SONA COLLEGE OF TECHNOLOGY, SALEM-5

(An Autonomous Institution)

M.E- Power Systems Engineering

(Dept of EEE)

CURRICULUM and SYLLABI

[For students admitted in 2025-2026]

PG Regulations 2023

Approved by BOS and Academic Council meetings

M.E-PSE
I

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E /M.Tech. Semester I under Regulations 2023 (CBCS)
Branch: Power Systems Engineering

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
	Theory courses									
1.	P23PSE101	Advanced Power System Analysis	3	0	0	0	3	PC	45	T
2.	P23PSE102	Electric and Hybrid Vehicles	3	0	2	0	4	PC	75	TL
3.	P23PSE103	High Voltage and Insulation Systems	3	0	0	0	3	PC	45	T
4.	P23PSE501	**Elective:** Power Quality	3	0	0	0	3	PE	45	T
5.	P23MAT501	**Elective:** Mathematical Methods for Power Engineering	2	1	0	0	3	PE	45	TT
6.	P23GE101	Research Methodology and IPR	3	0	0	0	3	PC	45	T
7.	P23GE701	**Audit Course:** English for Research Paper Writing	2	0	0	0	0	AC	30	T
	Practical courses									
8.	P23PSE104	Advanced Power System Simulation Laboratory	0	0	4	0	2	PC	60	L
Total Credits							**21**			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory,TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

Approved By

S.Padma	R.Shivakumar 12/9/25	J.Akilandeswari 14/9/25	
Chairperson, EEE– BoS	**Member Secretary, Academic Council**	**Dean-Academics**	**Chairperson, Academic Council & Principal**
Dr.S.Padma	**Dr.R.Shivakumar**	**Dr.J.Akilandeswari**	**Dr.S.R.R.Senthil Kumar**

Copy to:-

HOD/EEE, First Semester PSE Students and Staff, COE

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E /M.Tech. Semester II under Regulations 2023 (CBCS)
Branch: Power Systems Engineering

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
	Theory courses									
1.	P23PSE201	Modern Power System Protection	3	0	2	0	4	PC	75	TL
2.	P23PSE202	Power System Dynamics and Stability	3	0	0	0	3	PC	45	T
3.	P23PSE203	Restructured Power Systems	3	0	0	0	3	PC	45	T
4.	P23PSE506	**Elective:** Smart Grid	3	0	0	0	3	PE	45	T
5.	P23PSE511	**Elective:** Industrial Automation	3	0	0	0	3	PE	45	T
6.	P23GE702	**Audit Course:** Stress Management by Yoga	2	0	0	0	0	AC	30	T
	Practical courses									
7.	P23PSE204	Power Electronics Applied to Power Systems Laboratory	0	0	4	0	2	PC	60	L
8.	P23PSE205	Automation Laboratory	0	0	4	2	3	PC	90	LP
Total Credits							**21**			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory, TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

Approved By

Chairperson, Electrical and Electronics Engineering BoS	**Member Secretary, Academic Council**	**Dean-Academics**	**Chairperson, Academic Council & Principal**
Dr.S.Padma	**Dr.R.Shivakumar**	**Dr.J.Akilandeswari**	**Dr.S.R.R.Senthil Kumar**

Copy to:-

HOD/EEE, Second Semester M.E -PSE Students and Staff, COE

M.E-PSE
I

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E /M.Tech. Semester I under Regulations 2023 (CBCS)
Branch: Power Systems Engineering

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
	Theory courses									
1.	P23PSE101	Advanced Power System Analysis	3	0	0	0	3	PC	45	T
2.	P23PSE102	Electric and Hybrid Vehicles	3	0	2	0	4	PC	75	TL
3.	P23PSE103	High Voltage and Insulation Systems	3	0	0	0	3	PC	45	T
4.	P23PSE501	**Elective:** Power Quality	3	0	0	0	3	PE	45	T
5.	P23MAT501	**Elective:** Mathematical Methods for Power Engineering	2	1	0	0	3	PE	45	TT
6.	P23GE101	Research Methodology and IPR	3	0	0	0	3	PC	45	T
7.	P23GE701	**Audit Course:** English for Research Paper Writing	2	0	0	0	0	AC	30	T
	Practical courses									
8.	P23PSE104	Advanced Power System Simulation Laboratory	0	0	4	0	2	PC	60	L
Total Credits							**21**			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory,TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

Approved By

S.Padma	R.Shivakumar 12/9/25	J.Akilandeswari 14/9/25	
Chairperson, EEE– BoS	**Member Secretary, Academic Council**	**Dean-Academics**	**Chairperson, Academic Council & Principal**
Dr.S.Padma	**Dr.R.Shivakumar**	**Dr.J.Akilandeswari**	**Dr.S.R.R.Senthil Kumar**

Copy to:-

HOD/EEE, First Semester PSE Students and Staff, COE

ELECTRICAL AND ELECTRONICS ENGINEERING						
M. E. / POWER SYSTEM ENGINEERING						
SEMESTER - I	MATHEMATICAL METHODS FOR POWER ENGINEERING	L	T	P	J	C
P23MAT501		2	1	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	find the rank of the matrix and solve linear system of equations by direct and indirect methods.
CO2:	apply the concepts of eigenvalues and eigenvectors of a real matrix and their properties in diagonalization.
CO3:	find the power spectral density for the wide sense stationary process.
CO4:	apply the suitable methods to solve linear programming problem.
CO5:	apply the appropriate methods to solve nonlinear programming problem.

Pre-requisites:

- Basics of linear algebra
- Basics of calculus
- Basics of geometry
- Basics of statistics and probability

CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	3	3
CO2	3	3	2	3	3
CO3	3	3	2	3	3
CO4	3	3	2	3	3
CO5	3	3	2	3	3

Course assessment methods [Theory]

Direct		Indirect
CIE test I (10) (Theory) CIE test II (10) (Theory) CIE test III (10) (Theory) Assignment / Problem-solving / Seminar (10)	Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01	LINEAR SYSTEM OF EQUATIONS	9 Hours

Rank of a matrix – solution of linear system of equations by matrix method, Gauss elimination, Gauss – Jordan, Gauss – Jacobi and Gauss – Seidel methods.

Unit 02	EIGEN VALUES AND EIGEN VECTORS	9 Hours

Eigenvalues and eigenvectors – properties of eigenvalues and eigenvectors – Cayley-Hamilton theorem – diagonalization of symmetric matrices.

Unit 03	RANDOM PROCESSES	9 Hours

Classification of random processes – first order, second order, strictly stationary, wide-sense stationary processes – Auto correlation function and its properties – Power spectral density function and its properties.

Unit 04	LINEAR PROGRAMMING	9 Hours
Simplex algorithm – Big–M method – transportation problem – assignment problem.		
Unit 05	**NONLINEAR PROGRAMMING**	**9 Hours**
Formulation of nonlinear programming problem – constrained optimization with equality constraints – constrained optimization with inequality constraints – Kuhn-Tucker conditions with non-negative constraints.		

Theory: 30 Hrs	Tutorial: - 15 Hrs	Practical:	Project:–	Total Hours: 45 Hrs

TEXT BOOKS:

1. P. K. Gupta and D. S. Hira, "Problems in Operation Research", Sultan Chand and Sons Publishers, 4th Edition, 2015.
2. T. Veerarajan, "Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks", McGraw Hill Publishers, 4th Edition, 7th Reprint, 2018.
3. T. Veerarajan, "Linear Algebra and Calculus", McGraw Hill Publishers, 2019.

REFERENCE BOOKS:

1. H. A. Taha, "Operation Research: An Introduction", Pearson Publishers, 9th Edition, 2014.
2. M. K. Venkataraman, "Higher Mathematics for Engineering and Science", National Publishers, 2000.
3. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2018.

M.E/M.TECH REGULATIONS 2023	HEAD OF THE DEPARTMENT OF MATHEMATICS
S&H BoS DATE:08-07-2023	

Dr. S. JAYABHARATHI
ASSOCIATE PROFESSOR & HEAD
DEPARTMENT OF MATHEMATICS,
SONA COLLEGE OF TECHNOLOGY,
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Ph: 0427 - 4099999.

COURSE OUTCOMES:

At the end of the course, the students will be able to,

1. Compute solutions for large scale power systems using sparsity and optimal ordering schemes.
2. Analyze the power flow methods to find power flow solutions for various power networks.
3. Calculate the symmetrical and unsymmetrical fault parameters in typical power systems.
4. Carry out security assessment and enhancement procedures for various power networks.
5. Estimate the power system states using various techniques.

CO/PO, PSO Mapping (3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak COs Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)					
COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	3
CO2	2	3	3	3	3
CO3	2	3	3	3	3
CO4	2	2	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) (Theory) CIE test II (10) (Theory) CIE test III (10) (Theory)	Assignment / Problem –Solving /Seminar (10) Total CIE: **40 Marks** Semester End Examination : **60 Marks**	Course end survey

UNIT I SOLUTION TECHNIQUES 9

Sparsematrix techniques for large scale power systems- Optimally ordered Triangular Factorization- Triangular Decomposition- Gaussian Elimination- Triangular Decomposition of table of factors- Bi-factorization method- Sparsity and Optimal Ordering schemes- Comparative advantages for a sparse matrix.

UNIT II POWER FLOW SOLUTIONS 9

Power flow equation for "n" bus system-Overview of Gauss seidel and Newton Raphson method- Fast Decoupled power flow method- Power flow studies in system design and operation-Regulating Transformers.

UNIT III FAULT ANALYSIS 9

Types of faults- Transient on power system components- Symmetrical fault analysis using bus impedance matrix – Concepts in symmetrical components of unsymmetrical phasors- Sequence networks for various power system components- Unsymmetrical fault analysis in power systems.

UNIT IV SECURITY ANALYSIS 9

Factors affecting power system security - Security state diagram- Security assessment using Linear sensitivity factors- Generation shift and Line-outage distribution factors- Contingency analysis using sensitivity factors- Security enhancement by preventive, emergency and restorative control.

UNIT V STATE ESTIMATION 9

Introduction – Maximum Likelihood Weighted Least Squares Estimation-State Estimation of an AC network- State estimation by Orthogonal Decomposition algorithm- Detection and Identification of Bad measurements- Network Observability and Pseudo measurements- Application of power system state estimation.

Lecture: 45, Tutorial: 0, Total: 45 Hours

REFERENCE BOOKS:

1. John J. Grainger, William D. Stevenson, "Power System Analysis", Mc- Graw Hill, Reprint Edition, 2017.
2. Allen J Wood, Bruce F Wollenberg, "Power Generation and Control", John Wiley & Sons, New york, reprint edition, 2015.
3. M.A.Pai, "Computer Techniques in Power System Analysis", Tata McGraw- Hill publishing ltd, New Delhi, 2014.
4. P.Venkatesh, B.V.Manikandan, S.Charles raja and A.Srinivasan, "Electrical power systems- Analysis, security and Deregulation", PHI Learning Pvt Ltd, New Delhi, 2016.

S. Padma 4.8.23

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Department of EEE,
Sona College of Technology
Salem-636 005. Tamil Nadu.

COURSE OUTCOMES:

At the end of the course, the students will be able to,

1. Explain the necessity of hybrid electric vehicle and to model vehicles for its performance analysis.
2. Illustrate the basic concepts of hybrid and electric drive train topologies and explain power flow control with fuel efficiency analysis.
3. Explain the configuration and control of various motor drives used in hybrid and electric vehicles and to elaborate on the energy storage requirements for the electric vehicles.
4. Compare the performance of electric motor with IC engine in order to select Electric drive and energy storage technology and to explain various vehicle communication subsystems.
5. Classify and compare different energy management strategies and list the issues pertaining to its implementation.

CO/PO, PSO Mapping
(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak
COs Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	3	3
CO2	2	2	3	3	3
CO3	2	2	3	3	3
CO4	2	2	3	3	3
CO5	2	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) (Theory) CIE test II (10) (Theory) CIE test III (10) (Theory) CIE test IV (10) (Laboratory)	Assignment /Quiz/Seminar/mini project (10) Total CIE: **50 marks** Semester End Examination: **50 marks** [SEE- Theory (35 marks),Lab (15 marks)]	Course end survey

UNIT I INTRODUCTION TO HYBRID ELECTRIC VEHICLE 9

History of hybrid and electric vehicles- social and environmental importance of hybrid and electric vehicles- impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

UNIT II HYBRID TRAIN ARCHITECTURES AND POWER FLOW MANAGEMENT 9

Fundamental concept of hybrid traction- introduction to various hybrid drive-train topologies power flow control in hybrid drive-train architectures- fuel efficiency analysis. Basic concepts of electric traction- introduction to various electric drive-train topologies- power flow control in hybrid drive - train topologies- fuel efficiency analysis.

UNIT III ELECTRIC PROPULSION AND ENERGY STORAGE 9

Introduction to hybrid and electric vehicles- Configuration and control of DC Motor drives -AC Motor drives- Permanent Magnet Motor drives- Switch Reluctance Motor drives and drive system efficiency.

Energy storage requirements in Electric and Hybrid electric vehicles, Battery types, Properties of Batteries, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery Modeling - Run Time Battery Model, First Principle Model, Battery pack Design.

UNIT IV PERFORMANCE ANALYSIS AND VEHICLE COMMUNICATION SYSTEMS **9**

Matching the electric machine and the internal combustion engine (ICE)- Sizing the propulsion motor-sizing the power electronics- selecting the energy storage technology. Communications supporting subsystems- Introduction to CAN, LIN, FLEXRAY, MOST, KWP 2000 - Details of CAN, Introduction to V2V, V2I systems.

UNIT V ENERGY MANAGEMENT STRATEGIES **9**

Introduction to energy management strategies used in hybrid and electric vehicle- classification of different energy management strategies- comparison of different energy management strategies- implementation issues of energy strategies.

Lecture: 45, Tutorial: 0, Practical: 30 , Total: 75 Hours

REFERENCES BOOKS:

1. Iqbal Husain, "Electric and Hybrid vehicles Design Fundamentals", CRC Press, second edition 2013.
2. James Larminie, John Lowry, "Electric Vehicle Technology Explained" second Edition,Wiley 2012.
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.

MODELLING AND SIMULATION OF EHV

Simulation Tool: MATLAB/Simulink.

List of Experiments:

1. Simulation for AC to AC conversion.
2. Simulation for AC to DC conversion.
3. Simulation for DC to DC conversion.
4. Speed control of DC motor using IGBT.
5. To perform speed reversal of DC shunts Motor.
6. Speed control of switched Reluctance Motor.
7. Speed control of BLDC Motor.
8. Simulation of four Quadrant operation of three phase Induction Motor.
9. PWM based Z - source inverter.
10. V/f control of three phase induction motor.

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P23PSE103 **HIGH VOLTAGE AND INSULATION SYSTEMS** **3 0 0 03**

COURSE OUTCOMES:

At the end of this course the students will be able to,

1. Describe the various insulating materials used in power system
2. Illustrate breakdown mechanism of solid, liquid and gaseous dielectrics
3. Explain the high voltage generation methods and measurements
4. Evaluate insulation testing of electrical equipments
5. Describe the various Non-destructive testing in high voltage.

CO/PO, PSO Mapping (3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak COs Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)					
COs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	3	3
CO2	2	3	3	3	3
CO3	2	2	3	3	3
CO4	2	3	3	3	3
CO5	2	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) (Theory) CIE test II (10) (Theory) CIE test III (10) (Theory)	Assignment / Problem –Solving /Seminar (10) Total CIE: **40 Marks** Semester End Examination : **60 Marks**	Course end survey

UNIT I INSULATING MATERIALS IN POWER SYSTEM **9**

Review of insulating materials Gases, Vacuum, liquids and solids- characterization of insulation condition – permittivity, capacitance, resistivity and insulation resistance, dielectric dissipation factors- partial discharges sources, forms and effects- ageing effects- electrical breakdown and operating stresses- standards relating to insulating materials.

UNIT II BREAKDOWN MECHANISMS OF SOLID, LIQUID AND GASEOUS DIELECTRICS **9**

Introduction to insulation systems used in high voltage power apparatus - breakdown mechanisms of solid, liquid, gas and vacuum insulation.

UNIT III BASIC METHODS OF GENERATION AND MEASUREMENT OF TEST HIGH VOLTAGES **9**

Generation of high alternating voltages: cascaded transformers and series resonant circuit- Generation of high dc voltages: rectifier circuit and voltage multiplier circuit- Generation of impulse voltages: multistage impulse generator circuit- Generation of impulse currents – Measurement of high ac, dc and impulse voltages: voltage divider circuits- Digital Storage Oscilloscope for impulse voltage and current measurements.

UNIT IV INSULATION TESTING OF ELECTRICAL EQUIPMENTS **9**

Necessity for high voltage testing - testing of distribution and power transformers - voltage transformers - current transformers - bushings – overhead line and substation insulators - surge arresters – high voltage cables - circuit breakers and isolators – IEC and Indian standards.

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UNIT V NON-DESTRUCTIVE TESTING 9

Insulation resistance measurement- Measurement of tan delta and capacitance of dielectrics - grounded objects like transformers and alternators – Measurement of Partial discharges - location and measurement of discharges in electrical equipment –Dissolved gas in oil measurement.

Lecture: 45, Tutorial: 0, Total: 45 Hours

REFERENCE BOOKS:

1. Naidu, M.S. and Kamaraju,V., High Voltage Engineering, Tata McGraw Hill Publishing Company Ltd., New Delhi, 5th edition, 2013.
2. R.E.James and Q.Su, Condition Assessment of High Voltage Insulation in Power System Equipment, IET Power and Energy Series 53, 2008.
3. Adrianus,J. Dekker, Electrical Engineering Materials, Prentice Hall of India Pvt. Ltd., New Delhi, 1979.
4. Gallagher,T.J., and Permain,A., High Voltage Measurement, Testing and Design, John Wiley Sons, New York, 1984.

S. Padma 4.8.23

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P23PSE104 ADVANCED POWER SYSTEM SIMULATION LABORATORY 0 0 4 0 2

COURSE OUTCOMES:

At the end of this course, the students will be able to,

1. Compute load flow, contingency economic dispatch and unit commitment solutions for various power systems.
2. Analyze different power systems by carrying out various short circuit and state estimation techniques.
3. Model and simulate AGC and AVR systems for given power system.
   (All simulation shall be performed using suitable simulation softwares).

CO/PO, PSO Mapping (3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak COs Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)					
COs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (20) Quiz 1 (5) CIE test II (20) Quiz 2 (5)	RTPS (10) Total CIE: **60 marks** Semester End Examination: **40 marks**	Course end survey

LIST OF EXPERIMENTS

1. Load flow analysis by Newton-Raphson method
2. Load flow analysis by Fast decoupled method
3. Contingency analysis: to calculate sensitivity factors.
4. Economic dispatch using lambda-iteration method
5. Unit commitment: Priority-list schemes and dynamic programming.
6. Short circuit analysis in power system.
7. State estimation of power system network
8. Automatic Generation control for power system network
9. Familiarization of Relay Test Kit
10. Modeling and Simulation of AVR.

Total : 60 Hours

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COURSE OUTCOMES:

At the end of this course the students will be able to,

1. Describe the basic power quality issues.
2. Discuss about voltage related problems.
3. Evaluate harmonics in power system due to power electronic devices.
4. Evaluate power quality using measuring equipment.
5. Improve the power quality using different types of filters.

CO/PO, PSO Mapping
(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak
COs Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

COs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	3	3	3
CO2	1	1	3	3	3
CO3	2	3	3	3	3
CO4	2	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) (Theory) CIE test II (10) (Theory) CIE test III (10) (Theory)	Assignment / Problem –Solving /Seminar (10) Total CIE: **40 Marks** Semester End Examination : **60 Marks**	Course end survey

UNIT I INTRODUCTION **9**

Power quality, Voltage quality – power quality evaluation procedure – overview of power quality phenomena – classification of power quality problems – power quality measures and standards – THD-TIF-DIN-C-message weights – flicker factor – occurrence of power quality problems – power acceptability curves – overview of EMC and IEEE standards.

UNIT II VOLTAGE SAGS AND INTERRUPTIONS **9**

Long Interruptions: Causes – generation, transmission and distribution reliability – basic concepts of reliability evaluation techniques – costs.

Short Interruptions: Origin – influence on motors and electronic equipment – single phase tripping.

Sags: Introduction – sag magnitude, duration – load influence on voltage sags – sags in adjustable speed AC and DC drives.

UNIT III HARMONIC DISTORTION **9**

Harmonic distortion – harmonics versus transients – harmonic indices – harmonic sources from commercial and industrial loads – locating harmonic sources – SMPS – Three phase power converters – arcing devices – Harmonic Distortion of fluorescent lamps – effects of harmonic distortion – inter-harmonics – principles for controlling harmonics –devices for controlling harmonic distortion.

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UNIT IV POWER QUALITY MONITORING 9

Monitoring considerations –power quality measurement equipment – power quality data assessment – basic design of an expert system for monitoring applications – power quality monitoring in internet.

UNIT V POWER QUALITY IMPROVEMENT 9

Static compensator – Distribution static compensator – Dynamic voltage restorer – Power factor corrector – Active filters – Shunt active filters – applications – PSCAD / EMTDC – simulation of Active filters.

Lecture: 45, Tutorial: 0, Total: 45 Hours

REFERENCE BOOKS:

1. Math H.J. Bollen, "Understanding Power Quality Problems: Voltage sags and interruptions", IEEE press, 2011.
2. Roger C. Dugan, "Electrical power Systems Quality", McGraw Hill Education, Third edition, 2012.
3. Arrillaga J, Watson NR, Chen S, "Power System Quality Assessment", John Wiley & Sons, 2011.
4. Heydt G T, "Electric Power Quality", Stars in a Circle Publications, 1991.

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P23GE101 **RESEARCH METHODOLOGY AND IPR** 3 0 0 0 3

(Common to all M.E /M.Tech Programmes)

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Review the literature of the research problem
2. Choose appropriate data collection and sampling method according to the research problem.
3. Interpret the results of research and communicate effectively with their peers
4. Explain the Importance of intellectual property rights
5. Evaluate trade mark, develop and register patents.

CO/PO, PSO Mapping (3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak COs Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)					
COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	3
CO2	2	3	3	3	3
CO3	2	3	3	3	3
CO4	2	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) (Theory) CIE test II (10) (Theory) CIE test III (10) (Theory)	Assignment / Problem -Solving /Seminar (10) Total CIE: **40 Marks** Semester End Examination : **60 Marks**	Course end survey

UNIT I INTRODUCTION TO RESEARCH METHODS 9

Definition and Objective of Research, Various steps in Scientific Research, Types of Research, Criteria for Good Research, Defining Research Problem, Research Design , Case Study Collection of Primary and Secondary Data, Collection Methods: Observation, Interview, Questionnaires, Schedules,

UNIT II SAMPLING DESIGN AND HYPOTHESIS TESTING 9

steps in Sampling Design, Types of Sample Designs, Measurements and Scaling Techniques -Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests), concerning variance — one tailed Chi-square test.

UNIT II INTERPRETATION AND REPORT WRITING 9

Techniques of Interpretation, Precaution in Interpretation, Layout of Research Report, Types of Reports, Oral Presentation, Mechanics of Writing Research Report

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY 9

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights, Innovations and Inventions trade related intellectual property rights.

UNIT V TRADE MARKS, COPY RIGHTS AND PATENTS 9

Purpose and function of trade marks, acquisition of trade mark rights, trade mark registration processes, trademark claims —trademark Litigations- International trademark law Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

Lecture: 45, Tutorial: 0, Total: 45 Hours

TEXT BOOKS

1. C.R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques An Edition, New Age International Publishers, 2019.
2. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets", Delmar Cengage Learning, 4" Edition, 2012.
3. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", Tata Mc Graw Hill Education, 1" Edition, 2008.

REFERENCE BOOKS

1. Panneerselvam, R., Research Methodology, Second Edition, Prentice-Hall of India, New Delhi, 2013.
2. Ranjith Kumar, Research Methodology — A step by step Guide for Begineers, 4" edition, Sage publisher, 2014.
3. D Llewelyn & T Aplin W Cornish, "Intellectual Property: Patents, Copyright, Trade Marks and Allied Rights", Sweet and Maxwell, 1" Edition, 2016.
4. Ananth Padmanabhan, "Intellectual Property Rights-Infringement and Remedies", Lexis Nexis, 1" Edition, 2012.
5. Ramakrishna B and Anil Kumar H.S, "Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers", Notion Press, 1" Edition, 2017.
6. M.Ashok Kumar and Mohd. Iqbal Ali :"Intellectual Property Rights" Serials Pub

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P23GE701	English for Research Paper Writing	L	T	P	J	C
		2	0	0	0	0

Course Outcomes

At the end of the course, the student will be able to

CO1:	Demonstrate research writing skills both for research articles and thesis
CO2:	Frame suitable title and captions as sub-headings for articles and thesis
CO3:	Write each section in a research paper and thesis coherently
CO4:	Use language appropriately and proficiently for effective written communication
CO5:	Exhibit professional proof-reading skills to make the writing error free

Course Assessment methods

Direct		Indirect
CIE test I (30) CIE test II (30) CIE test III (40)	Total CIE: 100 marks Semester End Examination: NIL	Course end survey

Unit 01:	**6 Hours**
Planning and preparation, word order, breaking up long sentences, organising ideas into paragraphs and sentences, being concise and avoiding redundancy, ambiguity and vagueness	
Unit 02:	**6 Hours**
Interpreting research findings, understanding and avoiding plagiarism, paraphrasing sections of a paper/ abstract.	
Unit 03:	**6 Hours**
Key skills to frame a title, to draft an abstract, to give an introduction	
Unit 04:	**6 Hours**
Skills required to organise review of literature, methods, results, discussion and conclusions	
Unit 05:	**6 Hours**
Usage of appropriate phrases and key terms to make the writing effective - proof-reading to ensure error-free writing	

Theory: 30 Hrs	Tutorial: --	Practical: --	Project:--	Total Hours: 30 Hrs

TEXT BOOKS

1.	Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2.	Highman N , Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book, 1998
3.	Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
4.	Goldbort R, Writing for Science, Yale University Press, 2006. (available on Google Books)

REFERENCES

1	Martin Cutts, Oxford Guide to Plain English, Oxford University Press, Second Edition, 2006

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Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E /M.Tech. Semester II under Regulations 2023 (CBCS)
Branch: Power Systems Engineering

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
	Theory courses									
1.	P23PSE201	Modern Power System Protection	3	0	2	0	4	PC	75	TL
2.	P23PSE202	Power System Dynamics and Stability	3	0	0	0	3	PC	45	T
3.	P23PSE203	Restructured Power Systems	3	0	0	0	3	PC	45	T
4.	P23PSE506	**Elective:** Smart Grid	3	0	0	0	3	PE	45	T
5.	P23PSE511	**Elective:** Industrial Automation	3	0	0	0	3	PE	45	T
6.	P23GE702	**Audit Course:** Stress Management by Yoga	2	0	0	0	0	AC	30	T
	Practical courses									
7.	P23PSE204	Power Electronics Applied to Power Systems Laboratory	0	0	4	0	2	PC	60	L
8.	P23PSE205	Automation Laboratory	0	0	4	2	3	PC	90	LP
Total Credits							**21**			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory, TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

Approved By

Chairperson, Electrical and Electronics Engineering BoS	**Member Secretary, Academic Council**	**Dean-Academics**	**Chairperson, Academic Council & Principal**
Dr.S.Padma	**Dr.R.Shivakumar**	**Dr.J.Akilandeswari**	**Dr.S.R.R.Senthil Kumar**

Copy to:-

HOD/EEE, Second Semester M.E -PSE Students and Staff, COE

P23PSE201	MODERN POWER SYSTEM PROTECTION	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

At the end of the course, the students will be able to

CO1:	describe the protection schemes for power system equipment.
CO2:	explain static relays and their characteristics.
CO3:	discuss different digital protection scheme.
CO4:	illustrate modern trends in protective relaying.
CO5:	evaluate various relay testing methods.

Pre-requisite:

Protection and Switchgear

CO/PO, PSO Mapping
(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) - Theory CIE test II (10) - Theory CIE test III (10) - Theory CIE test IV (10) - Laboratory	Assignment /Quiz/Seminar/mini project (10) Total CIE: 50 marks Semester End Examination: 50 marks [SEE- Theory (35 marks),Lab (15 marks)]	Course end survey

Unit 01: INTRODUCTION — **9 Hours**

General philosophy of protection – Characteristic functions of protective relays – Protection schemes for Transmission lines, Transformers, Generators, Motors – Bus bar protection – Back up protection.

Unit 02: STATIC RELAYS AND THEIR CHARACTERISTICS — **9 Hours**

Static relays – Amplitude comparator, phase comparator – Static Over current relay – Synthesis of Impedance relay, MHO relay, Reactance relay, Quadrilateral relay, and Differential relay – Static frequency relay.

Unit 03: DIGITAL PROTECTION — **9 Hours**

Numerical relay – Sampling frequency – Digital signal processing – Digital filtering in protective relays – Relays algorithms – Over current relays , Directional relay , Impedance relay , MHO relay , Differential relay - Quadrilateral relay.

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Unit 04: MODERN TRENDS IN PROTECTIVE RELAYING	9 Hours
Carrier current pilot relaying – Phase comparison, carrier Aided distance protection – Travelling wave relays – Amplitude comparison relay , phase comparison relay – Fiber optic based relaying – SCADA architecture – Use of SCADA in interconnected power systems – PLC and DCS control.	
Unit 05: TESTING OF PROTECTIVE SYSTEMS AND ADAPTIVE PROTECTION	**9 Hours**
Testing of protective current and potential transformers – Testing of relays – primary and secondary injection tests – Relay burden – Relay setting – Relay co – ordination – Fault locators – Adaptive protection – Fault analysis – Adaptive techniques – Intelligent Electronics devices.	

Theory: 45 Hrs	Tutorial: –	Practical: 30 Hrs	Project:–	Total Hours: 75 Hrs

REFERENCES

1. Y.G .Paithankar, S.R.Bhide, "Fundamentals of Power System Protection". Prentice – Hall India, 2004
2. Badri Ram and D.N. Vishwakarma , " Power System Protection and Switch Gear" Tata McGraw Hill, New Delhi, 2003
3. Ravindra P.Singh, "Digital Power System Protection", PHI , New Delhi ,2007.
4. T.S.M.Rao , "Digital / Numerical Relays" Tata McGraw Hill, 2005.

List of Experiments

1. Stimulate a fault and analyse the functions of power system using relay.
2. Stimulation of bus bar protection using differential relay.
3. Stimulation of zone protection for transmission line.
4. Time line characteristics of MCB and MCCB.
5. Parallel operation of alternators using synchronization relay.
6. Testing of transformer oil break down voltage (BDV)
7. Determination of various parameters of contactors and relays.

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P23PSE202	POWER SYSTEM DYNAMICS AND STABILITY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the students will be able to

CO1:	analyze the mathematical modeling and inductance calculations in synchronous machine.
CO2:	develop the transfer function model for excitation, speed governing and turbine systems.
CO3:	analyze the small signal stability of SMIB power systems.
CO4:	analyze the small signal stability of SMIB and Multi-machine power systems with damping controllers.
CO5:	describe feedback controllers for small signal stability enhancement in power systems.

Pre-requisite:

Power System Analysis, Control Systems

CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem- solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: SYNCHRONOUS MACHINE MODELLING — **9 Hours**

Mathematical 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, Per Unit Representations- Power-invariant form of Park's transformation-Steady state analysis: Voltage, current and flux-linkage relationships- Computation of steady-state values.

Unit 02: MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS — **9 Hours**

Elements of an Excitation System, Types of Excitation Systems- Modeling of Excitation system components, Modeling of IEEE type ST1A Excitation system model, Turbine and Governing System Modeling- Classical transfer function of a hydraulic turbine (no derivation), Special characteristics of hydraulic turbine, Electrical analog of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation,: Modeling of Single reheat tandem compounded type Steam Turbine.

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Unit 03: SMALL SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS	9 Hours
Classification of Stability- State- Space representation- Eigen properties of state matrix: Eigen values and Eigenvectors for stability, Participation factor. Single Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis- Effects of Field Circuit Dynamics- Block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability.	
Unit 04: SMALL SIGNAL STABILITY ANALYSIS WITH CONTROLLERS	**9 Hours**
Effects of Excitation System: Thyristor Excitation System with AVR, Block diagram representation with Exciter and AVR, Effect of AVR on Synchronizing and Damping torque components, Power System Stabilizer: Block diagram representation with AVR and PSS, System state matrix including PSS- Small Signal Stability of Multi machine systems.	
Unit 05: ENHANCEMENT OF SMALL SIGNAL STABILITY	**9 Hours**
Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta P-Omega stabilizer-Frequency-based stabilizers – Digital Stabilizer – Excitation control design – Exciter gain – Phase lead compensation – Stabilizing signal washout and stabilizer gain – Stabilizer limits, Selection of PSS location.	

Theory: 45 Hrs	Tutorial: –	Practical: –	Project:–	Total Hours: 45 Hrs

REFERENCES

1. Prabha Kundur, "Power System Stability and Control", Tata McGraw-Hill, 2014.
2. J.Machowski, Bialek, Bumby, " Power System Dynamics and Stability", John wiley and sons, 2011.
3. L.Leonard Grigsby, " Power System Stability and Control", CRC Press, 2017.
4. Peter W.Sauer & M.A.Pai, "Power System Dynamics & Stability", Pearson Education, 2006.

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P23PSE203	RESTRUCTURED POWER SYSTEMS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the students will be able to

CO1:	discuss the need for restructuring of power industry and market models
CO2:	explain the basics of congestion management
CO3:	discuss about locational margin prices and financial 21 transmission rights
CO4:	explain the significance of ancillary services and pricing of transmission network
CO5:	elaborate the reforms of power sectors in India

Pre-requisite:

Power system operation and control

CO/PO, PSO Mapping
(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem- solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY — **9 Hours**

Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models, Electricity vis – a – vis other commodities, Market architecture, Case study

Unit 02: TRANSMISSION CONGESTION MANAGEMENT — **9 Hours**

Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion management – Capacity alleviation method.

Unit 03: LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS — **9 Hours**

Mathematical preliminaries: - Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights – Risk hedging functionality -Simultaneous feasibility test and revenue adequency –

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FTR issuance process: FTR auction, FTR allocation – Treatment of revenue shortfall – Secondary trading of FTRs – Flow gate rights – FTR and market power - FTR and merchant transmission investment.	
Unit 04: ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK	**9 Hours**
Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service - How to obtain ancillary service –Co- optimization of energy and reserve services - Transmission pricing – Principles – Classification – Rolled in transmission pricing methods – Marginal transmission pricing paradigm – Composite pricing paradigm – Merits and demerits of different paradigm.	
Unit 05: REFORMS IN INDIAN POWER SECTOR	**9 Hours**
Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.	

Theory: 45 Hrs	**Tutorial: --**	**Practical: --**	**Project:--**	**Total Hours: 45 Hrs**

REFERENCES

1. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility", CRC Press, 2001.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic, 2001.
3. Sally Hunt, "Making competition work in electricity", John Willey and Sons Inc, 2002.
4. Steven Stoft, "Power system economics: designing markets for electricity", John wiley and sons 2002.

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P23PSE204	POWER ELECTRONICS APPLIED TO POWER SYSTEMS LABORATORY	L	T	P	J	C
		0	0	4	0	2

Course Outcomes

At the end of the course, the students will be able to

CO1:	analyze the small signal stability of single machine and multi machine models.
CO2:	analyze the effect of FACTS controllers by performing steady state analysis.
CO3:	analyze the concepts in different wind energy conversion technologies.

CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (20) Quiz 1 (5) CIE test II (20) Quiz 2 (5)	RTPS (10) Total CIE: 60 marks Semester End Examination: 40 marks	Course end survey

LIST OF EXPERIMENTS

1. Small-signal stability analysis of single machine-infinite bus system using classical machine model
2. Small-signal stability analysis of multi-machine configuration with classical machine model
3. Load flow analysis of two-bus system with STATCOM
4. Transient analysis of two-bus system with STATCOM
5. Available Transfer Capability calculation using an existing load flow program
6. Modeling and simulation of variable speed wind energy conversion system- DFIG
7. Modeling and simulation of variable speed wind energy conversion system- PMSG
8. Simulation of MOSFET, IGBT based Choppers
9. Simulation of IGBT based Single phase inverters
10. Simulation of single phase AC voltage controller

Theory: --	Tutorial: --	Practical:60 Hrs	Project:--	Total Hours: 60 Hrs

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P23PSE205	AUTOMATION LABORATORY	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

At the end of the course, the students will be able to

CO1:	develop the PLC program for the implementation of logic gates.
CO2:	develop the PLC program for controlling the Pressure, Level and Flow Parameters and also for bottle Bain& cylinder actuation and elevator control applications.
CO3:	design and develop a real time industrial application in automation domain.

CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) – Laboratory Quiz 1 (5) CIE test II (10) – Laboratory Quiz 2 (5)	CIE III (10) – Project Record (10) Total CIE: 50 marks Semester End Examination: 50 marks SEE : Laboratory	Course end survey

LIST OF EXPERIMENTS

11. Write ladder logic program for AND and OR gate.
12. Write ladder logic program for NAND and NOR gate.
13. Write ladder logic program for NOT and EX-OR gate.
14. Automate the level and flow control using PLC.
15. Conduct the temperature control using PLC.
16. Conduct the pressure and flow control using PLC.
17. Conduct the control of elevator using PLC.
18. Study the Bottle filling process using PLC.
19. Conduct the cylinder sequencing using simple pneumatic direct control valve.
20. Write ladder logic program for the traffic light controller using PLC.
21. Conduct the special I/O for speed control of DC motor using PLC.
22. Programming in HMI and SCADA.

Theory: --	Tutorial: --	Practical:60 Hrs	Project:30 Hrs	Total Hours: 90 Hrs

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P23PSE506	SMART GRID	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the students will be able to

CO1:	distinguish between smart grids with conventional grid and explain the operations of Micro grid.
CO2:	apply modern communication technologies and discriminate challenges on smart grid with data analytics.
CO3:	illustrate the smart metering and sensing concepts on smart grids to industrial and commercial installations.
CO4:	explain the demand response management system and Formulate solutions for the power quality issues in smart grid.
CO5:	apply the smart grid system for real time simulation case studies of Substation automation and renewable energy system Formulate solutions for the power quality issues in smart grid.

Pre-requisite:

Power Quality, Generation, Transmission and Distribution

CO/PO, PSO Mapping
(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem- solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION TO SMART GRID & MICRO GRID — **9 Hours**

Introduction to Smart Grid - Evolution of Electric Grid - Concept of Smart Grid, Definitions, Need of Smart Grid- Concept of Robust &Self-Healing- Grid resilience and reliability - Present development & International policies in Smart Grid.

Micro-grid: Benefits, distributed generation, control, islanded and non-islanded operation, synchronous and asynchronous operation.

Unit 02: COMMUNICATION TECHNOLOGIES & DATA ANALYTICS — **9 Hours**

Home Area Network (HAN) - Neighbourhood Area Network (NAN), Wide Area Network (WAN) - Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication - Wireless Mesh Network. Basics of CLOUD Computing &Cyber Security for Smart Grid - Broadband over Power line (BPL). IP based protocols.

Data Analytics in the Smart Grid: Benefits, tools, Challenges, need of artificial intelligence and machine learning for Smart grid applications.

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Unit 03: SENSING, MEASUREMENTS, CONTROL AND AUTOMATION TECHNOLOGIES	9 Hours
Introduction to Smart Meters, Real Time Prizing, Smart Appliances - Automatic Meter Reading (AMR) - Outage Management System (OMS) - Plug in Hybrid Electric Vehicles (PHEV) - Vehicle to Grid, Smart Sensors - Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation, Smart Parks.	
Unit 04: DEMAND RESPONSE MANAGEMENT & POWER QUALITY IN SMART GRID	**9 Hours**
Energy efficiency, Energy Conservation, Demand response and HEMS, Power Quality issues of Grid connected Renewable Energy Sources -Power Quality Conditioners for Smart Grid - Web based Power Quality monitoring, Power Quality Audit- Phasor Measurement Units and applications- Geographical Information System.	
Unit 05: HIL SIMULATIONS & CASE STUDIES	**9 Hours**
Introduction to EMS and SCADA, RTU, IED, protocols and operations Case studies: Substation automation, Electric vehicles using Smart Grid, Energy storage systems in Smart grid, Demand response management, Integration of renewable energy system and Power quality management systems using Smart Grid.	

Theory: 45 Hrs	Tutorial: --	Practical: --	Project:--	Total Hours: 45 Hrs

REFERENCES

1. Uma Rao and Prema V "Smart Grid An Indian Adaptation Fundamentals Design Technology Applications Communication and Security", Wiley, 2021.
2. Lisa Ann Lamont and Ali Sayigh, "Application of Smart Grid Technologies Case Studies in Saving Electricity in Different Parts of the World", Academic Press, 2018.
3. Saurabh Mani Tripathi, Francisco M. Gonzalez-Longatt, "Real-Time Simulation and Hardware-in-the-Loop Testing Using Typhoon HIL", Springer , 2023.
4. Kenneth C. Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014.

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P23PSE511	INDUSTRIAL AUTOMATION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the students will be able to

CO1:	explain the fundamentals of PLC and its hardware.
CO2:	discuss the various instructions involved in PLC Programming language.
CO3:	identify the Sensors and Actuators for the various Industrial applications.
CO4:	select the Communication techniques for real time applications.
CO5:	describe the features of SCADA and its components.

Pre-requisite:

Electrical Machines, Embedded systems

CO/PO, PSO Mapping
(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem- solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION TO INDUSTRIAL AUTOMATION — **9 Hours**

Programmable Logic Controllers: Introduction - Relay based Automation - Evaluation of PLC's. Parts of PLC - Principles of operation, Advantages over relay logic - PLC sizes - PLC hardware components - I/O section - Discrete and Analog Module - CPU processor and memory module - Programming devices - PLC Programming Languages - Ladder diagram -Function Block Diagram - Latching relays - Converting simple relay ladder diagram in to PLC relay ladder diagram.

Unit 02: PLC INSTRUCTIONS — **9 Hours**

Timer Instructions: On delay, off delay and retentive Timer - Up counter, Down Counter and Up Down Counters, Relay – Type Instructions, Data Manipulating Program, Data Handling Instructions - Control Instruction, Math Instructions - Sequencer And Shift Register Instructions.

Unit 03: PLC I/O DEVICES — **9 Hours**

Input Devices: Manually operated Switches – Mechanically operated Switches – Analog and Discrete temperature switches - proximity switches - pressure switches NO and NC Push buttons and interlocking concepts.

Output devices: Contactor for motors - Stepper and servo motors – starters - WD, hydraulic and pneumatic cylinders - Analog valves.

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Unit 04: PLC COMMUNICATION DEVICES AND APPLICATIONS				9 Hours
Networking of PLC – Field bus – PROFI bus – Mod bus – Control Net, Device Net and PROFI Net protocols. Controlling a Robot with PLC, Conveyor belt motor control, Automatic car washing machine, PLC in quality inspection, Traffic light control system, Application of PLC in power plants.				
Unit 05: SUPERVISORY CONTROL AND DATA ACQUISITION				**9 Hours**
Introduction - Evaluation of SCADA – Interfacing PLC with SCADA – Features of SCADA –SCADA Architecture - Components of SCADA - Master Terminal Unit - Remote Terminal Unit - Alarm logging, Trend on line, off line, HMI and Introduction to DCS.				
Theory: 45 Hrs	**Tutorial: --**	**Practical: --**	**Project:--**	**Total Hours: 45 Hrs**

REFERENCES

1. Madhuchhanda Mitra, Samarjit Sen Gupta, "Programmable Logic Controllers and Industrial Automation, An Introduction" Penram Interactional Publishing Limited, 2012
2. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, Batten G. L., "Programmable Controllers", McGraw Hill Inc., Second Edition, 2011.
3. Stuart A Boyer, "SCADA supervisory control and data acquisition"2010.
4. F.D. Petruzella, "Programmable Logic Controllers" ", McGraw Hill Inc., Third Edition, 2011.

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P23GE702	Stress Management by Yoga	L	T	P	J	C
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Course Outcomes

At the end of the course, the student will be able to

CO1:	Develop physical and mental health thus improving social health
CO2:	Increase immunity power of the body and prevent diseases
CO3:	Accelerate memory power
CO4:	Achieve the set goal with confidence and determination
CO5:	Improve stability of mind, pleasing personality and work with awakened wisdom

Course Assessment methods

Direct		Indirect
CIE test I (30) CIE test II (30) CIE test III (40)	Total CIE: 100 marks Semester End Examination: NIL	Course end survey

Unit 01: **6 Hours**

Yoga-Introduction - Astanga Yoga- 8 parts-Yam and Niyam etc.- Do's and Don'ts in life-Benefits of Yoga and Asana- Yoga Exercise- and benefits- Pranayam Yoga- Nadi suthi, Practice and Spinal Sclearance Practice-Regularization of breathing techniques and its effects-Practice and kapalapathy practice.

Unit 02: **6 Hours**

Neuromuscular breathing exercise and Practice- Magarasa Yoga, 14 points Acupressure techniques and practice-Body relaxation practice and its benefits- Raja Yoga- 1.Agna –explanation and practice- Activation of Pituitary- Raja Yoga- 2. Santhi Yoga-Practice-Balancing of physical and mental power.

Unit 03: **6 Hours**

Raja Yoga- 3. Sagasrathara yoga –practice- Activation of dormant brain cells-Kayakalpa-theory- Kayakalpa –practice-Yogic exercise to improve physical and mental health and practice-Asanas –explanation-Practice-benefits

Unit 04: **6 Hours**

Sun namaskar- 12 poses-explanation and practice-Yoga –Asana-Padmasana, vajrasana,chakrasana, viruchasana etc-Stress management with Yoga-Role of women and Yoga Equality, nonviolence, Humanity, Self- control- Food and yoga Aware of self-destructive habits Avoid fault thinking (thought analysis-Practice)-Yoga Free from ANGER (Neutralization of anger)& practice

Unit 05: **6 Hours**

Moralisation of Desire & practice- Punctuality-Love-Kindness-Compassion Eradication of worries-Practice - Personality development, positive thinking-Good characters to lead a moral life How to clear the polluted mind- Benefits of blessing- Five- fold culture –explanation- Karma Yoga Practice In Geetha- Sense of duty-Devotion, self- reliance, confidence, concentration, truthfulness, cleanliness.

Theory: 30 Hrs	Tutorial: --	Practical: --	Project:--	Total Hours: 30 Hrs

REFERENCES

1. 'Yogic Asanas for Group Tarining-Part-I" Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

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