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 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**

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

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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.

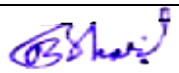
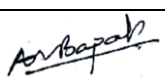
UNIT-6: Algorithm-III
Incident & reflected wave, coefficient of reflection, superimposed quantities & their properties & polarity versus fault location, reverse & forward faults, elliptical trajectory, Bergerons equation, discriminant function for single phase lines.
Recent advances-Synchrophasors &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

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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.

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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

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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