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

3 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**					

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Dean (Acad. Matt.)		**Version**	**1.02**	**AY 2014-15 Onwards**

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

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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

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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)	

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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	

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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

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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),

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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

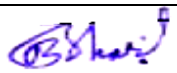
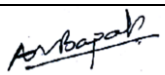
Transient stability, swing equation, equal area criterion, solution of swing equation, Numerical methods- Modified Euler's method, Runge-Kutta method, Multimachine stability, Extended equal area criterion

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	