation of linear constant. Coefficient difference equation, basic structure for IIR systems, transposed forms, and basic network structures for FIR systems lattice structures.

UNIT-5 Discrete Design technique
Design of discrete time IIR filters from continuous time filters, frequency transformation of low pass IIR filters, Design of FIR filter by windowing FIR filter design by Kaiser window method, frequency sampling method.

UNIT-6:Design Fourier transform
Design Fourier transform-discrete Fourier series, properties of discrete Fourier series, discrete Fourier transform, properties of DFT, circular convolution using discrete Fourier transform, decimation in time FFT algorithm, decimation in frequency FFT, FFT of long sequence using overlap add and overlap save method.

Text books:				
1	Discrete Time Signal Processing	2nd-2004	Etalon V.Oppenheim, Ronald W.Schafer & Buch	Pearson.
2	Digital Signal Processing : A computer based approach	2008	Sanjit Kumar Mitra	TMH
	Digital Signal Processing: A Practical Approach	2002	Emmanuel C. Ifeachor, Barrie W. Jervis	Prentice Hall of India Ltd.

Reference books:				
1	Digital Signal Processing : Theory and Application	3rd edition	Proakis and Manolakis	PHI Ltd.

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EL427/EL825	Artificial Intelligence Based Systems	L=3	T=0	P=0	Credits=3
PO/PSPO – b, e, i, k, l, m					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

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	On completion of the subject, student will able to perform the following task • Fundamental concept of fuzzy systems • Non-linear fuzzy control • Artificial neural network • Recurrent network • Associative Memories & self organizing network

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
Basic concept & performance analysis of recurrent associative memory, Bi-directional associative memory, Hamming net & MAXNET Unsupervised learning of clusters, counter propagation network, feature mapping, self organizing feature maps, cluster discovery network.

Text books:				
1	Introduction of Artificial Neural Networks	1992	Jacek Zurada	JPH
2	Neural Network & Fuzzy Systems	1992	Bart Kosko	Prentice Hall of India
3	Neural Networks	2009	Simon Haykin	(Maxwell) Macmillan Canada Inc.) Comprehensive Foundation
4	An Introduction to Fuzzy Control	2010	D. Drianko	Springer
5	Fuzzy sets: Uncertainty & information	1988	Klir & Folger	Prentice Hall of India
6	Digital Image Processing (AWPC)		Gonzalez.	

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EL 428/EL826	Power Plant Instrumentation	L=3	T=0	P=0	Credits=3
PO/PSPO – b, e, i, k, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Student will understand the overview of different techniques of instrumentation used in power generation	On completion of the subject, student will able to perform the following task Instrumentation for Power Generation Transducers Signal Conditioning Measurements in Power Plants Power System Instrumentation-I Power System Instrumentation-II (Advance Instrumentation)

UNIT-1: **Instrumentation for Power Generation**
Instrumentation requirements for Hydro, thermal, nuclear, solar and wind power generators, Thermal power plants, Block diagram, Details of boiler processes, UP&I diagram of boiler, Cogeneration.

UNIT-2: **Transducers**
Construction & Operating Characteristics of active and digital transducers, Measurement of temperature, pressure, displacement, acceleration, noise level, Instrumentation for strain, displacement, velocity, acceleration, force, torque and temperature.

UNIT-3 Signal Conditioning
Instrumentation amplifiers, isolation amplifiers, analog multipliers, analog dividers, function generators, timers, sample and hold, optical and magnetic isolators, frequency to voltage converters, temperature sensors. Shielding and grounding.

UNIT-4: Measurements in Power Plants
Non electrical parameters – Flow of feed water, fuel, air and steam with correction factor for temperature – Steam pressure and steam temperature – Drum level measurement – Radiation detector – Smoke density measurement – Dust monitor.

UNIT-5 Power System Instrumentation-I
Measurement of voltage, current, phase angle, frequency, active power and reactive power in power plants. Energy meters and multipart tariff meters.

UNIT-6: Power System Instrumentation-II (Advance Instrumentation)
Performance of Instruments Advanced instrumentation in power systems – Digital CT's, optical CT's etc. and their transient response. Capacitive voltage transformers and their transient behavior, Current Transformers for measurement and protection, composite errors and transient response

Text books:				
1	The control of Boilers	1991	Sam G. Dukelow	Instrument Society of India
2	Power Plant Engineering	2001	P. K. Nag	Tata Mcgraw Hill
3	Modern Power Station Practice: Instrumentation, controls and testing			Central Electricity Generation Board, Great Britan
4	Standard Boiler Operations	1994	S.M. Elonka and A.L. Kohal	Tata McGraw Hill, New Delhi
5	Mechanical and Industrial Measurements	1995	R. K. Jain	Khanna Publishers, New Delhi
6	Power Plant Engineering	1998	E. Al. Wakil	Tata McGraw Hill

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EL 429/EL827	Electrical Distribution Systems	L=3	T=0	P=0	Credits=3
PO/PSPO – b, c, e, h, i, l					

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	15	15	10	60	100	3 Hrs

Learning Objectives	Learning Outcomes
Student will be able to understand the various aspects	On completion of the subject, student will able to perform the following task • Load Forecasting • Distribution Feeders • Overhead lines and Cables • Reactive power compensation and applications of capacitors • Substation & Metering, instrumentation & Tariffs • Distribution automation (DA) & SCADA

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.

Text books:				
1	Electrical power Distribuion Systems	2009	V. Kamaraju	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

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