

COURSE: Non CRS PATTERN

Name of the Faculty: Technology and Engineering

Name of the Programme: Master of Engineering- Electrical Engineering (Electrical Power Engineering)

Mode of Learning: REGULAR

Semester Number (For Example 01,02,03, etc.):					01								
Maximum Courses/Papers for the present Semester:					08								
Minimum Courses/Papers for the present Semester:					08								
Maximum marks for the present Semester:					650								
Minimum marks for the present Semester:					00								
Total Credits for the present Semester:					NIL								
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week [Credit*]	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks for Minimum /Maximum Course/Paper/Subject/ Selection
1	Electrical Engineering	Core Compulsory	Advanced Power Electronics (ELE2144)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			
2	Electrical Engineering	Core Compulsory	Advanced Power Electronics (TW, Practical and Viva) (ELE2144L)	NA	03	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
								IA	--	--			
3	Electrical Engineering	Core Compulsory	Computations of Fields (ELE2145)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			
4	Electrical Engineering	Core Compulsory	Computations of Fields (TW, Practical and Viva) (ELE2145L)	NA	03	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
								IA	--	--			
5	Electrical Engineering	Core Compulsory	Smart Grid (ELE2146)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			

6	Electrical Engineering	Core Compulsory	Power System Stability and Control (ELE2147)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			
7	Electrical Engineering	Core Compulsory	Computational Methods in Power System Analysis (ELE2148)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			
8	Electrical Engineering	Core Compulsory	Computational Methods in Power System Analysis (TW, Practical and Viva) (ELE2148L)	NA	03	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
								IA	--	--			

Semester Number (For Example 01,02,03, etc.):					02								
Maximum Courses/Papers for the present Semester:					07								
Minimum Courses/Papers for the present Semester:					07								
Maximum marks for the present Semester:					600								
Minimum marks for the present Semester:					00								
Total Credits for the present Semester:					NIL								
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week [Credit*]	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/ IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks
1	Electrical Engineering	Core Compulsory	Reactive Power and Voltage Control (ELE2245)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			
2	Electrical Engineering	Core Compulsory	Deregulated Electricity Markets (ELE2246)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			
3	Electrical Engineering	Core Compulsory	Advanced Power System Protection (ELE2247)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			
4	Electrical Engineering	Core Compulsory	Advanced Power System Protection (TW, Practical and Viva) (ELE2247L)	NA	03	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
								IA	--	--			
5	Electrical Engineering	Core Compulsory	High Voltage Technology (ELE2248)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			

6	Electrical Engineering	Core Compulsory	High Voltage Technology (TW, Practical and Viva) (ELE2248L)	NA	03	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
								IA	--	--			
7	Electrical Engineering	Core Compulsory	Synchronized Phasor Measurement and Applications (ELE2249L)	NA	04	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30
								IA	--	30			

Semester Number (For Example 01,02,03, etc.):					03 & 04									
Maximum Courses/Papers for the present Semester:					01									
Minimum Courses/Papers for the present Semester:					01									
Maximum marks for the present Semester:					300									
Minimum marks for the present Semester:					00									
Total Credits for the present Semester:					NIL									
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week [Credit*]	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/ IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks	
1	Electrical Engineering	Core Compulsory	ME Dissertation (ELE2402)	NA		Project	Dissertation	UA	300	--	300	120	UA=300	
								IA	--	--				



FACULTY OF TECHNOLOGY AND ENGINEERING
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA VADODARA
Department of Electrical Engineering
2 year Post Graduate Course
ME ELECTRICAL (Electrical Power Engineering)

Part I

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME Electrical (Electrical Power Engineering)

Programme Specific Outcome(PSO)

- PSO1 Students will be able to apply specialized knowledge in classical as well as modern topics in the broad field of power systems, electrical drives, protection and highvoltage engineering, enabling post graduates to analyse, design, operate and integrate electrical systems.
- PSO2 Students will be able to apply the knowledge of ethical and management practices required to work in a team as well as a team leader.
- PSO3 To inculcate research attitude and life long learning in hard and soft skills.

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Syllabus of Courses

 सत्यं शिवं सुन्दरम्		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Electrical Engineering		Academic Year			2021-2022				
M EElectrical Engineering (Electrical Power Engineering): Regular Programme											
Year	I	Core / Elective / Foundation Advanced Power Electronics		Credits / Hours per week			04 + 03				
Semester	I	Year of Introduction: 2021 Year of Syllabus Revision: NIL		Maximum Marks / Grade			100 + 50				
Mode of Transaction		Lectures and Laboratory									
Course Outcome (CO) CO1: Develop various DC to DC converters and resonant converters. CO2: Compare different configuration of Active Filters CO3 : Explain Various methods for speed control of Induction Motor CO4: Explain FACTS controller. CO5 : Evaluate HVDC System											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development(SD)	Relevance to Local (L)/ National (N)/ Regional (R)/ Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional



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									nal Ethics (PE)
1.	Bidirectional Power Converters: Bidirectional DC-DC Converter - Analysis and control Design. System description and comparison of Unidirectional and Bidirectional Buck Boost Converter. Model representation of the Bidirectional Converter. Comparison of "Average" and "Switched" Models. Single-loop control. The Bidirectional converter with Cascade Control. Applications.	12	20	3	CO1	PSO1	Emp, Ent, SD	G	ENV, PE
2.	Vector Control of I.M.: Field oriented (Vector) Control of 3 phase squirrel Cage induction motor - Controller scheme for the separately excited DC motor, the nested closed loop strategy, controlled quantities in vector control. Types of inverters suitable for vector control. Space vectors, stator current space vector, time variation of current space vectors. Transformation from the actual 3 phase machine to the equivalent 2 phase machine and vice-versa. Voltage space vector "and" flux linkage space vector. Rotor windings; transformation of space vector coordinates from one reference frame to another, Mutual inductance between stator and rotor circuits. Dynamic flux model. Implementation of vector-control.	08	15	5	CO3	PSO2			
3.	Static VAR Compensator: Static Var systems for Reactive Power Control in Electrical Energy System. Types of static Var systems using thyristor converters : i) Saturated reactor ii) Thyristor controlled reactor (TCR) iii) thyristor switched capacitor (TSC) iv) Combined TCR and TSC compensator v) Thyristor controlled series compensator vi) static phase shifters (SPS) vii) Static condensers (StatCom).	10	20	5	CO4	PSO2			
4.	High Voltage DC Transmission (HVDC): Role of HVDC, traditional role of HVDC, New role of HVDC. Design of different converters & inverters. Modes of operation of rectifiers & inverters. HVDC Control system and their characteristics. Modelling of HVDC system. Types of HVDC links, reactive power requirement & filtering.	08	15	5	CO5	PSO2			
5.	Resonant inverters: Series resonant inverters with unidirectional and bidirectional switches. Full bridge inverters with bidirectional switches. Frequency response for series loaded, parallel loaded and	08	30	3	CO1	PSO2			

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	series parallel loaded. Parallel resonant inverters, class E resonant inverters. Resonant DC-link inverters. Multilevel inverters								
6.	Active filters: Requirement of active filters, types of active filters, their implementation. Harmonic survey and solution for active filters. Quality monitoring using wavelet transform.	06	15	5	CO2	PSO2			
Reference Books									
1.	Power Semiconductor Controlled drives by G K Dubey-Prentice Hall Incorporation								
2.	Thyristor Control of AC motors by J.M.D. Murphy-Prgamon Press								
3	Fundamentals of Electrical Drives-G K Dubey-Narosa Publishing House								
4.	Thyristor DC Drives - P.C. Sen - John Wiley & Sons.								
5.	Analysis of thyristor power conditioned motor by S.K. Pillai University Press								
6.	Power-Electronics and motor cpntrol by W. Shepherd Cambridge University Press								
7.	Power Electronics by M.H.Rashid								

Laboratory : 10-12 Simulation/Experiments based on syllabus contents

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Electrical Engineering	Academic Year	2021-2022
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M. E. (Electrical)(Electrical Power Engineering): Regular Programme										
Year	I	Computational Methods in Power System Analysis	Credits / Hours per week				04+ 03			
Semester	I	Year of Introduction: 2021 Year of Syllabus Revision: NIL	Maximum Marks / Grade				100 + 50			
Mode of Transaction		Lectures and Laboratory								
Course Outcome (CO) CO1 Choose numerical methods for solving power system problems/equations CO2 Discuss methods to exploit the sparse nature of power system matrices and their applications in power system analysis CO3 Develop algorithms and computer methods to solve load flow and optimal load flow problems CO4 Explain concept of power system security and function of energy control centers and use of computers in their functioning CO5 Formulate mathematical models and algorithms to estimate power system behavior using computers										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/ Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics (PE)
1.	Linear System Solvers: Gauss Elimination, LU Decomposition, Conjugate Gradient Method, Iterative Methods		08	15	6	CO1 CO2	PSO1 PSO3	SD	G	PE
2.	Nonlinear Systems of Equations: Newton Raphson Method, Convergence Properties, Continuation Methods, Power System Applications – Power Flow, Decoupled Power Flow		10	20	6	CO1 CO2 CO3 CO4 CO5	PSO1 PSO3	SD	G	PE

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3.	Sparse Matrix Solution Techniques: Sparsity Storage Schemes, Power System Applications	08	15	6	CO1 CO2 CO5	PSO1 PSO2 PSO3	SD	G	PE
4.	Short Circuit Studies: Bus Impedance Matrix Algorithm(s), Fault Analysis	08	15	6	CO1 CO5	PSO1 PSO3	SD	G	PE
5.	Optimization: Least Square State Estimation, Linear Programming, Nonlinear Programming, Power System Applications – Optimal Power Flow	10	20	6	CO1 CO3 CO4	PSO1 PSO2 PSO3	SD	G	PE
6.	Numerical Integration: Euler's Method, Runge-Kutta Method, Differential Algebraic Equations, Applications to Power System Stability Analysis	08	15	6	CO1 CO3 CO4 CO5	PSO1 PSO2 PSO3	SD	G	PE

Reference Books

1.	Computer Methods in Power System - Stagg and El Abiad
2.	Computational Methods for Electric Power Systems – Mariesa Crow
3.	Computer Techniques in Power System Analysis - M A Pai, DheemanChaterjee
4.	Computer Aided Power System Analysis by R N Dhar
5.	Advance Power System Analysis and Dynamics by L P Singh
6.	Energy Systems Theory by O I Elgerd

Laboratory : 10-12 Simulation based on syllabus contents.

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	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Electrical Engineering	Academic Year	2021-2022							
MEElectrical Engineering (Electrical Power Engineering): Regular Programme										
Year	I	Core / Elective / Foundation Computations of Fields	Credits / Hours per week					04 + 03		
Semester	I	Year of Introduction: 2021 Year of Syllabus Revision: NIL	Maximum Marks / Grade					100 + 50		
Mode of Transaction		Lectures and Laboratory								
Course Outcome (CO) CO1 Give Opinion for Electromagnetic and Electrostatic Fields CO2 Explain fundamentals of Field Analysis and different methods of field analysis CO3 Formulate Finite Element Analysis for given task. CO4 Create system to solve electrical engineering problems based on magnetic approach of FEM. CO5 Design system for electrical engineering problems based on electrostatic approach of FEM CO6 Criticize Advanced FEM and couple field solution for the system contains electrical engineering problems.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professionalism

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									nal Ethics (PE)
1.	Fundamentals of Electromagnetic and Electrostatic Fields	08	20	5	CO1	PSO1 PSO3	Emp, Ent, SD	G	ENV, PE
2.	Fundamentals of Field Analysis, Different Methods of Field Analysis	13	20	5	CO2	PSO1 PSO3			
3.	Introduction of Finite Element Method , Terminology, Methodology	13	20	6	CO3	PSO1 PSO3			
4.	FEM for Magnetics and It's application to Electrical Engineering Problems	07	15	6	CO4	PSO1 PSO2 PSO3			
5.	FEM for Electrostatics and It's application to Electrical Engineering Problems	07	15	6	CO5	PSO1 PSO2 PSO3			
6.	Advanced Finite Element Method, Introduction to coupled field solution of the system contains electrical engineering problems.	04	10	5	CO6	PSO1 PSO2 PSO3			

Reference Books

1.	Fundamentals of Electromagnetics by Mathew N O Sadiku
2.	Electrical Machine Analysis using Finite Elements by Nicola Bianchi
3.	Field Theory Concepts by Adolf J. Schwab, Springer Publication
4.	The Finite Element Method in Electromagnetics by Jian-Ming Jin, IEEE Press, Wiley Publication
5.	Numerical Methods for Partial Differential Equations by Sandip Mazumder, Elsevier Publication
6.	Methods for Electromagnetic Field Analysis by Ismo V. Lindell, IEEE Press
7.	MATLAB Based Finite Element Programming in Electromagnetic Modeling by Ozlem Ozgun Mustafa Kuzuoglu, CRC Press, Taylor & Francis Group
8.	Theory and Computation of Electromagnetic Fields by Jian-Ming Jin, IEEE Press, Wiley Publication
9.	The Finite Element Method for Electromagnetic Modeling by Gerard Meunier, Wiley Publication
10.	The Finite Element Method and Applications in Engineering using ANSYS by Erdogan Madenci and Ibrahim Guven, Springer Publication
11.	Numerical Solution of Differential Equations by Zhilin Li, Zhonghua Qiao and Tao Tang, Cambridge University Press



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12.	Computational Electromagnetics with MATLAB by Mathew N. O. Sadiku, CRC Press, Taylor & Francis Group
13.	The Electromagnetics through the Finite Element Method by Jose Roberto Cardoso, CRC Press, Taylor & Francis Group
14.	Numerical Modelling and Design of Electrical Machines and Devices by K. Hameyer and R. Belmans, WIT Press
15.	Harmonic Balance Finite Element Method by Junwei Lu, Xiaojun Zhao and Sotoshi Yamada, IEEE Press, Wiley Publication
16.	Finite Difference Time Domain Method for Electromagnetics with MATLAB Simulations by Atef Z. Elsherbeni and Veysel Demir, Scitech Publishing
17.	Different IEEE Journalson Computations of Fields

Laboratory : 10-15 Simulation/Experiments based on syllabus contents

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	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Electrical Engineering	Academic Year	2021-2022							
ME (Electrical Power Engineering): Regular Programme										
Year	I	Core / Elective / Foundation Power System Stability and Control	Credits / Hours per week					04		
Semester	I	Year of Introduction: 2021 Year of Syllabus Revision: NIL	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) CO1 Propose performance of generator connected to infinite bus with advance features CO2 Develop criteria for different power system stabilities CO3 Determine voltage stabilities CO4 Evaluate the system performance using Eigen Properties CO5 Estimate the system stability by energy function method										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics

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									(PE)
1.	Generator connected to Infinite Bus Small signal analysis. Linearization. Flux decay and Rotor-angle transfer functions. Closed loop analysis Root-locus diagrams. Small signal stability in presence of fast acting exciter voltage regulator. Power System stabilizer. Root locus analysis	09	15	6	CO1	PSO1 PSO3	Emp, Ent & SD	G	HV & PE
2.	Synchronous machine modeling, Synchronous machine modeling in d-q reference frame, Per unit system for Synchronous machine	07	10	6	CO2	PSO1 PSO2 PSO3			
3.	(a) Transient stability (Angle-stability) of multimachine system for large disturbances. Computer based algorithms for delta and omega trajectories for first swing computations. (b) Midterm & Long term transient stability analysis. 'Unstability' in subsequent cycles : effect of Generation controllers. Simulations & solution techniques.	14	25	6	CO2	PSO1 PSO2 PSO3			
4.	Voltage Stability : Basic Concepts : Classification. Static & dynamic voltage stability P-IVI, Q-IVI curves. Reverse effect of O.L.T.C.. Continuation power flow. Stability margins. Local & global bi-furcation. Voltage collapse.	06	10	5	CO3	PSO1 PSO2 PSO3			
5.	Further Topics on small signal analysis : State space representation. Linearization Analysis of stability. Eigen properties of state Matrix. Modal Matrices. Computation of eigen values & participation factor. Controllability & observability. Complex frequency. Eigen properties & transfer function. Illustration of application to single machine-infinite bus system.	08	20	5	CO4	PSO1 PSO3			
6.	Energy function methods. Physical and mathematical aspects. Lyspunov's method. Modelling issues. Energy function formulation. Potential energy boundary surface.	08	20	6	CO5	PSO1 PSO2 PSO3			

Reference Books

1	Power System Dynamics and Stability by P.W. Sauer and M.A. Pai. – PHI
2	Power System Analysis by Stevenson.
3	P. Kunduv – Power System Stability & Control – TMH
4	K.R. Padiyar - Power System Dynamics, Stability & Control



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5	Anderson and - Power System Stability and Control.
6	Modern Power System Analysis by Nagraath & Kothari
7	Voltage Stability of Electric Power Systems by T V Cutsem and Costas Vournas
8	Computational Techniques for Voltage Stability Assessment and Control, Power Electronics and Power Systems Series by Venkataramana Ajjarapu

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 सत्यं शिवं सुन्दरम्	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Electrical Engineering		Academic Year		2021-22					
ME Electrical (Electrical Power Engineering): Regular Programme										
Year	I	Core / Elective / Foundation Smart Grid	Credits / Hours per week				04			
Semester	I	Year of Introduction: 2021 Year of Syllabus Revision: NIL	Maximum Marks / Grade				100			
Mode of Transaction		Lectures								
Course Outcome (CO) CO1 Explain smart grid. CO2 Estimate control and automation methods in power system. CO3 Develop smart grid infrastructure frame work. CO4 Formulate smart substation, transmission and distribution practices. CO5 Propose smart grid application.										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics

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									(PE)
1.	What is Smart grid, drivers, Functionalities and key components of smart grid, smart grid maturity model	06	10	5	CO1	PSO1 PSO2 PSO3	Emp, SD	G	HV & PE
2.	Control and Automation Technologies, Smart metering-Architecture and technologies, interoperability, relevance of M2M communications in power sector and conceptual description, communication technologies and standards available for use in power sector, global frequency spectrum allocation, PLC communication Technologies, Application of M2M /IOT in power sector, cyber security	14	30	6	CO1 CO2	PSO1 PSO2 PSO3			
3.	Elements of Smart Grid, large scale renewable energy integration, power quality, microgrids, mini grids, low voltage DC grids, Energy storage Technologies, application and role of ES in power system, Electric vehicles and vehicle grid integration, energy efficiency and demand response ,Acts and regulations, demand side management, demand response, energy efficiency initiatives	16	30	6	CO1 CO2 CO3	PSO1 PSO2 PSO3			
4.	Smart substation, Transmission system and distribution	10	20	6	CO1 CO2 CO3 CO4	PSO1 PSO2 PSO3			
5.	Smart grid projects and regulations, Smart grid for smart cities	06	10	6	CO1 CO3 CO4 CO5	PSO1 PSO2 PSO3			

Reference Books

1.	Smart Grid Fundamentals & Applications – by I S JHA, Subir Sen, Rajesh Kumar and D P Kothari
2.	Smart Grid Controls -Overview and research opportunities- By JakobStoustrup, A. Annaswamy, A. Chakraborty, Dr. Zhihua Qu(Springer 2019)
3.	Smart Grid- Fundamentals and Technologies in Electric power system of the future- by Buchholz Bernd M, StyczynskiZbigniew (2020)
4.	Smart Grid Handbook – Forregulators and policy makers – ISGF
5.	Smart Grid Fundamentals of design and Analysis – Wiley IEEE press



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Part II

Bloom's Taxonomy Levels: 1. Remember 2. Understand 3. Application 4. Analysis 5. Evaluation 6. Creation

Programme Name: ME Electrical (Electrical Power Engineering)

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- PSO2 Students will be able to apply the knowledge of ethical and management practices required to work in a team as well as a team leader.
- PSO3 To inculcate research attitude and life long learning in hard and soft skills

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Syllabus of Courses

	The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Electrical Engineering		Academic Year		2021-22						
ME (Electrical Power Engineering): Regular Programme											
Year	I	Core / Elective / Foundation Advanced Power System Protection		Credits / Hours per week				04 + 03			
Semester	II	Year of Introduction: 2021 Year of Syllabus Revision: NIL		Maximum Marks / Grade				100 + 50			
Mode of Transaction		Lecturesand Laboratory									
Course Outcome (CO) CO1 Distinguish over current, earth fault and directional relay operation, their construction to design different protection schemes CO2 Develop Distance characteristics for various applications of power system using Numerical Algorithms. CO3 Discover pilot relaying principles for transmission line protection to design travelling wave relay. CO4 Predict power system equipment protection with differential relays. CO5 Plan power system protection with frequency and voltage relays CO6 Estimate CT, PT behavior to design modern CT, PT. based on EMTP software. CO7 Application of Evolutionary Programming to Power System Protection											
Unit No.	Topic			Contact Hours	Weightag (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship	Relevan ce to Local (L)/ National (N)/ Regional	Relatio n to Gender (G), Environ ment and Sustain



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							(Ent)/ Skill Develop ment (SD)	(R)/Glob al (G)	bility (ES), Human Values (HV)and Professio nal Ethics (PE)
1.	Review of Evaluation and need of protective relays, primary and back-up protection, classification of relays, Summation transformer, Operating principle and relay construction. EM, Static and numerical relays: motivation, basic hardware, Over current relays, various o/c relay characteristics, current and time setting calculation, o/c protective schemes, directional o/c relays using E. magnetic static and up based Earth fault and phase fault protection, directional earth fault relay.	08	10	4	CO1	PSO1 PSO3	Emp, Ent & SD	G	HV & PE
2.	Various distance protection schemes using X, Z, Y offset, angle-impedance relays using E. m., Static and μ p based relays with the help of A.C. and P.C., Polarized quantity sampling comparator for X, Y, offset mho Ch, effect of load variation R_f and power swing on performance of distance relays, out of step tripping and blocking relays, effect of line length and source impedance, selection of distance relays, quadrilateral relay, Elliptical relay, restricted X, Y and Z relays, specially distance schemes Review of digital signal processing and FPGA techniques: sampling, aliasing, courier, etc. Digital relaying algorithms, Numerical algorithms discrete Fourier transform technique, Walsh-Hadamard transform technique, discrete Fourier transforms and fast Fourier transforms wavelet transform etc. Concept of Adaptive Decision Schemes and Wide area Protection	10	15	4,6	CO1 CO2	PSO1 PSO3			
3.	Circulating and balanced voltage schemes, carrier aided and acceleration distance protection, Travelling waves relay	08	20	6	CO1 CO2 CO3	PSO1 PSO2 PSO3			
4.	Synchronous gen. protection, Power transformer protection, Bus zone protection, Induction motor protection	06	15	3	CO1 CO4	PSO1 PSO2			

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						PSO3			
5.	Protection of system against voltage collapse ,Over frequency & under frequency detection, load shedding & load Restoration phenomena, digital & static frequency relays & df/dt relays	06	15	6	CO1 CO5	PSO1 PSO2 PSO3			
6.	C.T., Accuracy, burden, Transient behavior of C.T., C.T and P.T. equivalent circuit, Modern Design and construction of C.T. and P.T. CT/PT modelling and standards, simulation of transients, electromagnetic transient program (EMTP).	08	15	6	CO1 CO6	PSO1 PSO2 PSO3			
7.	Application of Artificial Neural Networks, Fuzzy logic, Evolutionary Algorithm for PSP. Expert systems and Hybrid Schemes.	06	10	6	CO1 CO7	PSO1 PSO3			
Reference Books									
1	Digital Signal Processing in Power System Protection And Control-by Waldemar Reblzant, JanuszSzafran and Andrzej Wiszniewski(Springer)								
2	Digital Protection - L.P. Singh								
3	Power System Protection and Switchgear by Badriram and Vishwakarma, second edition								
4	Digital Power System Protection - Ravindra P. Singh								
5	Fundamentals of Power System Protection – Y.G. Paithankar, S.R. Bhide								
6	Power System Protection and Switchgear by Ravindranath and Chander								
7	Protective Relays their Theory and Practice Vol-I and II by A.R. Van C. Warrington								

Laboratory : 8-12 Experiments/Simulations based on syllabus contents.

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		The Maharaja Sayajirao University of Baroda Faculty Technology and Engineering Department of Electrical Engineering		Academic Year			2021-2022				
M. E. (Electrical Engineering): Regular Programme											
Year	I	Core / Elective / Foundation Deregulated Electricity Markets		Credits / Hours per week			04				
Semester	II	Year of Introduction: 2021 Year of Syllabus Revision: NIL		Maximum Marks / Grade			100				
Mode of Transaction		Lectures									
Course Outcome (CO) CO1 Explain market models in deregulated power systems and their working CO2 Discuss the behavior of various market players in participating in power markets CO3 Elaborate on the complexities arising in transmission of power in an open access era CO4 Explain the need of ancillary services in operating and maintaining electrical power systems CO5 Explain concept of power system security and function of energy control centers and use of computers in their functioning in deregulated markets											
Unit No.	Topic			Contact Hours	Weightage (%)	BT Level	CO	PSO	Elements of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional(R)/ Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV) and Professional Ethics (PE)
1.	Fundamentals of restructured power systems: Need for restructuring, market structures and participants, wholesale and retail competition			06	15	6	CO1	PSO1 PSO2 PSO3	SD	G	PE



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2.	Basic Concepts of Economics: – Demand, Supply, Inverse Demand and Supply functions, Modeling the Consumers and producers, Elasticity of supply, market equilibrium	06	10	6	CO1 CO2	PSO1 PSO2 PSO3	SD	G	PE
3.	Markets for Electrical Energy: Market mechanisms, Spot market	10	20	6	CO1 CO3	PSO1 PSO2 PSO3	SD	G	PE
4.	Participating in markets for electricity: Participants' perspective, Perfect and imperfect competition, market power	10	20	6	CO1 CO4	PSO1 PSO2 PSO3	SD	G	PE
5.	Transmission Networks and Electricity Markets: Centralized trading, transmission congestion – management and pricing, Nodal pricing, Financial Transmission Rights, Transmission pricing	14	25	6	CO1 CO5	PSO1 PSO2 PSO3	SD	G	PE
6.	Ancillary Service Management: Types of ancillary services, Reactive power as an ancillary service, market-based mechanisms for ancillary services	06	10	6	CO1 CO5	PSO1 PSO3	SD	G	PE

Reference Books

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| 1. | Understanding Electric Utilities and Deregulation – Lovin Philipson, H. Lee Wills |
| 2. | Power System Restructuring and Deregulation – Loi Lee Lai |



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3.	Fundamentals of Power System Economics – Kirschen and Strabac
4.	Power System Restructuring – Marija Ilic
5.	Operation of Restructured Power System – K. Bhattacharya, Daadler, Bollen

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MEElectrical Engineering (Electrical Power Engineering): Regular Programme										
Year	I	Core / Elective / Foundation High Voltage Technology	Credits / Hours per week				04 +03			
Semester	II	Year of Introduction: 2021 Year of Syllabus Revision: NIL	Maximum Marks / Grade				100 + 50			
Mode of Transaction		Lectures and Laboratory								
Course Outcome (CO)										
CO1 Interpret the breakdown mechanism of different dielectric medium; partial discharge and techniques to identify the behavior PD										
CO2 Criticize different methods of pulse power, measurement and diagnostic technologies for different application related to high voltage applications.										
CO3 Design electromagnetic launcher.										
CO4 Appraise the performance of Insulation under different condition and it's system design used for Power Apparatus and Components.										
CO5 Explain different application of high voltage engineering in industry, safety features and electrostatic hazards.										
CO6 Formulate electrical transients in power system .										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional

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									Ethics (PE)
1	Review of Breakdown Mechanisms of Different Dielectrics : Introduction- Dielectrics -Properties and Factors affecting the performance of Breakdown-Breakdown Mechanisms -Total And Partial Breakdown -Insulation Characteristics of Long Air Gap	04	10	5	CO1	PSO1 PSO2 PSO3	SD	G	PE
2	Insulation System Design of Power Apparatus and Components : Introduction -Insulating Materials for Various Electric Machines - Design Requirements -Insulation Design of Insulators and Outdoor Insulators, Bushings, Capacitors, Power Transformer, Instrument Transformer, Cable Joints, Surge Arrestors and Diverters	05	08	5	CO4	PSO1 PSO2 PSO3			
3	Pulse Power Engineering : Introduction -Pulsed Electric Fields and their behavior in Different Dielectrics -Energy Storage Devices -Pulse Generating Devices - Switching Devices -Pulse Forming Networks -Pulse Transmission and Transformation -Power and Voltage Adding -Measurement Techniques of Pulsed Power Apparatus -Pulsed Power Applications	07	10	5	CO2	PSO1 PSO2 PSO3			
4	Electromagnetic Launchers : Introduction, Comparison between Conventional Launchers and Electromagnetic Launchers, Construction, Working and Design of : Coilgun, Railgun, Thomson Actuators, Hybrid Launchers, Different Novel Launchers.	05	10	6	CO3	PSO1 PSO2 PSO3			
5	Measurement and Diagnostic Technologies : Introduction, Digital Impulse Recorders, Digital Techniques in HV tests, Testingautomation, Electric field measurement, Electro-optic Sensors, Magneto-opticSensors, Measurement of very fast transients in GIS, Space charge measurementtechniques, electro-optical imaging techniques, Non Destructive Testing of Electrical Apparatus, Dielectric Constant Measurement, Capacitance and Tan Delta Measurement, DC Resistivity Measurement, SFRA	06	10	5	CO2	PSO1 PSO2 PSO3			



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6	Application of High Voltage Engineering In Industry : Introduction, electrostatic applications- electrostatic precipitation, separation , painting /coating, spraying ,imaging ,printing ,Transport of materials, Sandpaper Manufacture, Smoke particle detector, Electrostatic spinning ,pumping , propulsion , Ozoneration, Biomedical applications, Plasma-based applications: Ion Beam accelerators, Ion nitriding for surface hardening of materials, Ion thrusters for space applications. Nuclear electro-magnetic Pulse simulation, High voltage sources for Cathode ray oscilloscopes & electron microscopes -LASER Applications	04	08	5	CO5	PSO1 PSO2 PSO3			
7	Safety And Electrostatic Hazards : Introduction, Nature of static electricity, Triboelectric series, Basic laws of Electrostatic electricity, materials and static electricity, Electrostatic discharges (ESD), Static electricity problems , Hazards of Electrostatic electricity in industry, Hazards from electrical equipment and installations, Static eliminators and charge neutralizers, Lightning protection.	04	08	5	CO5	PSO1 PSO2 PSO3			
8	Pollution and Contamination Performance of Power Apparatus and Systems : Introduction, Artificial Testing, Performance of Insulators, Surge Arrester & Diverters and Indoor Equipment	03	06	5	CO4	PSO1 PSO2 PSO3			
9	Electric Transients in Power System : Introduction , Travelling Waves on Transmission Line, Computation of Power System Transients, Lightning, Switching and Temporary Over Voltages, Behavior of Winding and its Parameter Under Transient Condition, Insulation Coordination of EHV and UHV Transmission Systems, Solution Techniques for Electromagnetic Transients in Power System, Digital Simulation of Electric Transients in Power System	10	20	6	CO6	PSO1 PSO2 PSO3			
10	Partial Discharge : Introduction, Types, Discharges under different condition, PD Detection, PD Measurement, Localization of PD, PD Detection in	04	10	5	CO1	PSO1 PSO2 PSO3			



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	Actual Specimen, PD Analysis								
Reference Books									
1.	Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-Hill Publishing Company Ltd., 5th Edition, New Delhi, 2013.								
2.	High Voltage and Electrical Insulation Engineering by Ravindra Arora and Wolfgang Mosch, IEEE Press, Wiley Publication								
3.	Kuffel E., Zaengl W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsevier India Pvt. Ltd, 2005								
4.	Partial Discharge in HV Equipment by F. Kruguer, Butterworths & Co, Publications Ltd 1989								
5.	Pritindra Chowdhari, “Electromagnetic Transients in Power Systems”, PHI Ltd. 2nd Edition, New Delhi, 2012.								
6.	Indulkar, C. S., Kothari, D. P., Ramalingam, K., “Power System Transients: A Statistical Approach”, Prentice Hall of India Limited, New Delhi, 2nd Edition, 2012.								
7.	N. Watson and J. Arrillaga, Power Systems Electromagnetic Transients Simulation (Energy Engineering), IET								
8.	Akihiro Ametani (Ed), Numerical Analysis of Power System Transients and Dynamics, IE								
9.	Pulsed Power Engineering by Professor Dr.Hasjoachim Bluhm.								
10.	High Voltage Engineering Practice and Theory. Dr. Holtzhausen J.P. Dr. Vosloo W.L. 2nd Ed. Newnes. 2014.								
11.	Introduction to High Power Pulse Power Technology by S.T. Pai and Qi Zhang, World Scientific.								
12.	Dr. P.H. Ron’s Notes on Pulse Power Technology.								
13.	Traveling waves of Transmission systems – by LV Bewley.								
14.	Insulation Co-ordination ELBS in H.V. Electrical Power Systems by W. Diesendorf, Butter worth publications, London, 1974.								
15.	Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, (Second edition) Newage International (P) Ltd., New Delhi, 1990.								
16.	Thapar B., Power System Transients and High Voltage Principles , Capital Pub.								
17.	P. Gill, Electrical Power Equipment Maintenance and Testing, 2nd edition, CRC Press, 2008.								
18.	N.H.Malik, A.A.Ai-Arainy, M.I.Qureshi, “Electrical Insulation in power systems”, Marcel Dekker, inc., 1998.								
19.	A. Greenwood, Electrical transients in power systems, 2nd edition, New York: Wiley Interscience, c1991.								
20.	Transmission Line Reference book 345 kV and above, EPRI, Palo Alto, USA, 1982								
21.	Ravi S Gorur, Edward Cherney and Jeffrey Burnham, “Outdoor Insulators”, text book, Phoenix, Arizona, USA 1999.								
22.	Bradwell A, “Electrical Insulation”, text book, Peter Peregrinus Ltd, London, UK, 1983								
23.	G.V. Barbosa –Canovas , “Pulsed electric fields in food processing: Fundamental aspects and applications” CRC Publisher Edition March 1 2001.								
24.	Surge phenomena in electrical machines by Bedrich Heller, A.								
25.	Shoait Khan, “ Industrial Power System”, CRC Press, Taylor & Francis group, 2008.								
26.	H L M Lelieveld and Notermans.S,et.al., “Food preservation by pulsed electric fields: From research to application”, Woodhead Publishing Ltd. October 2007.								
27.	Kind and Karner, “High Voltage Insulation”, Translated from German by Y.Narayana Rao, Frider. Vieweg, & Sohn, Braunschweig, Weishaden, 1985.								
28.	Dieter Kind and Kurt Feser, “High Voltage Test Techniques”, Second Edition, SBA Electrical Engineering Series, New Delhi, 1999.								
29.	Looms, J.S.T., “Insulators for High Voltages”, Peter Peregrinus Ltd., London,1988.								



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30.	Working Group 33/13-09 (1988), 'Very fast transient phenomena associated with Gas Insulated System', CIGRE, 33-13, pp. 1-20.
31.	H.M. Ryan (ed.), High Voltage Engineering and Testing, 2nd edition, London: Institution of Electrical Engineers, c2001.
32.	R.E. James and Q. Su, Condition Assessment of High Voltage Insulation in Power System Equipment, IET, 2008.
33.	Recent IEEE Journals, CIGRE publications and Standards.

Laboratory : 8-12 Experiments/ Simulations based on syllabus contents.

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M EElectrical Engineering (Electrical Power Engineering): Regular Programme									
Year	I	Core / Elective / Foundation Reactive Power and Voltage Control	Credits / Hours per week	04					
Semester	II	Year of Introduction: 2021 Year of Syllabus Revision: NIL	Maximum Marks / Grade	100					
Mode of Transaction		Lectures							
Course Outcome (CO) CO1 Outline Reactive power control basics to predict power transmission system performance. CO2 Rate Reactive power control methods and their performance on transmission lines CO3 Design FACT devices component, their modelling, and application. CO4 Predict Compensation, filters requirements with respect to disturbance, harmonics. CO5 Plan Reactive Power Management.									
Unit No.	Topic	Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employability (Emp)/ Entrepreneurship (Ent)/ Skill Development (SD)	Relevance to Local (L)/ National (N)/ Regional (R)/Global (G)	Relation to Gender (G), Environment and Sustainability (ES), Human Values (HV)and Professional Ethics



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									(PE)
1.	Power System Concepts of Reactive Power; Need for its control.	01	2	2	CO1	PSO1 PSO2	Emp, Ent, SD	G	ENV, PE
2.	Theory of Steady State Reactive Power Control in Electric Transmission systems. Fundamentals of V-Q analysis and control, Study of various line compensation techniques, series, shunt (Passive or active), Composite series and shunt Load Compensation, Load Symmetrizing, P. F. correction	07	15	2,5	CO1 CO2	PSO1 PSO2			
3.	Reactive Power Compensation and Dynamic performance of Transmission Systems. Effects of various reactive power control devices, sub synchronous resonance and methods of its control	05	10	2,5	CO1 CO2	PSO1 PSO2			
4.	Static and Dynamic Modeling of SVC and STATCOM, Static Series Compensator (TSSC, TCSC, SSSC), Static Voltage and Phase Angle Regulators (TCVR and TCPAR), D-STATCOM, Combined Compensators (UPFC, IPFC)	05	10	6	CO3	PSO1 PSO2 PSO3			
5.	Modeling of Static Var Systems and their control, Modeling of different SVS Configurations, Design of controllers, Voltage Controller, Auxiliary Controller, Applications of SVS, Improvement of dynamic stability with SVS alone, SVS with generator excitation control, Enhancement of transient stability, Damping of torsional oscillations, SVS for dynamic reactive power support at HVDC terminals, Load compensation, Specifications of SVS	08	20	6	CO3	PSO1 PSO2 PSO3			
6.	Compensation performance under system disturbance: Small perturbations, Abnormal conditions (faults, load rejections etc., overloads (Temporary over voltages).	05	10	6	CO4	PSO1 PSO2 PSO3			
7.	System Studies: Stability studies, dynamic behavior studies, control system verification, dynamic performance evaluation, overvoltage control	05	10	6	CO4	PSO1 PSO2 PSO3			
8.	Harmonics and Filters : Harmonic generation in SVS, deleterious effects of harmonics, filter systems, design of filters	06	15	6	CO4	PSO1 PSO2 PSO3			
9.	Reactive Power Management: Placement of SVS in power systems, discussion of methodology of reactive power Planning with a case	03	08	6	CO5	PSO1 PSO2			



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	study.					PSO3			
Reference Books									
1.	T.J.E. Miller : Reactive Power Control in Electric Systems - Wiley Inter science, 1982								
2.	R.M. Mathur : Static compensation for reactive power control, Cantext publications, Winnipeg, CANADA - 1984								
3	IEEE Tutorial : Reactive Power : Basics, Problems and Solutions, IEEE Power Engg Society, 1987								
4.	IEEE Tutorial : Power Electronics Applications in Power Systems, IEEE Power Engg, Society - 1978								
5.	IEEE 1976 winter : Analysis and Control of Sub synchronous Meeting & Tesla Resonance Symposium Publication								
6.	Research Papers in Technical Journals.								
7.	Understanding Facts, by N G Hingorani & Laszlo Gyugyi								
8.	FACTS Controllers in Power Transmission & Distribution by K.R. Padiyar								
9.	R. Mohan Mathur and Rajiv K. Varma, "Thyristor Based FACTS Controller for Electrical Transmission Systems", Wiley Interscience Publications, 2002								

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ME Electrical Engineering (Electrical Power Engineering): Regular Programme										
Year	I	Core / Elective / Foundation Synchronized Phasor Measurement and Applications	Credits / Hours per week					04		
Semester	II	Year of Introduction: 2021 Year of Syllabus Revision: 2023	Maximum Marks / Grade					100		
Mode of Transaction		Lectures								
Course Outcome (CO) CO1 Explain fundamentals related to Synchronized Phasor Measurement Techniques. CO2 Determine the parameter related to Phasor Measurement. CO3 Plan Phasor measurement unit and Phasor Data Concentrator for wide area measurement in power system										
Unit No.	Topic		Contact Hours	Weightage (%)	BT Level	CO	PSO	Element s of Employa bility (Emp)/ Entrepre neurship (Ent)/ Skill Develop ment (SD)	Relevan ce to Local (L)/ National (N)/ Regional (R)/Glob al (G)	Relation to Gender (G), Environ ment and Sustaina bility (ES), Human Values (HV)and Professio nal Ethics (PE)

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1.	Introduction: Historical Background, Need of Synchronized Phasor Measurement, Synchronized Phasor Technologies, Recent Trends	14	25	5	CO1	PSO1 PSO2 PSO3	SD	G	PE
2.	Estimation: Phasor Estimation based on Frequency, State Estimation, Optimal PMU placement Technique, Phasor Measurement Units and Phasor Data Concentrators	12	25	5	CO2 CO3	PSO1 PSO3			
3.	WAMS and PMU: WAMS architecture, Sensors for PMUs, Hardware for PMU and PMU Integration, PMU Architecture, Monitoring, detection, and correction using synchro phasor Measurements	16	30	6	CO2 CO3	PSO1 PSO3			
4.	Phasor Measurement Applications: Protection System based on Phasor Inputs, Wide Area Measurement Systems & Application, Examples of WAMS, Stability Monitoring and Assessment	10	20	6	CO3	PSO1 PSO2 PSO3			
Reference Books									
1.	Synchronized Phasor Measurements for Smart Grids by D.K.Mohanta and M.Jaya Bharata Reddy								
2.	Synchronized Phasor Measurements and Their Applications by Arun G Phadke and James S Thorp, Springer Publication								
3.	Application of Time-Synchronized Measurements in Power System by MladenKezunovic, SakisMeliopoulos, VaithianathanVenkatasubramanian, and Vijay Vittal Springer Publications								
4.	Phasor Measurement Units and Wide Area Monitoring Systems by Antonello Monti, Carlo Muscas and FerdinandaPonci, Academic Press, Elsevier Publication								
5.	Yong Li, Dechang Yang, Fang Liu, Yijia Cao, Christian Rehtanz, Interconnected Power Systems: Wide-Area Dynamic Monitoring and Control Applications, Springer, 2015								
6.	Ali Abur, Antonio Gómez Expósito, Power System State Estimation: Theory and Implementation, CRC Press, 2004								
7.	Ma J., Makarov Y., Dong Z, Phasor Measurement Unit and its Applications on Modern Power Systems, Springer, 2010								
8.	IEEE Power & Energy Society, IEEE Standard for Synchrophasor Data Transfer for Power Systems, IEEE New York, 2011								
9.	Xu B, Abur A, Optimal Placement of Phasor Measurement units for State Estimation, PSERC, Final Project Report, 2005								
10.	P. M. Anderson, A. A. Fouad, Power system control and stability, 2nd ed., John Wiley & Sons, 2008								
11.	P. Kundur, Power System Stability and Control, McGraw Hill, New York, 1994.								
12.	Muscas C, Pegoraro PA. Opportunities and challenges for PMU deployment in distribution systems.IEEE Smart Grid Newsl 2014:(July).								