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

M. Tech.

SoE & Syllabus 2014

1 to 4 Semester

Department of Electrical Engineering

Integrated Power systems

Update on Nov. 2017

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

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

M. Tech. SCHEME OF EXAMINATION 2014

Department of Electrical Engineering

Integrated Power Systems

Sl. No.	Course Code	Course Title	Contact Hours				Credits	% Weightage				ESE Duration Hrs.
			L	T	P	Total Contact Hrs.		MSE - I	MSE - II	TA	ESE	
I SEMESTER												
1	EL1901	Advanced Power Electronics	3	0	0	3	3	15	15	10	60	3
2	EL1902	Analog & Digital Protection	3	0	0	3	3	15	15	10	60	3
3	EL1903	Digital Control System	3	0	0	3	3	15	15	10	60	3
4	EL1904	HVDC Power Transmission	3	0	0	3	3	15	15	10	60	3
5	EL1905	Power System Modelling	3	0	0	3	3	15	15	10	60	3
6	EL1906	Lab: Analog & Digital Protection	0	0	4	4	2			40	60	
8	EL1907	Lab: Advance Power Electronics	0	0	4	4	2			40	60	
Total			**15**	**0**	**8**	**23**	**19**					
II SEMESTER												
1	EL1911	Power System planning	3	0	0	3	3	15	15	10	60	3
2	EL1912	Application of Power Electronics to Power System	3	0	0	3	3	15	15	10	60	3
3	EL1913	Power Quality	3	0	0	3	3	15	15	10	60	3
4	**Professional Elective- I**		3	0	0	3	3	15	15	10	60	3
	EL1916	Electrical Drives and Controls										
	EL1918	Renewable Energy System										
5	**Lab: Professional Elective I**		0	0	4	4	2			40	60	
	EL1917	Lab: Electrical Drives and Controls										
	EL1919	Lab: Renewable Energy System										
6	**Professional Elective II**		3	0	0	3	3	15	15	10	60	3
	EL1920	Advanced Digital Signal Processing										
	EL1921	EHV Power Transmission										
	EL1922	Restructuring of Power System										
7	EL1914	Power System Simulation	0	0	4	4	2			40	60	
8	EL1915	Seminar	0	0	2	2	1			100		
Total			**15**	**0**	**10**	**25**	**20**					
III SEMESTER												
1	**Professional Elective - III**		3	0	0	3	3	15	15	10	60	3
	EL1933	Power System Stability										
	EL1934	Electrical Distribution Systems										
	EL1935	Power System Operation and Control										
	EL1936	Transients in Power Systems										
2	**Professional Elective - IV**		3	0	0	3	3	15	15	10	60	3
	EL1937	Distribtuted Automation										
	EL1938	Power Electronics for Renewable Energy Systems										
	EL1939	Control System Design										
3	EL1931	Lab.: Power System Design	0	0	4	4	2			40	60	
4	EL1932	Project Phase -I	0	0	16		8			100		
		Total	**6**	**0**	**20**	**10**	**16**					
IV SEMESTER												
1	EL1941	Project Phase-II	0	0	20	24	12			40	60	
Total			**0**	**0**	**20**	**24**	**12**					
Grand Total of Credits							**67**					

Chairperson		**Date of Release**	Nov. 2017	**Applicable for**
Dean (Acad. Matt.)		**Version**	**1.02**	**AY 2014-15 Onwards**

Integrated Power System

First Semester

EL1901	Advanced Power Electronics	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: To study power semiconductor devices and circuits and their applications

UNIT-1:Power Semiconductor Devices
Overview of power semiconductor devices SCR ,IGBT ,MOSFET ,IGCT their characteristics protection

UNIT-2:DC to DC Converters
Buck, Boost, Buck-Boost, Cuk and switch mode power supply (SMPS).

UNIT-3:Pulse Width Modulation
Types of PWM,SPWM,SVPWM and RPWM. Voltage & Frequency control of inverter.

UNIT-4:Inverters
Principle of Operation, Performance parameters, series and parallel inverter, single phase and three phase bridge inverters and their voltage Control, Harmonic Reduction, types of PWM techniques, different methods to control output voltage.

UNIT-5 : Advanced Converters
Multi level converter,Multi pulse converter , Resonant converters, Three-phase to three phase Matrix converter, Front end rectifier.Resonant converter (Types of resonant converter)

UNIT-6 :Design of converters
Magnetic circuit ,active elements, passive elements

Text books:

1	Power Electronics Circuits Devices application	1994	M.H. Rashid	PHI
2	Modern Power Electronics		P. C. Sen	A. H. Wheeler Publishing Co.
3	Power Electronics Principles and Applications	Joseph Vithayathil	2017	MacGraw Hill
4	Power Electronics	Ned Mohan, Tora M. Udeland, William P. Robbins		John Wiley & sons
5	IEEE/IEE Publication			

Reference books:

1	Power Electronics	1993	Cyril W Lander	MHL

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

Integrated Power System

First Semester

EL1902	Analog & Digital Protection	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: To study analog protection and digital protection.

UNIT-1:**EHV line Protection**
Relay coordination using over current relay, Drawback of over current relay, Distance protection of three phase lines, carrier aided schemes. Stability of protection on power swing.

UNIT-2: **Transformer & Machine Protection**
Various fault occurring on transformers, alternators & large motors & complete protection against these fault.

UNIT-3: Basic elements of Digital Protection
Evolution of digital relays from electromechanical relays , Performance & operational characteristics of digital protection, Basic elements of digital protection, Signal conditioning, transducers, surge protection, analog filtering, analog multiplexer.
Conversion system- Sampling theorem, signal aliasing error, sample & hold circuit, multiplexer, analog to digital conversion, digital relay as a unit .
Digital filtering system- Low pass, High pass, FIR &IIR Filters.

UNIT-4 : Algorithms-I
Sinusoidal wave based algorithm, first & second derivative method, two sample & three sample technique.

UNIT-5: Algorithms-II
Fourier analysis &Fourier transform based algorithm.
Walsh function based algorithm, Differential equation based technique.

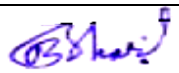
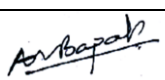
UNIT-6: Algorithm-III
Incident & reflected wave, coefficient of reflection, superimposed quantities & their properties & polarity versus fault location, reverse & forward faults, elliptical trajectory, Bergerons equation, discriminant function for single phase lines.
Recent advances-Synchrophasors & Wavelet analysis.

Text books:

1	Fundamentals of Power System Protection 2005	Y.G.Paithankar&S.R.Bhide	Prentice Hall of India
2	Digital Protection for power system	A.T.Johns&S.K.Salman	Peter Peregrinus Ltd.

Reference books:

1	Power System Protection	Ungradetal	Marcel Dekker Pub
2	Transmission Network Protection	Y.G.Paithankar	Marcel Dekker Pub
3	Power System Protection (Static Relays)	T.S. MadhavaRao	Tata McGraw-Hill,
4	English Electric Relay Application Guide		
5	IEEE/IEE Publications		

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

Integrated Power System

First Semester

EL1903	Digital Control System	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: To understand the advance concepts in control system.

UNIT-1:**Introduction**
Revive of state variable analysis, types of sampling operations, Sample and Hold operations, Sampling theorem, Basic discrete time signals, Discretisation of continuous time system.

UNIT-2:**Analysis of Digital Control Systems and Stability Methods**
Z-Transforms, Properties of Z-Transform, Inverse Z-Transforms, Pulse Transfer Function, Difference equations, Z-Transform method for solving the difference equations, Block diagram and signal flow graph analysis, Time response of digital control systems. Mapping between s-plane and z-plane, stability methods: Modified Routh's Criterion, Jury's method, Lyapunov stability analysis.

UNIT-3:Models of Control Systems
Problem of pole placement, effect of addition of poles & zeros to open loop transfer function, design of Digital compensator using root locus plots.

UNIT-4:State Variable analysis of Digital Control Systems
State variable description of digital control systems, conversion of state variable models to transfer function and vice versa, solution of state difference equations, controllability and observability, design of state feedback and state estimation.

UNIT-5:PID control
Conventional tuning methods such as Ziegler Nichols methods, Refined zeigler Nichols method etc., Introduction to optimization methods for tuning of PID controller; Particle swarm optimization (PSO), Genetic Algorithms (GA) etc.

UNIT-6:Optimal and Robust control system design
Review of optimal control, Linear Quadratic Regulators (LQR), LQR tracking problem, H_2-optimal control, H_∞-optimal control, Introduction to multivariable robust controls.

Text books:

1	Digital Control and State Variable Methods	M. Gopal	Tata Mc-Graw-Hill
2	Discrete Time Control Systems	K.Ogata	Pearson Education,(Singapore) (Thomson Press India).
3	Digital Control Systems	B.C Kuo	Prentice Hall
4	Optimal control: Linear Quadratic Methods	B.D.O. Anderson	Dover publications
5	Robust control design & optimal control Approach	Senglin	John Wiley & sons

Reference books:

1	Control System Engg	I.J. Nagrath&M.Gopal	John Wiley & sons
2	Control System Analysis and Design	K.K. Aggarwal	Khanna Publishers
3	Optimal Control	BDO Andersom, Moore	Dover Publications

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

Integrated Power System

First Semester

EL1904	HVDC Power Transmission	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: To learn the principles of conventional High Voltage Direct Current Transmission and modern trends in it. Multiterminal HVDC systems are also studied. Also voltage source converter technology is introduced.

UNIT-1:**Introduction to HVDC**
Development of HVDC technology comparison between HVAC and HVDC, Applications of HVDC transmission, Type of DC transmission, Selection of converter configuration.

UNIT-2:**Rectifier and inverter**
Rectifier and inverter operation of Line commutated converters, Analysis of rectifier with two-valve condition, Analysis of rectifier with two-three valve conduction, Analysis of inverter with two valve conduction, Analysis of inverter with two-three valve conduction.Introduction to HVDC with Voltage Source Converters(VSC)

UNIT-3: **Digital simulation**
Digital simulation of converters, Generalized equation for simulation of converters, Derivation of converter equations with Two valve conduction, Three valve conduction.

UNIT-4:Control of HVDC converters and system
Requirements of control system for HVDC converter, Rectifier compounding, Inverter compounding, Converter control characteristics, Converter firing schemes: Individual phase control (IPC) , Equidistant pulse control (EPC), Draw backs of individual phase control, Draw backs of EPC, Higher level controls, power controllers, Characteristics & non characteristics harmonics, Different methods to overcome problem of non-characteristics Harmonics.**,**Filters.Starting and stopping of DC links.

UNIT-5 : Multiterminal HVDC system
Fault development and protection, Inter action between AC-DC power system, Over-voltage on AC/DC side Multi-terminal HVDC system, Control of MTDC system,

UNIT-6:Modeling of HVDC system
Per unit system representation for power flow solution, Representation for stability studies.Effect of HVDC Link on Stability. Faults and Protection of HVDC Systems. HVDC circuit breaker

Text books:

1	High voltage direct current transmission		J. Arrillaga	Peter Peregrinus ltd. London, U.K.
2	Direct Current Transmission (Vol.I)	1971	E. W. Kimbark	Wiley Interscience
3	HVDC power Transmission Systems	1990	K. R. Padiyar	Wiley Eastern Ltd.

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

Integrated Power System

First Semester

EL1905	Power System Modeling	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: To understand the concept of modelling of Electrical equipment such as synchromous machines, transformer, transmission line etc.To understand the excitation system used for thermal power generator. Students also learn the load modelling.

UNIT-1: **General Background**
Evolution of electric power system, structure of power system, power system control, design and operating criteria for stability.

Power System stability Problems
Basic Concepts & definition, rotor angle stability, voltage stability & Voltage collapse, mid-term & long term stability, Classification of Stability.

UNIT-2:**Synchronous Machine Modeling I**
Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation.

UNIT-3 : Synchronous Machine Modeling II
Per Unit Representations: The Park's transformation, power-invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values.

UNIT-4 : Excitation and prime-mover controllers
Excitation system, excitation system modeling, excitation system –standard block diagram, system representation by state equations, prime mover control system, examples.

UNIT-5 : Transformer modeling & the per unit system
Introduction, single phase transformer model , three phase transformer connection , per phase analysis, p.u. normalization, p.u. three phase quantities, p.u. analysis of normal system , regulating transformer for voltage & phase angle control.

UNIT-6:Load modeling
Basic load- modeling concept, static load models, dynamic load model, modeling of I.M., acquisition of load model parameters.

Transmission line Modeling
Introduction, derivation of terminal V,I relations, waves on transmission lines, transmission matrix, lumped circuit equivalent, simplified models, complex power transmission (short line,medium & long line, Radial line).

Text books:

1	Power System Stability and Control	1993	P. Kundur	McGraw-Hill
2	Dynamic Models for Steam and Hydro Turbines in Power System Studies			IEEE Committee Report
3	Power System Control and Stability	1978	P.M Anderson and A.A Fouad	Iowa State University Press, Ames, Iowa

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

Integrated Power System

First Semester

EL1906	Lab: Analog & Digital Protection	L=0	T=0	P=4	Credits=2

Evaluation Scheme	TA	ESE	Total
	40	60	100

Objective: To study/ perform the practicals based on syllabus

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 study mho relay & offset mho relay.
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. To study MICOM P430 distance protection relay.
14. Study of relay co-ordiantion using SKM Power tools software.

Practicals based on MATLAB:-

15. To calculate peak value by full cycle window (Fourier Analysis)
16. To calculate peak value by half cycle window(Fourier Analysis)
17. Analytical Analysis by two sample method
18. Analytical Analysis by three sample method
19. Analytical Analysis by sample and derivative method
20. Analytical Analysis of first and second derivative method
21. To calculate peak values by Walsh coefficient
22. To calulate walsh function

First Semester

EL1907	Lab: Advance Power Electronics	L=0	T=0	P=4	Credits=2

Evaluation Scheme	TA	ESE	Total
	40	60	100

Objective: To study/ perform the practical based on syllabus

Advanced power electronics Laboratory
The list of practical will be according to the syllabi of Advanced power Electronics

Integrated Power System

Second Semester

EL1911	Power System Planning	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: To understand the load forecasting for the planning of power generation. To do the generation planning considering reliability, environmental aspects. Students also understand how to design the optimal power availability .

UNIT-1: **Introduction**
Introduction of power planning, National and Regional Planning, structure of P.S., planning tools, Electricity Regulation

UNIT-2: **Load Forecasting & Generation Planning**
Electrical Forecasting, forecasting techniques modeling. Generation planning, Integrated power generation cogeneration/captive power, Power pooling and power trading.

UNIT-3 : Transmission planning and Power System Economics
Transmission and distribution planning, Power system Economics, Power sector finance, financial planning, private participation Rural Electrification investment, concept of Rational tariffs.

UNIT-4: Reliability
Power supply Reliablity, Reliability planning, Reliability evaluation, Functional zones, Generation reliability, Generation & Transmission reliability, Quality of Supply.

UNIT-5 : System Operation & Environmental Aspects in Planning
System operation planning, load management, load prediction, reactive power balance, online power flow studies, state estimation, computerized management, power system simulator.
Computer aided planning, wheeling, Environmental effects, Greenhouse effect, Technological impacts, Insulation coordination, Reactive compensation.

UNIT-6:Power System Security :
Operation in Power System Security :- Introduction, Factors affecting power system security, Contingency analysis, ac power flow security analysis, concentric relaxation, bounding area method.
State Estimation :- Introduction, Method of least squares, Maximum likelihood weighted least square estimation, State estimation by orthogonal decomposition, Detection and identification of bad measurements, network observability and pseudo-measurements.

Text books:				
1	Electrical Power System Planning	**Edition (Year of publication)**	A.S.Pabla	Macmillan India Ltd.
2	Power Generation, Operation & Control	**2011**	Allen J. Wood, B.F. Wollenberg	Wiley India, Reprint
3	Modern Power System Analysis	**4th Edition**	D.P. Kothari, I.J. Nagrath	Tata Mcgraw Hill Education Pvt. Ltd.
4	Electrical Power Systems – Analysis, Security and Deregulation	**Third Printing**	P. Venkatesh, B. V. Manikandan, S. Charles Raja, A. Srinivasan	PHI Learning Pvt. Ltd.

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

Integrated Power System

Second Semester

EL1912	Application of Power Electronics to Power System	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: To understand how the constraints of the AC power transmission can be solved and performance of AC transmission can be enhanced by different FACTS controllers. The objective is also study comprehensively different FACTS controllers like shunt, series, shunt-series and phase angle regulators.

UNIT-1:Introduction
Introduction of Semiconductor Devices , Steady state and Dynamic Problems in AC Systems, Flexible AC transmission system : Introduction , types of Facts controllers.

UNIT-2:Shunt FACT Controllers
TCR(Thyristor Controlled Reactor) , TSC(Thyristor Switched Capacitor) ,FC-TCR(Fixed Capacitor -thyristor controlled reactor),TSC-TCR(Thyristor Switched Capacitor Thyristor switched Capacitor),Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling of svc for power flow and transient stability – Applications: Enhancement of transient stability – Steady state power transfer – Enhancement of power system damping – Prevention of voltage instability.

UNIT-3 : Series FACT Controller
TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit – Enhancement of system damping-SSR Mitigation, TSSC, GCSC.

UNIT-4: Converter based Shunt and Series controllers
STATCOM – Different modes of operation of working, different control strategies. Comparison with Static VAR Compensator (SVC). Different advantages and the constraints.
SSSC- Introduction, Inductive and the capacitive modes of operations. Different control strategies. Comarison with Thyristor based series controllers. Constraints of the SSSC

UNIT-5:Phase Shifter and Phase angle Regulator
TCPAR, TCVR, Voltage Controlled Source Based Phase Shifter and Angle Regulator, Introduction working and control strategies.

UNIT-6 :Other FACTS Controller
UnifiedPower Flow Controller(UPFC), Interline Power Flow Controller(IPFC): Introduction ,Controlled Strategies and Application

Text books:

1	Thyristor – Based Facts Controllers for Electrical Transmission Systems	R.MohanMathur, Rajiv K.Varma	IEEE press and John Wiley & Sons, Inc
2	Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems	Narain G. Hingorani	Standard Publishers Distributors, Delhi
3	FACTS Controllers in Power Transmission and Distribution	K.R.Padiyar	New Age International(P) Limited, Publishers, New Delhi

Reference books:

1	Flexible A.C. Transmission Systems	1999	A.T.John	Institution of Electrical and Electronic Engineers (IEEE)
2	HVDC and FACTS controllers – Applications of Static Converters in Power System	APRIL 2004	V.K.Sood	Kluwer Academic Publishers

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

Integrated Power System

Second Semester

EL1913	Power Quality	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 objective is to understand the different power quality problems, its causes, effects and various mitigating custom power devices. Further the subject is concentrated to analyse the different control strategies and algorithm.

UNIT-1:**Introduction**
Introduction – Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT-2:**Non Linear Loads**
Single phase / Three phase static converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

UNIT-3: **Measurement and Analysis Method**
Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error – Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform.

UNIT-4:Analysis and Conventional Mitigation Methods
Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices.

UNIT-5 : Voltage Sag
Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

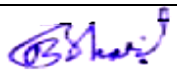
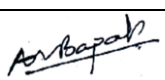
UNIT-6:Power Quality Improvement
Utility-Customer interface –Harmonic filters: passive,–Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC – control strategies: P-Q theory, Synchronous detection method – Custom power park – Status of application of custom power devices.

Text books:

1	Power Quality Enhancement Using Custom Power Devices	2002	ArindamGhosh	Kluwer Academic Publishers
2	Electric Power Quality	1994(2nd edition)	G.T.Heydt	Stars in a Circle Publications
3	Power Quality	Edition (Year of publication)	R.C. Duggan	Publisher

Reference books:

1	Power system harmonics	A.J. Arrillga	Publisher
2	Power electronic converter harmonics	Derek A. Paice	Publisher
3	Title of the book	Author(s)	Publisher

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

Integrated Power System

Second Semester

EL1916	Electrical Drives And Controls	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:: To understand the mathematical modeling of drives and the latest technology. Stress is given on Vector control, space vector modulation control of induction motor and synchronous motor. Adaptive control and introduction to fuzzy and neural control of drives is introduced.

UNIT-1:**Analysis of DC Motor:** State variable representation of seperately excited DC motor and DC shunt motor, Converters for DC drives,Average value analysis of DC drive.Machine control with voltage controlled converter, Machine control with current controlled converter.

UNIT-2:**- Analysis of Induction Motor:**
Reference frame theory, Balanced Set,Transformation of resistance and flux linkages, Theory of symmetrical Induction motor, voltage and torque equations in machine variables and their transformation to arbitrary reference frame, state vector representation of the equations, free acceleration characteristics,

UNIT-3: **Induction motor control systems**
Voltage Source Inverter Drive with PWM,Current Source Inverter Drive, Forced commutated inverter drive control of Induction motor, Flux Vector control of Induction motors, Direct torque control.

UNIT-4:Synchronous motors Drives:
Synchronous machines equations in different reference frames,
Synchronous motor drives with sinusoidal waveforms, True Synchronous mode and Self controlled mode Load commutated inverter drives
Synchronous motor drive with trapezoidal waveforms(Brushless DC motor).,Vector Control of Synchronous motors, Switched reluctance motor and its control.

UNIT-5 : Space vectors:
Stator space current, stator voltage space vector, stator flux linkage space vector, transformation of space vector coordinates from one reference frame to another. Space vector Modulation ,Control of Induction motor by Space vector Modulation.

UNIT-6:Digital Control of Drives
Adaptive control principles,Gainscheduling,Self tuning control,Model referencing adaptive control,Sliding Mode control,Idea of Fuzzy and Neural Control.
Necessity and Application of Digital signal processors to control of AC/DC Drives.BasicArchitectoure of Texas Instruments TMS320LF2407 processor,Programming methods
Idea of Field Programmable Gate Arrays(FPGA) Technology.

Text books:

1	Analysis of Electric Machinery		Paul, C. Krause	McGraw Hill
2	Modern Power Electronics and AC Drives		B.K. Bose	Prentice Hall
3	Texas Instruments TMS320LF2407 processor Manual			
4	Variable frequency AC motor Drive system		David Finney	IEE Press
5	Control of Electrical Drives	1996	W. Leonhard	Springer Verlag
6	Electric Drive		VedamSubramanyam	Tata McGraw Hill

Reference books:

1	High-Power Converters and AC Drives	2006	Bin Wu	Wiley & IEEE Press
2	Power Electronics, Converters, Applications and Design	3rd Edition	Ned Mohan, T. M. Undeland, W. P. Robbins	Media Enhanced
3	'Power Semiconductor Controlled Drives	1989	G.K. Dubey	Prentice Hall, N. Jersey
4	Electric Drives	2002	Krishnan	Prentice Hall of India

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

Second Semester

EL1917	Lab Electrical Drives and control	L=0	T=0	P=3	Credits=1.5

Evaluation Scheme	TA	ESE	Total
	40	60	100

List of Practicals

1. Study of program written in C to generate Pulse width modulated pulses with DSP
2. Closed Loop Speed control of separately excited D.C. motor
3. Closed Loop Speed control of Brushless DC motor
4. Closed Loop Speed control of Induction motor
5. Vector control of Induction motor
6. Control of Switched Reluctance motor with DSP program
7. To study the Simulation of DC Drive in MATLAB
8. To study the Simulation of Vector Control in MATLAB

Integrated Power System

Second Semester

EL1918	Renewable Energy System	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: To study the major renewable energy sources including solar, wind, Biomass for different applications.

UNIT-1:**Introduction to Energy Sources**
World Energy Futures, Conventional Energy Sources, Renewable Energy Sources, Prospects of Renewable Energy Sources. Environmental aspects of Electrical Energy Generation.

UNIT-2:**Solar Energy -**
a) Introduction to Solar Radiation and its measurement, Introduction to Solar Energy Collectors and Storage.
b) Applications of Solar Energy: Solar Thermal Electric Conversion, Thermal Electric Conversion Systems, Solar Electric power Generation
Solar Photo- Voltaics, Solar Cell Principle, Semiconductor Junctions, Conversion efficiency and power output, Basic Photo Voltaic System for Power Generation. Solar photovoltaic modules, maximum power point tracking and algorithms

UNIT-3: **Wind Energy:**
a) Introduction to wind energy Conversion, the nature of the wind, Power in the wind.
b) Wind Energy Conversion: Wind data and energy estimation, Site Selection Considerations, Basic Components of a Wind Energy Conversion System, Classification of WEC Systems, Schemes for Electric Generation using Synchronous Generator and Induction Generator, Wind energy Storage.

UNIT-4:Direct Energy Conversion Processes (Overview) :
a) Information on Magneto Hydro Dynamic Power Generation:
b) Thermo-Electric Generation: Basic principles of thermo-electric powergeneration, Seebeck, Peltier, Thomson effects, Thermo-Electric power generator, Analysis, materials.
c) Thermionic Generation: Thermionic emission and work function, Basic thermionic generation.
d) Fuel Cells H_2O_2**C**ell, Classification of fuel Cells, Types, Advantages, Electrodes, Polarization.
e) Thermo Nuclear Fusion Energy: The basic Nuclear Function and Reactions Plasma Confinement, Thermo Nuclear function Reactions.

UNIT-5 : Energy from Biomass:
a) Introduction: Biomass conversion technologies, photosynthesis, Bio-gas generation, types of bio-gas plants.
b) Biomass as a Source of Energy: Method for obtaining energy from Bio-mass, Biological Conversion of Solar Energy.

UNIT-6:
Applications of Renewable energy
Wind Farms: Grid interfacing of wind farm, methods of grid connection, grid system and properties. Small hydro power, Hybrid systems: Wind- solar, wind photovoltaic etc,

Text books:				
1	Non-Conventional Sources of Energy	4th Edition, 2010	G.D. Rai	Khanna Publishers
2	Non Conventional Energy Sources	2nd Edition.2009	B. H. Khan	The McGraw Hill Companies
3	Renewable energy sources and conversion technology	1990	N.K. Bansal, M. Kleemann, M. Heliss	Tata McGraw Hill
Reference books:				
1	Direct Energy Conversion		R. A. Coombie	Pitman
2	Renewable energy sources and emerging technologies	1st Edition,2008	D. P. Kothari	PHI
3	Related IEEE/IEE Publications			

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

Second Semester

EL1919	Lab : Renewable Energy System	L=0	T=0	P=3	Credits=1.5

Evaluation Scheme	TA	ESE	Total
	40	60	100

List of Practical's

Integrated Power System

Second Semester

EL1920	Advanced Digital Signal Processing	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:

UNIT-1:**Introduction**
Mathematical description of change of sampling rate – Interpolation and Decimation, Filter implementation for sampling rate conversion – direct form FIR structures, DTFT, FFT, Wavelet transform and filter bank implementation of wavelet expansion of signals

UNIT-2:**Estimation Techniques**
Discrete Random Processes – Ensemble averages, Stationary processes, Autocorrelation and Auto covariance matrices, Parseval's Theorem, Wiener-Khintchine Relation – Power Spectral Density**,** AR, MA, ARMA model based spectral estimation, Parameter Estimation,

UNIT-3: **Prediction Techniques**
Linear prediction – Forward and backward predictions, Least mean squared error criterion – Wiener filter for filtering and prediction, Discrete Kalman filter.

UNIT-4:Digital Signal Processor
Basic Architecture – Computational building blocks, MAC, Bus Architecture and memory, Data Addressing, Parallelism and pipelining, Parallel I/O interface, Memory Interface, Interrupt, DMA.

UNIT-5 : APPLICATION OF DSP
Design of Decimation and Interpolation Filter, FFT Algorithm, PID Controller, Application for Serial Interfacing, DSP based Power Meter, Position control.

UNIT-6:VLSI IMPLEMENTATION
Basics on DSP sytem architecture design using VHDL programming, Mapping of DSP algorithm onto hardware, Realisation of MAC & Filter structure.

Text books:

1	Adaptive Signal Processing	Third edition, 2004	Bernard Widrow, Samuel D. Stearns	Pearson Education
2	Statistical & Adaptive signal processing, spectral estimation, signal modeling, Adaptive filtering & Array processing	2000	**Author(s)**	McGraw-Hill International
3	Statistical Digital Signal Processing and Modelling	**Edition (Year of publication)**	Monson H. Hayes	John Wiley and Sons, Inc

Reference books:

1	Digital Signal Processing	2002	John G. Proaks, Dimitris G. Manolakis	Pearson Education
2	Digital Signal Processing		S. Salivahanan, A. Vallavaraj and C. Gnanapriya	TMH
3	Digital Signal Processing- Implementation using DSP Microprocessors with Examples from TMS320C54xx	**2004**	Avatar Sing, S. Srinivasan	Thomson India
4	DSP Integrated Circuits	1999	Lars Wanhammer	Academic press, New York
5	Digital Signal Processing: A Modern Introduction	2007	Ashok Ambardar	Thomson India edition, 2007.

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

Integrated Power System

Second Semester

EL1921	EHVAC Power Transmission	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: Mention the objectives of the course here. Not more than 5 lines

UNIT-1:**Introduction**
Standard transmission voltages – different configurations of EHV and UHV lines – average values of line parameters – power handling capacity and line loss – costs of transmission lines and equipment – mechanical considerations in line performance.

UNIT-2:**Calculation of Line Parameters**
Calculation of resistance, inductance and capacitance for multi-conductor lines – calculation of sequence inductances and capacitances – line parameters for different modes of propagation – resistance and inductance of ground return, numerical example involving a typical 400/220kV line using line constant program.

UNIT-3: **Voltage Gradients Of Conductors**
Charge-potential relations for multi-conductor lines – surface voltage gradient on conductors – gradient factors and their use – distribution of voltage gradient on sub conductors of bundle - voltage gradients on conductors in the presence of ground wires on towers.

UNIT-4:Corona Effects-I :
Power losses and audible losses: I^2R loss and corona loss - audible noise generation and characteristics - limits for audible noise - Day-Night equivalent noise level- radio interference.

UNIT-5 : Corona Effects – II :-
Corona pulses (their generation and properties),Frequency spectrum,Properties of pulse trains and filter response ,Limits for radio interference fields ,the CIGRE formula,The RI excitation functionProcedure for obtaining excitation fudnction from CIGRE Formula,Design of filter, television Interference.

UNIT-6:Electrostatic Field Of EHV Lines
Effect of EHV line on heavy vehicles - calculation of electrostatic field of AC lines- effect of high field on humans, animals, and plants - measurement of electrostatic fields - electrostatic Induction in unenergised circuit of a D/C line - induced voltages in insulated ground wires - electromagnetic interference.

Text books:

1	Extra High Voltage AC Transmission Engineering	Second Edition, 1990	Rakosh Das Begamudre	New Age International Pvt. Ltd
2	Power Engineer's Handbook	6th Edition, Oct. 2002		TNEB Engineers' Association
3	Microtran Reference Manual www.microtran.com		Microtran Power System Analysis Corporation	

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

Integrated Power System

Second Semester

EL1922	Restructuring of Power System	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

UNIT-1:Deregulation of Electricity Market

Introduction to Power System Deregulation, Reform Motivations, Traditional Model, Separation of Ownership, Competition and Direct Access in the Electricity Market, Role of ISO, Retail Market, International Experiences

UNIT-2:Electricity Market Characteristics

Direct Access and Power Wheeling, Pool & Bilateral trading, Bidding and Auction Mechanisms, Market Timing, Sequential and Simultaneous Markets, Scheduling, Gaming, Congestion Management

UNIT-3: Transmission Open Access

Transmission Open Access, Transmission Pricing, Impact of Congestion and Management, ATC and Factors affecting ATC, Determination of ATC, Ancillary Services and their management, Electricity Bill 2003 and its impact.

UNIT-4 Optimal Power Flow

OPF and its Formulation, Constraints, Different solution Techniques, Non Linear Programming (NLP) and Genetic Algorithm.

UNIT-5: SCADA and Distribution Automation

SCADA & Distribution Automation, Energy management system

UNIT-6: Power System Communication

Analog and Digital Communication, communication architecture, Power system communication, PLCC, Optical Fibre etc

Text books:

1	Power System restructuring and deregulation	2001	Loi Lei Lai	John Wiley and Sons, UK.
2	Operation of Restructured Power Systems	2001	K. Bhattacharya, MHT Bollen and J.C Doolder	Kluwer Academic Publishers, USA
3	Power System Operation and Control		A.J Wood and B.F Wollenberg	John Wiley and Sons

Reference books:

1	Computational Methods for large Sparse Power System Analysis: An Object Oriented Approach	**Edition (Year of publication)**	S.A Soman, Khafasok, ShubhaPandit	S.A Kluwer Academic Publishers

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

Second Semester

EL1914	Power System Simulation	L=0	T=0	P=4	Credits=2

Evaluation Scheme	TA	ESE	Total
	40	60	100

Development of algorithms & flowcharts and digital simulation of the following using ETAP/MATLAB Software package:

1. Z-bus and Y-bus formulation
2. Load flow studies
3. fault analysis
4. Transient stability studies.

Second Semester

EL1915	Seminar	L=0	T=0	P=2	Credits=1

Evaluation Scheme	TA	ESE	Total
	100		100

Third Semester

EL1931	**Lab.: Power System Design**	L=0	T=0	P=3	Credits=3

Evaluation Scheme	TA	ESE	Total
	40	60	100

Practices may be carried out on the following topics but are not limited.

- HVDC Transmission
- HVAC transmission.
- Steady state and transient stability.
- Voltage stability.
- Different fault analysis.
- Sub synchronous resonance.
- Reactive power compensation (shunt, series etc.).

Groups can be formed for some of the practical's consisting of four or five students for the following reasons to get every student involved in the practical

(a) Different voltages and different power ratings in some of the practical may be assigned to them.
(b) Various reactive power compensators etc.

Integrated Power System

Third Semester

EL1934	ELECTRICAL DISTRIBUTION SYSTEMS	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

Objectives: To understand the various aspects of distribution including type of distribution system, voltage level, equipment's used, protection etc.

UNIT-1:Introduction to Distribution systems, Regulations, Electricity Act 2003, Energy conservation act-2001, electricity rules-2005, electricity authority regulations, distribution code, consumer values, consumer satisfaction, measurement standards of consumer satisfaction, Model distribution system.
Explanation of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads. Load, Management Strategies : Differential tariff, load staggering, interruptible load, supplies, maintenance of essential services, integrated system operation, use of captive generation & cogeneration in distribution network, distribution system measures, conservation.

UNIT-2:Feeders : Radial and loop types, Engineering considerations for voltage levels and loading, causes of unbalance and unequal drops. System analysis : Voltage drop and power loss calculations, manual methods of solution of radial networks, three-phase & non-three-phase primary lines load flow and symmetrical component applications.

UNIT-3: Voltage control : Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop calculations and compensations, Reactive power requirements, economic consideration & best location.

UNIT-4: Distribution System Reliability : Basic defination, Appropriate levels of distribution reliability, Series & Parallel System, Markov Processes, Distribution reliability Indices, System and customer based indices, load and energy based indices, usage of reliability indices.

UNIT-5 : Introduction to Distribution Automation, Data acquisition system and decentralized control, data acquisition and protection considerations of control panel. Circuit breaker, reclosers, sectionalizers, location of sectionalizers, fuses, low voltage and current limiting fuses, expulsion fuses, fuses applications considerations, lightning protection, disconnect switches, non load break disconnect switches, break disconnect switches., relays.
Earthing System: Earth and safety, nature of an earth electrode, earth conductor sized, design of earthing electrode, electrode earth resistance, temporary earthing, system earthing, line and substation earthing, substation earthing mat, consumer installation earthing.

UNIT-6: Substation :-Substation layout, selection criteria, voltage and spacing load, space and location, distribution substation protection needs, distribution substation construction methods, trends in distribution substation, insulation coordination, voltage regulation, distribution substation layout, one feeder substation, single bus substation, two transformer distribution substation, automatic switching, double bus substation, bus arrangements, fault, distribution substation protection, zones of protection, transformer and bus protection, feeder overcurrent protection, substation grounding.

Text books:

1	Electric Power Distribution	4th edition, 1997	A.S.Pabla, , .	Tata McGraw-Hill Publishing Company
2.	Electric Power Distribution System Engineering	2nd Edition 2008	Turan Gonen	CRC Press

Reference books:

1	A Text Book of Electric Power Distribution Automation	Edition (Year of publication)	K. Khedkar and Dr. G. M. Dhole,.	Laxmi Publications

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

Integrated Power System

Third Semester

EL1935	Power System Operation and Control	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

Objectives: Mention the objectives of the course here. Not more than 5 lines

UNIT-1:**Load Forecasting**
Introduction – Estimation of Average and trend terms – Estimation of periodic components – Estimation of Stochastic components : Time series approach – Auto- Regressive Model, Auto-Regressive Moving – Average Models – Kalman Filtering Approach – On-line techniques for non stationary load prediction.

UNIT-2:**Unit Commitment**
Constraints in unit commitment – Spinning reserve **–** Thermal unit constraints **–** Other constraints – Solution using Priority List method, Dynamic programming method - Forward DP approach Lagrangian relaxation method – adjusting .

UNIT-3: **Generation Scheduling**
The Economic dispatch problem – Thermal system dispatching with network losses considered – The Lambda – iteration method – Gradient method of economic dispatch – Economic dispatch with Piecewise Linear cost functions – Transmission system effects **–** A two generator system **–** coordination equations **–** Incremental losses and penalty factors-Hydro Thermal Scheduling using DP.

UNIT-4:Control of Power Systems
Review of AGC and reactive power control -System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Corrective controls (Preventive, emergency and restorative) - Energy control center – SCADA system – Functions – monitoring , Data acquisition and controls – EMS system.

UNIT-5 : State Estimation
Maximum likelihood Weighted Least Squares Estimation: - Concepts - Matrix formulation - Example for Weighted Least Squares state estimation ; State estimation of an AC network: development of method **–** Typical results of state estimation on an AC network **–** State Estimation by Orthogonal Decomposition algorithm.

UNIT-6:Advance Measurements
Introduction to Advanced topics : Detection and Identification of Bad Measurements , Estimation of Quantities Not Being Measured , Network Observability and Pseudo **–** measurements **–** Application of Power Systems State Estimation .

Text books:

1	Electric Energy System Theory - an Introduction	**2002**	O.I.Elgerd	Tata McGraw Hill, New Delhi
2	Power System Stability and Control		P.Kundur	EPRI Publications, California
3	Power System Operation and Control		A.J Wood and B.F Wollenberg	John Wiley and Sons

Reference books:

1	Computer Aided Power System Analysis and Control	**1984**	A.K.Mahalanabis, D.P.Kothari. and S.I.Ahson	Tata McGraw Hill publishing Ltd

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

Integrated Power System

Third Semester

EL1936	Transients in Power Systems	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

Objectives: The insulation system be capable of withstanding such high normal system voltages, it should also be capable of withstanding transient overvoltage associated with external lighting discharges or internal switching operations without any outage.

UNIT-1:**Travelling Waves On Transmission Line**
Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behaviour of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion – Multi-conductor system and Velocity wave.

UNIT-2:**Computation Of Power System Transients**
Principle of digital computation – Matrix method of solution, Modal analysis,Z transforms, Computation using EMTP – Simulation of switches and non-linear elements.

UNIT-3 : Lightning, Switching And Temporary Overvoltages
Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Factors contributing to line design – Switching: Short line or kilometric fault – Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault – Very Fast Transient Overvoltage (VFTO)

UNIT-4:Behaviour Of Winding Under Transient Condition
Initial and Final voltage distribution - Winding oscillation - traveling wave solution -
UNIT-5 : Transformer under Surge Condition
Behaviour of the transformer core under surge condition – Rotating machine – Surge in generator and motor

UNIT-6:
Insulation Co-Ordination
Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS), insulation level, statistical approach, co-ordination between insulation and protection level –overvoltage protective devices – lightning arresters, substation earthing.

Text books:

1	Electromagnetic transients in Power System	1996.	PritindraChowdhari	John Wiley and Sons Inc
2	Electrical Transients in Power System	1991	Allan Greenwood	Wiley & Sons Inc. New York
3	Surges in High Voltage Networks	1980	Klaus Ragaller	Plenum Press, New York

Reference books:

1	Extra High Voltage AC Transmission Engineering	Second edition,1980	Rakosh Das Begamudre	Newage International (P) Ltd., New Delhi
2	High Voltage Engineering	2004.	Naidu M S and Kamaraju V	Tata McGraw-Hill Publishing Company Ltd., New Delhi
3	. IEEE Guide for safety in AC substation grounding IEEE Standard 80-2000			
	Very fast transient phenomena associated with Gas Insulated System'		CIGRE, Working Group 33/13-09 (1988)	

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

Integrated Power System

Third Semester

EL1937	Distribution Automation	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

Objectives: Mention the objectives of the course here. Not more than 5 lines

UNIT-1:**Distribution Automation and the utility system**
Introduction to Distribution Automation (DA), control system interfaces, control and data requirements, centralized (Vs) decentralized control, DA System (DAS), DA Hardware, DAS software.

UNIT-2:**Distribution Automation Functions**
DA capabilities, Automation system computer facilities, management processes, Information management, system reliability management, system efficiency management, voltage management, Load management.

UNIT-3:**Communication Systems for DA**
DA communication requirements, Communication reliability, Cost effectiveness, Data rate requirements, Two way capability, Ability to communicate during outages and faults, Ease of operation and maintenance, Conforming to the architecture of data flow.

UNIT-4:Communication systems used in DA
Distribution line carrier (Power line carrier), Ripple control, Zero crossing technique, telephone, cable TV, Radio, AM broadcast, FM SCA, VHF Radio, UHF Radio, Microwave satellite, fiber optics, Hybrid Communication systems, Communication systems used in field tests.

UNIT-5 : Technical Benefits
DA benefit categories, Capital deferred savings, Operation and Maintenance savings, Interruption related savings, Customer related savings, Operational savings, Improved operation, Function benefits, Potential benefits for functions, function shared benefits, Guide lines for formulation of estimating equations, Parameters required, economic impact areas, Resources for determining benefits impact on distribution system, integration of benefits into economic evaluation.

UNIT-6:Economic Evaluation Methods
Development and evaluation of alternate plans, Select study area, Select study period, Project load growth, Develop Alternatives, Calculate operating and maintenance costs, Evaluate alternatives, Economic comparison of alternate plans, Classification of expenses and capital expenditures, Comparision of revenue requirements of alternative plans, Book Life and Continuing plant analysis, Year by year revenue requirement analysis, short term analysis, end of study adjustment, Break even analysis, Sensitivity analysis computational aids.

Text books:

1	A Text Book of Electric Power Distribution Automation	K. Khedkar and Dr. G. M. Dhole,.	Laxmi Publications
2	Electric Power Distribution	A. S. Pabla	Tata McGraw Hill Publication, New Delhi
3	Distribution Automation	IEEE Tutorial Course	

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

Integrated Power System

Third Semester

EL1938	**Power Electronics for Renewable Energy Systems**	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

Objectives: To overview the different renewable energy system and generator usedand to understand their different configurations and topology. The objective is to study the various Grid interactive power converter topologies used in Wind and solar energy conversion system and their hybrid combination and the related power quality issues.

UNIT-1:introduction
Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNIT-2: Solar Thermal and Photovoltaic System
Solar Thermal: Different Solar Concentrators and solar thermal applications
Solar Photovoltaic: PV cell equivalent and V-I, P-V characteristics, DC-DC Converters and its role in Maximum Power Point Tracking (MPPT), MPPT techniques (Direct and Indirect)

UNIT-3: Solar PV converters and Configurations
PV inverters: PV inverter Configurations, PV based transformerless inverter topologies.
Configuration: Standalone, Grid interactive, Bi-Modal systems, Grid synchronization (time and frequency Domain), Islanding and detection methods, Generic control for PV inverters.

UNIT-4: Wind Energy Conversion System (WECS)
WECS: Introduction to WECS, Wind turbine technologies, WECS configurations and fundamentals of WECS controls, wind MPPT control, operation and analysis of wind generators (IG, PMSG, SCIG, DFIG)

UNIT-5 : Power Converters, Configurations and Controls for Wind Energy Systems
Power Converters: AC Voltage Controllers, PWM inverters, Grid interactive inverters
Configurations and Controls: Fixed speed WECS, Variable speed WECS (converter configurations for IG, PMSG based WECS and their controls)

UNIT-6 : Hybrid Renewable Energy System and Power Quality (PQ)
Need for Hybrid Systems and type of Hybrid systems, PQ issues in grid interconnections, measurement of voltage flicker, voltage dip, voltage swell, harmonics in grid integration and remedial measures.

Text books:

1	power electronics Hand book	2001.	Rashid .M. H	Academic press,
2	Non conventional energy sources	1993	Rai. G.D	Khanna publishes,
3	Solar energy utilization	1993	Rai. G.D	Khanna publishes,

Reference books:

1	Wind energy system	1995	Gray, L. Johnson	prentice hall inc
2	Non-conventional Energy sources		B.H.Khan	Tata McGraw-hill Publishing Company,New Delhi
3	Modern Power Electronics and AC Drives		B. K. Bose	Prentice Hall PTR
	Analysis of Electric Machinery and Drive Systems		P. C. Krause, O. Wasynzuk, and S. D. Sudhoff	John Wiley & Sons, New York

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

Integrated Power System

Third Semester

EL1939	Control System Design	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

Course objectives

The theory of design of control system is particularly useful for various analytical design approaches in various power system problems. Students will study the time domain and frequency domain approach for linear time invariant systems. They shall be explored to design of discrete state variable and state estimation using observers and the optimal control methods are covered for specific systems.

Course Outcomes

Upon successful completion of this course you should be able to:

1) Design PID controller and compensators for practical systems 2) Understand time domain and frequency
3) domain interpretations of various controller 4) Apply the controller design methods for discrete systems
5) Design discrete state variable systems 6) Formulate the observer design procedures
7) Understand and solve the formulation of optimal control problems

UNIT-1: CONVENTIONAL DESIGN METHODS IN TIME DOMAIN

Design specifications, Fixed configuration design, Time domain interpretations of PI, PD and PID controllers and lead, lag and lag-lead compensators- Root locus based design, Design examples.

UNIT-2: CONVENTIONAL DESIGN METHODS IN FREQUENCY DOMAIN

Frequency domain specifications, Correlation between time and frequency domain, Frequency domain interpretations of PI, PD and PID controllers and lead, lag and lag-lead compensators, Design examples

UNIT-3 : DESIGN IN DISCRETE TIME DOMAIN

Design of Discrete-time control system by conventional methods: Introduction, Digital implementation of analog controller (PID and lead-lag controllers) : Digital controllers, Realization of pulse transfer function by direct, Cascade and parallel programming. Design based on root locus method. Dead beat controller.

UNIT-4 : DISCRETE DESIGN IN FREQUENCY DOMAIN

Mapping between S plane and Z plane, Bilinear transformation, Design based on frequency domain for PID and lag lead compensators. . Design examples

UNIT-5: DISCRETE STATE VARIABLE DESIGN

Discrete pole placement- state and output feedback-estimated state feedback, state feedback with integral control, State Estimation Problem -State estimation- Luenberger's observer and reduced order observer. Concept of Sliding Mode controller.

UNIT-6: OPTIMAL CONTROL

Formation of optimal control problems-Results of Calculus of variations- Hamiltonian formulation-solution of optimal control problems- Evaluation of Riccati's equation. State and output Regulator problems-- dynamic programming-Design examples.

Text books:

1	Modern control system Theory	2005	M. Gopal	New Age International
2	Digital control systems	2004	Benjamin C. Kuo	Oxford University Press
3	Discrete time control systems	2002	Katsuhiko Ogata	Pearson Education Asia
4	Control systems principals and design	2003	M. Gopal	TMH

Reference books:

1	Control system Design	2003	Graham C. Goodwin, Stefan F. Graebe and Mario E. Salgado	PHI (Pearson), 2003
2	Digital Control of Dynamic Systems	2002.	G. F. Franklin, J. D. Powell and M Workman	PHI (Pearson),

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

Integrated Power System

Third Semester

EL1933	**Power System Stability**	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

Objectives: To understand various types of stabilities in power system, their analysis and means to overcome the instability.

UNIT-1: Introduction

Power System Operation and Control, power system stability, classification of stability, mid-term and long term stability, Impact on Power System Operation, classical representation of synchronous machine in a single machine infinite bus system (SMIB), limitations of classical model

Unit 2: Excitation and Prime Mover

Characteristics and types of excitation systems, IEEE type-I excitation system, Prime mover and energy supply systems, mathematical modeling of simple excitation system, power system stabilizers

UNIT-3: Steady state and transient characteristics of system

Phasor diagrams in terms of voltages Eq, Eq', and Vg for salient and non salient pole machines, Derivation of power expressions, saliency, Characteristics of system with generator operating at synchronous speed

UNIT4: Steady state stability

Steady state stability, characteristics, effect of damping, positive, negative resistance and turbine regulation, effect of induced currents in field winding, stability analysis with excitation

Unit 5: Transient stability

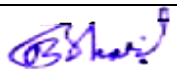
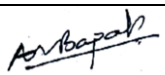
Transient stability, swing equation, equal area criterion, solution of swing equation, Numerical methods- Modified Euler's method, Runge-Kutta method, Multimachine stability, Extended equal area criterion

Unit 6: Voltage stability

Classification of voltage stability, voltage stability analysis: static and dynamic, comparison with angle stability, Voltage collapse, prevention of voltage collapse

Text books:			
1	Power System Stability and control	Prabha Kundur	Mc Graw Hill Inc
2	Power System Stability Vol. III	Edward Kimbark	IEEE Press, Wiley Inter science John Wiley & Sons Publication
3	Power System Dynamics : Stability and Control	K.R. Padiyar	2nd edition BS Publications
4	Computational Techniques for voltage stability assessment and control	Aijarapu V	. Springer

Reference books:			
1	Power System Dynamics : Stability Control	Jan Machowski	John Wiley & Sons (2nd Edition)
2	Power System Analysis	Grainger, Stevenson	McGraw-Hill series in Electrical & Computer Engineering

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

Third Semester

EL1932	Project Phase-I	L=0	T=0	P=16	Credits=8

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	0	0	100	0	100	

Fourth Semester

EL1941	Project Phase-II	L=0	T=0	P=24	Credits=12

Evaluation Scheme	MSE-I	MSE-II	TA	ESE	Total	ESE Duration
	0	0	40	60	100	