SAVITRIBAI PHULE PUNE UNIVERSITY

FACULTY OF ENGINEERING

SYLLABUS FOR

M.E. ELECTRICAL ENGINEERING

(2017 course)

WITH EFFECT FROM YEAR 2017-18

Structure for M.E.(Electrical Engineering) (2017 Course)

Semester - I

Subject Code	Subject	Teaching Scheme	Examination Scheme				Total Marks	Credit
		Lect./Pr.	Paper		TW	Oral / Presentation		
			In Semester Assessment	End Semester Assessment				
503401	Power System Modeling	4	50	50	--	--	100	4
503402	Advanced Power Electronics	4	50	50	--	--	100	4
503403	Computer Applications in Power Systems	4	50	50	--	--	100	4
503404	Research Methodology	4	50	50	--	--	100	4
503405	Elective-I	5	50	50	--	--	100	5
503406	PG Lab -1	4	--	--	50	50	100	4
Total		**25**	**250**	**250**	**50**	**50**	**600**	**25**

Semester - II

Subject Code	Subject	Teaching Scheme	Examination Scheme				Total Marks	Credit
		Lect./Pr.	Paper		TW	Oral / Presentation		
			In Semester Assessment	End Semester Assessment				
503407	AC /DC drives	4	50	50	--	--	100	4
503408	Advance Power System Protection	4	50	50	--	--	100	4
503409	Power System Dynamics	4	50	50	-	-	100	4
503410	Elective-II	5	50	50	--	--	100	5
503411	PG Lab-II Or Mini Project	4	--	--	50	50	100	4
503412	Seminar-I	4	--	--	50	50	100	4
Total		**25**	**200**	**200**	**100**	**100**	**600**	**25**

Semester - III								
Subject Code	**Subject**	**Teaching Scheme**	**Examination Scheme**				**Total Marks**	**Credits**
		Lect./Pr.	**Paper**		**TW**	**Oral / Presen tation**		
			In Semester Assessment	End Semester Assessment				
603401	Power System Planning & Reliability	4	50	50	--	--	100	4
603402	Power Quality Assessment and Mitigation	4	50	50	--	--	100	4
603403	Elective III	5	50	50	--	--	100	5
603404	Seminar II	4	--	--	50	50	100	4
603405	Project Stage - I	08	--	--	50	50	100	8
Total		**25**	**150**	**150**	**100**	**100**	**500**	**25**

Semester - IV							
Subject Code no.	**Subject**	**Teaching Scheme**	**Examination Scheme**			**Total Marks**	**Credits**
		Lect./Pr.	**Paper**	**TW**	**Oral / Presen tation**		
603406	Seminar-III	5	--	50	50	100	5
603407	Project work Stage II	20	--	150	50	200	20
Total		**25**	**--**	**200**	**100**	**300**	**25**

Evaluation of Seminars and Project in different semesters would be carried out as per rules and regulations of ME programs under faculty of engineering effective from July 2024.

List of Elective Subjects

Note: Select any one subject from module I and one subject from module II for each Elective.

Elective-I (5 credits)		**Elective-II (5 credits)**		**Elective-III (5 credits)**	
Module I (credits=4)	Module II (credit=1)	Module I (credits=4)	Module II (credit=1)	Module I (credits=4)	Module II (credit=1)
1) Advanced Topics in Power System	1) Electrical Transients in Power System	1) Power Sector Economics Restructuring & Regulation	1)Application of Power Electronics to Power System	1) Renewable Energy	1) Artificial Intelligent tools
2)Electric and Hybrid Vehicles	2)Electronics for Renewable Energy Systems	2) Distributed generation and micro grid	2) Green building design	2) Advance Processors and Applications	2) Intelligent Sensors and instrumental ion
3) Advanced Digital Signal Processing	3) Industrial Automation and Control	3) Embedded Systems	3)Control System design and estimation	3)Artificial Neural Network and its applications in power system	3) Human Rights

EXAMINATION SCHEME GUIDELINES

A) Compulsory subjects: Credits 4

Total marks: 100

To be done at Institute Level		**University Exam**	
In semester assessment Units 1 - 4		**End semester assessment**	
Class tests	30 Marks	Units 1- 4	18 Marks
Assignments/PPT/ Mini Project	20 Marks	Unit 5	16 Marks
		Unit 6	16 Marks
Total	50 Marks	Total	50 Marks

B) Elective subjects: Credits 5

Total marks: 100

Module 1 (Credits – 4)			
In semester assessment Units 1-4		**End semester assessment**	
Class tests	15 Marks	Units 1 & 2	12 Marks
Assignments/PPT presentation	10 Marks	Units 3 & 4	14 Marks
		Unit 5	12 Marks
		Unit 6	12 Marks
Total	25 Marks	Total	50 Marks

Module 2 (Credit – 1)	
In semester assessment	Units 1-2
Class tests / Assignments/PPT	25 Marks

B.O.S.
Electrical Engineering

Semester - I

503401: POWER SYSTEM MODELING

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment : 50

Course Objectives :

1. Introduce basic modeling concepts of various power system components.
2. Develop detail model of synchronous machine for dynamic studies.
3. Analyze synchronous machine model for steady state & transient state
4. Describe basics of excitation systems, voltage regulators and their parameters.
5. Develop models of different excitation systems.
6. Extend concept of mathematical modeling for transmission line, SVC and loads

Course Outcomes: Student will be able to

CO1:-Develop simple models for electrical power system components.

CO2:-Perform analysis of synchronous machine behavior for steady state & transient state

CO3:-Write models of different excitation systems.

CO4:-Apply concept of modeling for transmission line, SVC and loads

Unit 1 Modeling of Power System Components:
The need for modeling of power system, different models for power system analysis. Simplified models of non-electrical components like boiler, steam, hydro-turbine & governor system. Transformer modeling, tap-changing & phase-shifting transformer modeling. [8 Hrs.]

Unit 2 Synchronous machine modeling:
Model for steady-state analysis. The development of model for dynamic studies. The current & flux linkage models using Park's transformation leading to simulation as linear model.
[8 Hrs.]

Unit 3 Analysis of synchronous machine modeling:
Synchronous machine connected to an infinite bus, its simulation for steady-state condition and transient conditions. [8 Hrs.]

Unit 4 Excitation system modeling - I:
Simplified view of excitation control. Block Diagram of Excitation control scheme, effect of change in excitation on system parameters, Exciter with rheostat control, Definitions of voltage response ratio & exciter voltage ratings. Voltage regulators such as electro-mechanical and solid state. [8 Hrs.]

Unit 5 Excitation system modeling - II:
Excitation control systems using dc generator exciter, dc generator pilot excitation scheme, modelling of self and separately excited dc generator, AC excitation system: Field controlled alternator rectifier system (stationary diode type), Brushless excitation system (rotating diode type),static excitation system: Potential source controlled rectifier system, compound source controlled rectifier system. [8 Hrs.]

Unit 6 Transmission line, SVC and load modeling :
Transmission line modeling, Applications of Clark's & Kron's transformation, static VAR compensators, static load modeling, induction motor modeling using synchronous machine model.
[8 Hrs.]

Text Books:

1. Power Systems Dynamics – K.R.Padiyar, B.S. Publications
2. Power System Control and Stability – Vol. – I – Anderson & Foud, IEEE Press, New York.
3. Power Systems Dynamics-Analysis and simulation –R. Ramanujam, PHI Learning Private limited New Delhi.

Reference Books:

1. Power System Dynamics & Control – Kundur, IEEE Press , New York
2. Power System Operation & Control – P.S.R. Murthy
3. "Electrical Energy System Theory – an introduction" by Olle Elgerd. TMH Publishing Company 2nd Edition, New Delhi
4. "Power System Analysis" – John J. Granier and W.D. Stevenson Jr, 4th Edition, McGraw Hill International student edition.

503402: ADVANCED POWER ELECTRONICS

Teaching Scheme
Lectures:4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Course Objectives :

1. To learn about various advancements in Power Electronics.
2. To know working of various types of Power Electronic converter configurations.
3. To understand use of different energy storage systems.
4. To know various advanced control techniques for Power flow control in converter configurations.

Course Outcome: after successful completion of this course, student will be able to

CO1 Select appropriate Power Electronic converter configuration for desired application.
CO2 Analyze working and control requirements of the Power Electronic converter configuration.
CO3 Choose and apply the suitable control technique for operation of Power Electronic converter configuration.
CO4 Select the required energy storage system correctly.
CO5 Compare and comment on performance of the chosen Power Electronic converter configuration with other converters for same application.

Unit 1 Voltage Source Converters:
Review of 3-ph- full wave bridge converter, operation and harmonics, 3 level voltage source converters. PWM converter. Generalized technique of harmonic elimination and voltage control. Advanced modulation techniques (space vector modulation, 3 harmonic PWM), Converter rating.
[8 Hrs]

Unit 2 (i) Self and Line commutated current source converter: Basic concepts of CSC, converters with self commutating devices. Comparison with voltage source converter.
(ii) Matrix Converter: 3×3 matrix converter, principle of working, mathematical treatment, comparison of matrix converter with multipulse converter. [8Hrs.]

Unit 3 Multilevel Inverters:
Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, switching device currents, d.c. link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel converters
Applications of multilevel Inverter:
Reactive power compensation Back to back intertie system, Utility compatible adjustable speed drives. [8Hrs.]

Unit 4 Energy Storage Systems:
Flywheel energy storage system, Superconducting magnetic energy storage system, other advance energy storage systems [6Hrs.]

Unit 5 Resonant Pulse Converters:

Types of Resonant pulse converters, Series resonant inverters with unidirectional & Bidirectional switches, Analysis of half bridge and full bridge configurations, Frequency response of series resonant inverters, Parallel resonant inverters, Voltage control of resonant inverters, Class E Resonant inverter and rectifier , zero current and zero V switching resonant Converters, comparison. [8 Hrs]

Unit 6 Akagi's p-q theory:

Conventional concepts of active and reactive power in single phase and three phase circuits- Equation of power with sinusoidal voltage source and non-linear loads - αβo transformation of three phase four wire system- Akagi's instantaneous power (pq) theory- relationship between Akagi's components and conventional active and reactive power application of pq theory to reactive and harmonic power compensation in simple circuits.

[10Hrs]

Text Books:

1. Power Electronic Control in Electrical Systems by E.Acha, Miller & Others (Newnes, Oxford publication) – first Edition
2. Power Electronics by M.H.Rashid Prentice Hall of India Pvt. Ltd. New Delhi, (3^{rd} Edition)

References:

1) Understanding FACTS by N.G. Hingorani&L.Gyugyi (IEEE Press, Indian Edition)
2)E.H.Watanube, R.M. Stephen and Maurico Ardes "New Concepts of instantaneous active and reactive powers in Electrical systems with Generic loads" (IEEE transaction on Power Delivery Vol.8, no.2 April 1993, PP-697-703.
3) L.Benchaita, S. Sadaate and A. Salemnia – " A comparison of voltage source and current source shunt Active filter by simulation and Experimentation" (IEEE Transaction on Power Systems , Vol 14, No.2, May 99, PP 642-647.
4) H.Akagi, E.H. Watanabe and M.Aredes "Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press, New York.

503403: COMPUTER APPLICATIONS IN POWER SYSTEMS

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hours / Week	In Semester Assessment: 50
Credits: 4	End Semester Assessment: 50

Course Objectives:-The student will be able to

1. Learn mathematical functions of various optimization techniques
2. Understand the necessity of load flow studies and various methods of load flow studies
3. Understand the applications of various methods for optimal power flow analysis

Course Outcome:- At the end of course, student will be able to

CO1:- Conversant with various optimization techniques.

CO2 :- Use methods of power flow analysis, optimal power flow analysis

CO3:- Elaborate optimal power system operation

Unit 1 Optimization Techniques

Introduction, Statement of an optimization problem, design vector, design constraints, constraint surface, objective function, classification of optimization problem. Classical optimization Techniques, single variable optimization, multivariable optimization with equality constraints, Direct substitution method, constrained variation method, Lagrange Multiplier method, formulation of multivariable optimization, Kunh Tucker conditions.

[8 Hrs.]

Unit 2 Optimization Techniques

Nonlinear Programming, Unconstrained optimization Techniques, Direct search methods, Indirect search methods, Descent methods, One dimensional minimization methods, unimodal function, elimination methods. [8 Hrs.]

Unit 3 Load Flow Studies

Revision of Load flow studies by using Newton Raphson method (polar and rectangular). Contingency evaluation, concept of security monitoring, Techniques of contingency evaluation, Decoupled load flow and fast decoupled load flow. [8 Hrs.]

Unit 4

Three Phase Load Flow: Three phase load flow problem notation, specified variables, derivation of equations.

AC-DC load flow: Introduction, formulation of problem, D.C. System model, converter variables, Derivation of equations, Inverter operation, generalized flow chart for equation solution. [8 Hrs.]

Unit 5 Optimal Power Flow Analysis

Optimal power flow analysis considering equality and inequality constraints. Economic dispatch with and without limits (Classical method) Gradient method, Newton’s method, Newton Raphson method. [8Hrs.]

Unit 6 Optimal Power System Operation

Calculation of loss coefficients, loss coefficients using sensitivity factors, power loss in a line, Generation shift distribution factors, Transmission loss coefficients, transmission loss formula as a function of generation and loads, economic dispatch using loss formula which is function of real and reactive power, linear programming method.

[8Hrs]

Text Books:

1. Computer Aided Power System Operation and Analysis-R.N.Dhar, Tata McGraw Hill New Delhi.
2. Computer Techniques in Power System Analysis- M.A. Pai, Tata Mc-Graw Hill New Delhi.
3. Computer Methods in Power System Analysis- Stagg and El.Abiad, Mc-Graw Hill (International Student Edition.)

Reference Books :

1. Computer Analysis of Power Systems-J.Arrilinga, C.P.Arnold. Wiely Eastern Ltd.
2. Optimisation Techniques-S.S.Rao, Wiely Eastern Ltd, New Delhi.
3. Modern Power System Engineering, Nagrath and Kothari (Tata McGraw Hill)
4. Electrical Energy System Theory–an introduction- Olle Elgerd. TMH Publishing Company, New Delhi.
5. Power System Optimisation- D. P. Kothari, J. S. Dhillon, PHI.
6. Power Generation Operation and Control – Allen Wood, Wiley Publications.
7. NPTEL online course on “Power System analysis”

503404: RESEARCH METHODOLOGY

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment :50

Course Objectives: The student will be able to

1. To give knowledge about basic concepts in research.
2. To train students for technical writing.
3. To cultivate quality research output.

Course outcome: At the end of the course, students will be able to

CO1 :- Carry out literature review and write it in proper format
CO2 :- Enlist different parts of thesis and research proposal.
CO3:- Find research metrics and information about patents from on line resources.

Unit 1: Basics of research

Definition, Research Characteristics, Research Need, Objectives and types of research: Motivation and objectives – Research methods vs Methodology, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Research Formulation, Defining and formulating the research problem, Selecting the problem Necessity of defining the problem, Importance of literature review in defining a problem.

Using web for literature review, Types of literature: books, papers, reviews, treatise, monographs, patents, process of identifying gap areas from literature review Development of working hypothesis. Different tools for literature survey. [8 Hrs]

Unit 2: Technical Writing:

Writing Thesis: Structure and components of scientific reports, Types of report – Technical reports and thesis, Significance, Different steps in the preparation, Layout, structure and Language of typical reports.

Writing papers: types of technical papers, Journal papers, Conference papers, Survey papers, Poster papers, Comparison, Structure of a survey, conference and journal paper.

Writing Research Proposal: Importance of research funding in research, standard formats for different research schemes of AICTE, DST. Preparation for research proposal, how to write a research proposal. . [8 Hrs]

Unit 3: Assessment of research output:

Measure for quality of research, citation index Researcher metrics (i10-index, H-index etc.), Article metrics, Journal Metrics.

Ethical practices in research such as plagiarism, acknowledgment etc. Commercialization of research, Copy right, royalty, Intellectual property rights and patent law, Trade related aspects of Intellectual Property Rights, patent search, drafting and filing patent, legal procedure in granting patent.

` [8 Hrs]

Unit 4

Linear Programming : Standard form of a linear programming problem-geometry of linear programming problems-definitions and theorems, linear simultaneous equations: Elimination method, Jacobi's method, Relaxation method solution of the system of pivotal reduction of a general system of equations, simplex method. [8 Hrs]

Unit 5

Constrained Nonlinear Programming : Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method, Introduction to Convex Programming Problem. Finite Difference approximations of partial derivatives. [8 Hrs]

Unit 6

Following methods with applications to particular problem of Electrical Engineering:
Genetic algorithm, Simulated Annealing method, PSO, GA, SAM, Ant Colony method, ARIMA, Linear regression, Multi regression. [8 Hrs]

Text Books :

1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An introduction to Research Methodology, RBSA Publishers
3. Suresh Sinha, Anil K Dhiman,Research Methodology, ESS Publications,Volumes 2
4. Day R.A., How to Write and Publish a Scientific Paper, Cambridge University Press
5. Wadehra, B.L. Law relating to patents, Trade Marks, copyright designs and geographical indications. Universal Law Publishing
6. Shail Jain, R.K. Jain, Patents: Procedures and Practices, Universal Law Publishing Co. , New Delhi, 2011.
7. K.V.Mittal and C. Mohan, "Optimization Methods in operation Research and System Analysis"- New Age International (p) Limited, 3rd edition 1996.
8. Moritz Diehl- Franc, ois Glinuer-Eliass Jarlebring, Wim Michiels, " Recent Advances in Optimization ans its Applications in Engineering", Springer.
9. James A. Momoh, Electric Power Systems Applications of Optimization.
10. Soliman Abdel- HadySoliman, Abdel-Aal Hassan Mantawy, " Modern Optimizatin Techniques with Applications in Electric Power Systems"

References:

1. Louis Cohen, Lawrence Manion and Keith Morrison, Research Methods in Education, 7th Edition, Cambridge University Press, ISBN – 978-0415-58336-7
2. Anthony, M., Graziano, A.M. and Raulin, M.L., Research Methods: A Process of Inquiry, Allyn and Bacon
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, APH Publishing Corporation

4. Leedy, P.D. and Ormrod, J.E., Practical Research: Planning and Design, Prentice Hall
5. Fink, A., Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Satarkar, S.V., Intellectual Property Rights and Copy Right. ESS Publications.
7. Royston M. Roberts, Serendipity: Accidental Discoveries in Science, Wiley Publication, 1989
8. James A. Momoh, Electric Power Systems Applications of Optimization.
9. Soliman Abdel- Hady Soliman, Abdel-Aal Hassan Mantawy, " Modern Optimization Techniques with Applications in Electric Power Systems"

In semester assessment of the course must include following assignments (Any 2):

1. Write a literature survey for a given topic.
2. Write a research proposal for given research scheme.
3. Write an application for filing a patent.
4. Case study for famous inventions/discoveries and famous failures.
5. Write a paper using technical writing language such as Latex.

(ELECTIVE- I)

<table>
<tr><th>CODE</th><th>TEACHING SCHEME</th><th colspan="5">EXAMINATION SCHEME</th><th rowspan="3">CREDITS</th></tr>
<tr><td rowspan="3">503405</td><td rowspan="2">Lect/week</td><td colspan="2">Paper</td><td rowspan="2">TW</td><td rowspan="2">Oral / Presentation</td><td rowspan="2">Total</td></tr>
<tr><td>In semester Assessment</td><td>End Semester Assessment</td></tr>
<tr><td>5</td><td>50</td><td>50</td><td>-</td><td>-</td><td>100</td><td>5</td></tr>
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Code No.	**Modules of 4 credit (Select any one)**	**Code No.**	**Modules of 1 credit (Select any one)**
503405 M1(i)	1)Advanced Topics in Power System	503405 M2(i)	1)Electrical Transients in Power System
503405 M1(ii)	2) ELECTRIC AND HYBRID VEHICLES	503405 M2(ii)	2) Power Electronics for Renewable Energy Systems
503405 M1(iii)	3)Advanced Digital Signal Processing	503405 M2(iii)	3) Power Electronics and Control
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503405 M1(i): ADVANCED TOPICS IN POWER SYSTEM

COURSE OUTCOMES:

CO1	Describe the configuration of Automatic Generation Control.
CO2	Design the structure & Modeling Of Synchronous Machine.
CO3	Describe the Power System Model
CO4	Explain Effect Of ULTC And Load Characteristics On Voltage Stability
CO5	Discuss Contingency analysis ZBUS Method in Contingency Analysis
CO6	Discuss power system security

Course contents:

UNIT-I: [7 hours]

Generation Control Loops, AVR Loop, Performance and Response, Automatic Generation Control of Single Area and Multi Area Systems, Static and Dynamic Response of AGC Loops, Economic Dispatch and AGC.

UNIT-II: [7 hours]

Transient Stability Problem, Modeling Of Synchronous Machine, Loads, Network, Excitation and Systems, Turbine And Governing Systems, Trapezoidal Rule Of Numerical Integration Technique For Transient Stability Analysis, Data For Transient Stability Studies, Transient Stability Enhancement Methods

UNIT-III: [7 hours]

Low Frequency Oscillations, Power System Model For Low Frequency Oscillation Studies, Improvement Of System Damping With Supplementary Excitation Control, Introduction To Sub Synchronous Resonance and Countermeasures.

UNIT-IV: [7 Hours]

Voltage Stability Problem, Real And Reactive Power Flow In Long Transmission Lines, Effect Of ULTC And Load Characteristics On Voltage Stability, Voltage Stability Limit, Voltage Stability Assessment Using PV Curves, Voltage Collapse Proximity Indices, Voltage Stability Improvement Methods.

Unit-V: **[7 Hours]**

Contingency analysis ZBUS Method in Contingency Analysis, Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single Contingencies, Analysis of Multiple Contingencies, Contingency Analysis of DC Model, System Reduction for Contingency and Fault Studies.

Unit-VI: [7 Hours]

Introduction to power system security. System state classification, Load Forecasting & State Estimation: Estimation of average, periodic, stochastic components of load, basic idea of state estimation of power system. State estimation in power systems Security analysis.

Reference books:

1. Electric Energy System Theory: An Introduction. O.I. Elgard, .II Edition, McGraw Hill, New York, 1982.
2. Power Generation, Operation And Control., A.J. Wood, B.F. Wollenberg, .John Wiley And Sons, New York, 1984, 2nd Edition: 1996.
3. Computer Modeling Of Electrical Power Systems., J. Arrilaga, C.P. Arnold, B.J. Harker, Wiley, New York, 1983.
4. Power System Engineering, I.J. Nagrath, O.P. Kothari, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
5. Electric Power System Dynamics, Yao-Nan-Yu,
6. Power System Stability and Control. P. Kundur McGraw Hill, New York, 1994.
7 Power System Dynamics, Stability and Control, K.R. Padiyar Interline Publishing (P) Ltd., Bangalore, 1999.
8. Voltage Stability of Electric Power Systems. C. Van Custem, T. Vournas, Rlever Academic Press (U.K.), 1999.
9. Power System Analysis and Design. B.R. Gupta, III Edition, A.H. Wheeler & Co. Ltd., New Delhi, 1998.
10. Reactive Power Control in Electric Power Systems. T.J.E. Miller John Wiley and Sons, New York, 1982.

8. Voltage Stability of Electric Power Systems. C. Van Custem, T. Vournas, Rlever Academic Press (U.K.), 1999.
9. Power System Analysis and Design. B.R. Gupta, III Edition, A.H. Wheeler & Co. Ltd., New Delhi, 1998.
10. Reactive Power Control in Electric Power Systems. T.J.E. Miller John Wiley and Sons, New York, 1982.

503405 M1(ii):: ELECTRIC AND HYBRID VEHICLES

COURSE OUTCOMES:

CO1	Describe the configuration and performance of Electric vehicles
CO2	Design the structure of Hybrid Electric Vehicle
CO3	Describe the operation of Fuel Cells
CO4	Explain Electric propulsion system and Motor control systems
CO5	Discuss energy storage devices and generators

COURSE CONTENTS:

UNIT I ELECTRIC VEHICLES ***(08 Hours)***

Introduction, Layout of an Electric Vehicle, Performance of Electric Vehicles a) Traction Motor Characteristics b) Tractive Effort and Transmission Requirements c) Vehicle Performance , Energy Consumption, Advantages and Limitations, Specifications, System Components, Electronic Control System.

UNIT II: HYBRID VEHICLES **(08 Hours)**

Concepts of Hybrid Electric Drive Train, Architectures of Series Hybrid Electric Drive Trains, Architectures of Parallel Hybrid Electric Drive Trains, Merits and Demerits, Series Hybrid Electric Drive Train Design, Parallel Hybrid Electric Drive Train Design.

UNIT III: FUEL CELLS & SOLAR CARS **(08 Hours)**

Photovoltaic Cells, Tracking, Efficiency, Solar Cars, Fuel Cells - Construction & Working, Equations, Possible Fuel Sources, Fuel Reformer, Design, Cost Comparison.

UNIT IV: ELECTRIC PROPULSION SYSTEM AND MOTOR CONTROL SYSTEM **(10 Hours)**

DC Motors Characteristics, Speed and Torque Control, Regenerative Braking.AC Motors Characteristics, Speed and Torque Control.
PM- BLDC Motors Characteristics, Speed and Torque Control.Reluctance Motors Characteristics, Speed and Torque Control, Regenerative Braking.

UNIT V: ENERGY STORAGES & GENERATORS **(08 Hours)**

Electrochemical Batteries: Types of Batteries, Lead-Acid Batteries, Nickel Based Batteries, Lithium Based Batteries, Electro Chemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency, Ultra Capacitors, DC Generators, AC Generators, Voltage and Frequency Regulations

REFERENCES:

1) Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.
2) James Larminie and John Loury, “Electric Vehicle Technology – Explained”, John Wiley & Sons Ltd, 2003.
3) Sandeep Dhameja, “Electric Vehicle Battery Systems”, Butterworth – Heinemann, 2002.
4) Ronald K Jurgen, “Electric and Hybrid – Electric Vehicles”, SAE, 2002.
5) Ron Hodkinson and John Fenton, “Light Weight Electric/Hybrid Vehicle Design”, Butterworth – Heinemann, 2001.
6) Iqbal Husain, “Electric and Hybrid Vehicles- Design Fundamentals” CRC Press, 2011

503405 M1(iii):: ADVANCED DIGITAL SIGNAL PROCESSING

COURSE OUTCOMES:

CO1	Apply digital signal processing techniques to analyze LTI systems in time and frequency domain
CO2	Design and Analyze FIR digital filters
CO3	Design and Analyze IIR digital filters
CO4	Understand and be able to implement adaptive signal processing algorithms
CO5	Acquire the basics of multirate digital signal processing
CO6	Explain and implement digital signal processing techniques on general purpose Digital signal processors

COURSE CONTENTS:

UNIT I: DISCRETE TIME SIGNALS **(08 Hours)**

Introduction to Discrete time signals LTI system-stability-properties-sampling frequency domain Representation of discrete time signals and systems, discrete random signals-transforms, Properties, Inverse Z transforms.

UNIT II: DIGITAL FIR FILTER DESIGN **(08 Hours)**

Design of FIR filters - structures, windowing method, optimal method, Frequency sampling method.

UNIT III: DIGITAL IIR FILTER DESIGN **(06 Hours)**

Design of IIR filter: Impulse invariant method, Matched z-transform method, bilinear method.

UNIT IV: ADAPTIVE DIGITAL FILTERS **(08 Hours)**

Adaptive filters, Examples of Adaptive filtering, the minimum mean square error criterion; The Windrow and Hoff LMS Algorithm, Recursive least square Algorithm, Applications.

UNIT V: MULTI RATE DIGITAL SIGNAL PROCESSING **(06 hours)**

The basic sample rate Alteration Devices-Filters with sampling rate Alteration systems, Multistage Design of Decimators and Interpolators, Arbitrating rate sampling rate converter, Polyphase decomposition, digital filter design –Application.

UNIT VI: GENERAL PURPOSE DIGITAL SIGNAL PROCESSORS **(06 hours)**

Architecture of general purpose Digital signal processors, Implementation of DSP algorithms on general purpose processors.

REFERENCES:

1) Digital signal processing: A Practical Approach, Emmanuel C. Ifeachor, Barrie W. Jervis, Pearson Education.
2) Digital Signal Processing Principal, Algorithms and Applications, John G. Proakis, Dimitris G. Manolakis Pearson
3) Digital signal processing: A Computer Based Approach, Sanjit K. Mitra, Tata McGraw hill Pub, Company Limited New Delhi, 2001.
4) Digital signal processing, Alan Oppenheim, V and Ronals W. Schafer, Prentice Hall of India Private Limited, New Delhi, 1992.
5) Signals and systems, Simon Haylaim and Barry van veen, John wiley and sons India.
6) Digital signal processing, S,Salivahanan, Tata Mc Graw Hill Education Private Limited, New Delhi, 2010.

503405 M2(i): ELECTRICAL TRANSIENTS IN POWER SYSTEM

Upon successful completion of this course the student will be able to:

CO1	Understand basic concepts of travelling wave
CO2	Understand and analyze the electrical transients and effects on transmission line

1.ELECTRICAL TRANSIENTS IN POWER SYSTEM

Course contents:

UNIT-I Review Of Travelling Wave Phenomena [8 Hours]

Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behavior of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion.

UNIT-II Lightning, Switching and Temporary Overvoltage [9 Hours]

Lightning over-voltages: interaction between lightning and power system- ground wire voltage and voltage across insulator; switching overvoltage: Short line or kilometric fault, energizing transients-closing and re-closing of lines, methods of control; temporary over-voltages: line dropping, load rejection; voltage induced by fault; very fast transient overvoltage (VFTO).

References:

1., Electrical Transients in Power System, Allan Greenwood Wiley & Sons Inc. New York, 1991.

2. Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre, (Second edition) Newage International (P) Ltd., New Delhi, 1990.

3. High Voltage Engineering, Naidu M S and Kamaraju V, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

4. EMTP Theory Book, Hermann W. Dommel, second Edition, Microtran Power System Analysis corporation, Vancouver, British Columbia, Canada, May 1992, Last Update: April 1999.

4. EMTP Literature from www.microtran.com.

503405 M2(ii): POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

COURSE OUTCOMES:

CO1	1) Provide knowledge about the stand alone and grid connected renewable energy systems.
CO2	2) Equip with required skills to derive the criteria for the design of power converters for renewable energy applications.

COURSE CONTENTS:

UNIT I: INTRODUCTION (08 Hours)

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems: operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II: ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION (08 Hours)

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

REFERENCES:

1) S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electricaal Systems”, Oxford University Press, 2009
2) Rashid M. H. “Power Electronics Hand book”, Academic press, 2001.
3) Rai G.D., “Non Conventional Energy Sources”, Khanna publishes, 1993.
4) Rai. G.D.,” Solar Energy Utilization”, Khanna publishes, 1993.

503405 M2(iii): INDUSTRIAL AUTOMATION AND CONTROL

Course Outcome: - At the end of course, student will be able to

CO1:	Know the automation in Industry
CO2:	Select appropriate technique for control and automation

Unit 1 : Introduction

Architecture of industrial automation system, development trends in industrial automation, classification of existing systems, and functionality of industrial automation system. Relay and contactor logic, AC and DC relays and their role for load control. Power and Auxiliary contactors and their usage for load control. [8Hrs]

Unit 2 : Industrial Measurement System Characteristics

Sensors and control logic, control using potential free output sensors, Control using PO, PC, NO, NC type output sensor, 2W (2 wire), 3W (3 wire), 4W (4 wire) and 4WC sensors, Linear potentiometer Timer hardware architecture, Controlling industrial system using timers, Controlling industrial system using counters. Temperature measurement, Pressure, Force and Torque Sensors, Motion Sensing, Flow measurement, Signal Conditioning, Data Acquisition Systems.

[8Hrs]

References:

1. Lingefeng Wang, Kay Chen Tan, “Modern Industrial Automation and Software Design” John Wiley & Sons Inc.
2. K. L.S. Sharma, “ Overview of Industrial Process Automation” Elsevier
3. Kok Kiong “Drives and Control for Industrial Automation” Springer

503406: P.G. LABORATORY –I

Objective: To develop the analytical and practical skills in the students.

Course Outcomes:

Upon successful completion of this LAB-I the student will be able to:

CO1	Apply the knowledge to design the practical circuits for applications.
CO2	Model and simulate different electrical and electronics systems
CO3	Simulate and test the circuit performance for comparative study.

The power system lab -1 will be comprising of **at least TWO** experiments from each of the subjects MTEE101 to MTEE105 such as representation of Power System Elements like Synchronous machines, transformers, transmission lines, loads, power system load flow, short circuit studies and power system stability studies using MATLAB-SIMULINK, PSCAD, CAPS software. Study of power semiconductor devices, study AC to DC, DC to DC converter circuits etc using software, design as well as by building up the circuits in laboratories. Renewable energy systems

Semester – II

503407: AC/ DC DRIVES

COURSE OUTCOMES:

1) Explain the basics of Electrical Drives.
2) Develop the closed loop controlled DC drives.
3) Describe the modern trends of DC Dives.
4) Explain the basics methods of speed control of Induction motor.
5) Apply the various speed control methods for controlling the speed of Induction motor.
6) Apply the various speed control methods for controlling the speed of synchronous motor.
7) Use vector control method for controlling the Induction motor drive.

COURSE CONTENTS:

UNIT I: INTRODUCTION **(03 Hours)**

Electrical Drives, advantages, elements of drive system, drive characteristics, criteria for selection of drive components, dynamics of D.C. motor drives, steady-state stability.

UNIT II: D.C. DRIVES ***(09 Hours)***

Introduction, principle of DC motor speed control, phase controlled converters, steady state analysis of three phase converter controlled DC motor Drive, two quadrant three phase controlled DC drive. Introduction, Principle of operation of the chopper, Chopper controlled drives, Duty-ratio control, current-limit control, steady state analysis, four quadrant chopper circuit, chopper for inversion, chopper with other power devices, mode of chopper, input to the chopper, steady state analysis of chopper controlled DC Drives, pulsating torques, DC motor Drive with field weakening, four quadrant DC motor drives, converter selection and characteristics

UNIT III: CLOSED-LOOP CONTROL OF DRIVES **(08 Hours)**

Introduction- Basic features of an Electric Drive- Block diagram representation of Drive systems, signal flow graph representation of the systems, Transfer functions, transient response of closed loop drives systems. Speed control of a separately excited DC drive with inner current loop and outer speed loop,

UNIT IV: SPEED CONTROL OF INDUCTION MOTOR **(10 Hours)**

Principles of speed control , Various methods of Induction motor drive, Variable voltage operation, Variable frequency operation, Constant flux operation, Torque-Slip characteristic, Constant Torque and Constant power operation, Implementation of V/f control with slip compensation scheme Speed control of VSI and CSI fed drives - design examples. Closed loop control schemes - dynamic and regenerative braking - speed reversal.Torque slip characteristics- speed control through slip - rotor resistance control- chopper controlled resistance equivalent resistance combined stator voltage control and rotor resistance control- design solutions. Closed loop control scheme. Slip power recovery - torque slip characteristics - power factor considerations.

UNIT V: VECTOR CONTROL OF INDUCTION MOTOR DRIVE (07 Hours)

Review of dq0 model of 3-Ph IM, Principle of vector control of IM - Direct vector control - Indirect vector control with feedback - Indirect vector control with feed-forward - Indirect vector control in various frames of reference, Decoupling of vector control with feed forward compensation - Direct Torque Control of IM

UNIT VI: SPEED CONTROL OF SYNCHRONOUS MOTOR DRIVES (09Hours)

Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations.

Types of PM Synchronous motors - Torque developed by PMSM - Model of PMSM - Implementation of vector control for PMSM

; .

REFERENCES:

1) G.K.Dubey, Power Semi conductor controlled Drives, New Age Int. Pub.
2) S.B.Dewan, G.R.Slemon & A.Stranghan, Power Semi conductor controlled Drives, Johnwiley Pub.
3) Shepherd Hullay & Liag, Power Electronics & Motor Control: Cambridge Univ. Press
4) R.Krishnan, Electric Motor drives – Modelling, Analysis & Control:, PHI India,Ltd.
5) Vedam Subramanyam, Thyristor Control of Electric Drives.
6) Vector Control of AC Drives, I. Boldea and S. A. Nasar, CRC Press LLC, 1992.

503408: ADVANCED POWER SYSTEM PROTECTION

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment: 50

Course Objectives:

1. To understand effects of different short circuit faults on power system.
2. To analyse steady state and transient performance of current and potential transformer.
3. To study two point and three point Least Error Squared (LES) technique.
4. To understand digital protection of synchronous generator and transformer.
5. To understand different protection schemes of transmission line.
6. To comprehend different aspects of setting and coordination of distance and overcurrent relay.

Course Outcomes: At the end of course, the student will be able to

CO1:- Develop an algorithm for short circuit studies in power system.

CO2:- Differentiate between measuring and protective devices and use CTs and PTs suitably.

CO3:- Do phasor calculation using two point and three point Least Error Squared technique and differentiate between the two.

CO4:- Apply different digital protection schemes for synchronous generator and transformer.

CO5:- Differentiate between different protection schemes of transmission line.

CO6:- Differentiate between relay setting and coordination in case of distance relays and overcurrent relays.

Unit I: Short circuit studies in designing relaying scheme:
Types of faults, assumptions, development of algorithm for S.C. studies, PC based integrated software for S.C. studies, transformation to component quantities, S.C. studies of multiphase systems. [8 Hrs]

Unit II: Current and voltage transformers:
A) Current Transformer: Polarity and dot marks, difference between measuring and protective devices, equivalent circuit, steady state and transient performance, accuracy class.
B) Potential Transformer: Steady state and transient performance.
C) CCVT: Equivalent circuit, applications, transient response, classification and design.
[8 Hrs]

Unit III: Numerical Protection
Introduction, block diagram of numerical relay, sampling theorem, correlation with a reference

wave, digital filtering, and numerical over- current protection, phasor calculation using two point and three point LES techniques, Fourier analysis, Half and full DFT. [8 Hrs]

Unit IV A) Digital protection of Synchronous generator:
Introduction, faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator.
B) Digital Protection of Power Transformer:
Introduction, faults in a transformer, schemes used for transformer protection, digital protection of transformer [8Hrs]

Unit V: Digital Protection of Transmission Line:
Introduction, Protection scheme of transmission line, distance relays, travelling wave relays, digital protection scheme based upon fundamental signal, hardware design, software design, digital protection of EHV/UHV transmission line based upon traveling wave phenomenon, new relaying scheme using amplitude comparison. [8 Hrs]

Unit VI: Distance and overcurrent relay setting and co-ordination: Directional instantaneous IDMT overcurrent relay, directional multizone distance relay, distance relay setting, co-ordination of distance relays, co-ordination of overcurrent relays, computer graphics display, man-machine interface subsystem, integrated operation of national power system, application of computer graphics. [8 Hrs]

Text Books:

1. Digital Protection- L. P. Singh, New Age International (P) Limited Publishers, New Delhi, 2nd Edition
2. Transmission Network Protection- Paithankar Y. G. (Marcel & Dekker, New York)

Reference Books :

1. Fundamentals of Power System Protection- Paithankar Y. G. & Bhide (PHI New Delhi)
2. Protective Relaying for Power System II-Stanley Horowitz (IEEE press , New York)
3. Digital Relay / Numerical relays – T.S.M. Rao, Tata Mc Graw Hill, New Delhi
4. NPTEL course on power system protection by S. A. Soman.

503409: POWER SYSTEM DYNAMICS

Teaching Scheme
Lectures: 4 Hours / Week
Credits : 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessment : 50

Course Objectives:

1. Understand fundamental concepts & their classification in power system stability.
2. Explore voltage stability and islanding concepts in power stability studies
3. Impart knowledge on the design and application of Power system Stabilizer.
4. Extend basic stability analysis for multi machine system.
5. Analyze dynamics of synchronous generator connected to infinite bus.

Course Outcomes: Students will be able to

CO1 Solve basic power system stability problems.

CO2 Interpret the design and working and of Power system Stabilizer.

CO3 Develop a model of synchronous generator connected to infinite bus for dynamic analysis

CO4 Apply and solve dynamic stability problems of synchronous generator connected to infinite bus.

Unit 1 Review of Classical Methods:
System model, states of operation and system security, steady state stability, transient stability, simple representation of excitation control. [8 Hrs.]

Unit 2
a) Voltage Stability:
Definition, factors affecting voltage instability and collapse, analysis and comparison of angle and voltage stability, analysis and comparison voltage instability and collapse, control of voltage instability.
b) Islanding: Necessity for islanding, methods, use, advantages and disadvantages, implication on power system dynamic performance.
[8 Hrs.]

Unit 3 Power System Stabilizers:
Basic concepts of control signals in PSS, structure and tuning, field implementation, PSS design and application, future trends. [8 Hrs.]

Unit 4 Multi-machine System- Fundamentals:
Development of swing equation for coherent & non coherent group of multi machines, power flow in multi machine system, simplified multi machine model, Improved model of the system for linear load. [8 Hrs.]

Unit 5 Dynamics of Synchronous Generator Connected to Infinite Bus:
System model, simplified synchronous machine model, calculation of Initial conditions, system simulation, improved model of synchronous machine, inclusion of SVC model. [8 Hrs]

Unit 6 Detail Analysis of Single Machine:
Small signal analysis, applications of Routh-Hurwitz criterion, analysis of synchronizing and damping torque, state equation for small signal model.
[8 Hrs.]

Text Books:

1. Power System Dynamics- K.R. Padiyar, B.S. Publications
2. Power System Dynamics Control – Prabha S. Kundur, IEEE Press , New York

Reference Books :

1. Power System Stability – E.W. Kimbark, IEEE press, N.Y, Vol.
2. Power System Control and Stability – Vol. – I – Anderson &Foud, IEEE Press, New York.
3. Power System Voltage Stability – C. W. Taylor., McGraw Hill International student edition
4. Distributed Generation Islanding – implication on power system dynamics performance. –
5. R.A. Walling, N. W. Miller, Power Engineering Society, Summer Meeting, 2002, IEEE Publication, 25 July 2002, Vol. I, PP 92-9

(ELECTIVE- II)

503410 M1(i): DISTRIBUTED GENERATION AND MICROGRID

Course Objectives:-

Course Outcomes:

Upon successful completion of this course the student will be able to:

CO1	Understand exploration of renewable energy sources
CO2	Understand philosophy of distributed generation
CO3	Understand various issues of DG with grid integration
CO4	Understand the concept of micro grid and various power quality issues.

DISTRIBUTED GENERATION AND MICROGRID

Course content:

UNIT I – INTRODUCTION (9 hours)

Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

UNIT II – DISTRIBUTED GENERATIONS (DG) (9 hours)

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

UNIT III – IMPACT OF GRID INTEGRATION (9 hours)

Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT IV- MICROGRIDS (10 hours)

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques.

UNIT V- POWER QUALITY ISSUES IN MICROGRIDS (5 hours)

Power quality issues in microgrids- Modelling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids.

REFERENCES:

1. Voltage Source Converters in Power Systems: Modeling, Control and Applications, AmirnaserYezdani, and Reza Iravani, IEEE John Wiley Publications,2009.
2. Power Switching Converters: Medium and High Power, Dorin Neacsu, CRC Press, Taylor & Francis, 2006.
3. Solar Photo Voltaics, Chetan Singh Solanki, PHI learning Pvt. Ltd., New Delhi,2009.
4. Wind Energy Explained, theory design and applications, J.F. Manwell, J.G. McGowan Wiley publication,2002.
5. Biomass Regenerable Energy, D. D. Hall and R. P. Grover, John Wiley, New York, 1987.

6Renewable Energy Resources, John Twidell and Tony Weir, Tyalor and Francis Publications, 2005.

503410 M1(ii): EMBEDDED SYSTEMS

COURSE OUTCOMES:

1) Define and explain embedded systems and the different embedded system design technologies explain the various metrics or challenges in designing an embedded system
2) Become aware of the architecture of the ARM processor and its programming aspects (assembly Level)
3) Foster ability to understand the internal architecture Processor LPC 2148
4) Understand key concepts of embedded systems like IO, timers, interrupts, interaction with peripheral devices
5) Design real time embedded systems using the concepts of RTOS.
6) Analyze various examples of embedded systems based on ARM processor.

COURSE CONTENTS:

UNIT I: INTRODUCTION TO EMBEDDED SYSTEMS (08 Hours)

Introduction to embedded system -Definition and Classification, Design challenges, Optimizing design metrics, time to market, applications of embedded systems and recent trends in embedded systems, memory management, Overview of Processors and hardware units in an embedded system, Software embedded into the system, communication protocols like SPI, I2C, CAN etc.

UNIT II: ARCHITECTURE OF ARM7TDMI (05 Hours)

Introduction to ARM core architecture, ARM extension, family, Pipeline, memory management, Bus architecture, Programming model, Registers, Operating modes, instruction set, Addressing modes, memory interface.

UNIT III: ON CHIP PERIPHERALS AND INTERFACING LPC2148 (08 Hours)

Study of on-chip peripherals – Input/ output ports, Timers, Interrupts, on-chip ADC, DAC, RTC modules, WDT,PLL, PWM,USB, I2C, SPI, CAN etc.

UNIT IV: INTERFACING WITH LPC2148 (08 Hours)

Need of interfacing, interfacing techniques, interfacing of different displays including Graphic LCD, controlling a DC motor using PWM, Keypad controllers, stepper motor controllers.

UNIT V: REAL TIME OPERATING SYSTEMS (08 Hours)

Definitions of process, tasks and threads, I/O Subsystems, Interrupt Routines Handling in RTOS, RTOS Task scheduling models, Handling of task scheduling and latency and deadlines as performance metrics, Co-operative Round Robin Scheduling, Case Studies of Programming with RTOS.

UNIT VI: INTRODUCTION TO ARM 9 (05 Hours)

ARM926EJ-S, Features, Specifications (LPC314x /LPC315x As reference controllers)

REFERENCES:

1) Embedded Systems Architecture, Programming and Design, Rajkamal, TATA McGraw-Hill, First reprint Oct, 2003.
2) Embedded Systems Design, Second Edition, Steve Heath, Elsevier India Pvt. Ltd. 2007.
3) Andrew Sloss, Andew Sloss, "ARM System Developers Guide"
4) Introduction to Embedded systems, Shibu K V, Tata McGraw Hill First print – 2009.
5) An Embedded Software Primer, David E,Simon, Pearson Education Asia, 2000.
6) Embedded Systems Design, A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002.

Computers as Components; Principles of Embedded Computing System Design Wayne Wolf, Harcourt India, Morgan Kaufman Publishers, First Indian Reprint 2001

503410 M2(i).APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS

Course Outcomes:

Upon successful completion of this course the student will be able to:

CO1	Understand the concept of FACTs
CO2	Select and implement proper compensator to solve the problems occurring power transmission
CO3	Model and analyze the FACT controllers
CO4	Understand and apply the active filtering techniques in mitigation of harmonic distortion.

Module2.1.APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS

Course contents:

Unit 1

Review of semiconductor devices, Steady state and dynamic problems in AC systems, Power flow

[5 hrs]

Unit 2

Flexible AC transmission systems (FACTS): Basic realities & roles, Types of facts controller, Principles of series and shunt compensation. [6 hrs]

References:

1. Understanding of FACTs., Hingorani, N. G.; IEEE Press 1996.

2. Power Quality.; Heydt G.T.; Stars in a Circle Pblications , Indiana, 1991.

3. Static Reactive Power Compensation.; Miller T.J.E.; John Wiley & Sons, New York, 1982

4. Flexible AC Transmission System. (FACTs).; Yong Hua Song.; IEE 1999.

5. Recent Publications on IEEE Journals.

503410 M2(ii) : GREEN BUILDING DESIGN

Teaching Scheme	**Examination Scheme**
Lectures: 1 Hr/Week	In-Semester Examination : 25 Marks
Credit : 1	

Course outcome

At the end of this course student is able to

CO1: Learn green and sustainable design techniques for both commercial and residential buildings.

CO2: Design water, lighting, energy efficiency plan using renewable energy source.

Unit1 : Sustainability and Building design

Sustainability, objectives of sustainable development, Sustainable aspects of habitat design, sustainable buildings, principles, approaches and characteristics, climate data, climate parameters and zones, comparative analysis of various climatic zones, site planning recommended check list for identifying site characteristics, site development and layout. Efficient water management and waste water treatment, solid waste management. [7 Hrs]

Unit 2 : Energy efficiency

Solar passive techniques in building design to minimize load on conventional system i.e. heating, cooling, ventilation and lighting. Designing Energy efficient lighting and HVAC systems. Use of renewable energy system to meet part of building load. Green building certification. Overview various green building in India. Policy and regulatory mechanism. [7 Hrs]

Text Book :

Seven wonders of Green Building Technology- Karen Sirvaitis, Twenty first century books.

References :

1. Sustainable Building Design Manual, Volume 2, TERI, New Delhi
2. Energy Efficient Buildings in India, TERI, New Delhi
3. Sustainable Building Design Manual, Volume 1 TERI, New Delhi

503410 M2(iii): DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS

Teaching Scheme
Lectures: 4 Hrs./Week
Credits: 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Prerequisite: Fourier series, Fourier transform, Z transform

Course Outcome:
At the end of course student is able to
CO1: Classify discrete time signal and system and determine Z and inverse Z-transform of DTS.
CO2: Determine frequency response of first and second order LTI system with phase and group delay.

Unit 1
A) Discrete Signals and systems: Sampling of continuous time signals, quantization, aliasing, Sampling Theorem**,** Elementary discrete-time signals, classification, sequence operations, Discrete-time systems and classification, impulse response, linear convolution and its properties, Discrete-time systems described by difference equations. [4Hrs]
B) Z transform: Definition, basics, properties, inverse Z-transform using power series and partial fraction Solution of difference equation, Analysis of LTI system. [4Hrs]

Unit 2
Frequency analysis of discrete time signals:
A) Discrete Time Fourier Transform: Frequency response of DTS, Discrete frequency spectrum and range, DTFT Definition and its properties, Numericals. [3 Hrs]
B) Discrete Fourier Transform: Definition and Properties of DFT, Circular convolution, Linear convolution using circular convolution, Fast Fourier Transform: Radix 2 DIT and DIF algorithms. [5 Hrs]

Text Books:
1. Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
2. Proakis J., Manolakis D., "Digital signal processing", 3rd Edition, Prentice Hall, ISBN 81-203-0720-8
3. P.Ramesh Babu "Digital Signal Processing" 4^{th} Edition, Scitech Publication, Chennai

Reference Books:
1. Oppenheim A., Schafer R., Buck J., "Discrete time signal processing", 2nd Edition, Prentice Hall, 2003, ISBN-81-7808-244-6
2. Rebizant**,** Waldemar, Szafran, Janusz, Wiszniewski, Andrzej, "Digital Signal Processing in Power System Protection and Control", 1st Edition. Springer, 2011, ISBN 0857298011, 9780857298010

503411: PGLAB-II or MINI PROJECT

Students are instructed to frame and perform laboratory assignment/experiments based on each of theory Course. The assignment should encompass the hardware and engineering computation software such as MATLAB, PSCAD, ETAP etc. techniques/tools introduced in the concerned subjects and should prove to be useful for the PG program in the relevant field with moderate to high complexity. Assignment should be a full-fledged system design problems with multidimensional solutions suggested.

Or

The student should select a small project (as suggested by faculty adviser) relevant to Electrical Drives or Control System. Project work based on signal analysis, signal conditioning, state of art, professional software acquaintance like MATALAB, ETAP, PSCAD, PSIM similar work.

503412: SEMINAR-I

Seminar-I shall be on state of the art topic of student's own choice based on relevant specialization approved by an authority. Student should deliver seminar on the state of the art topic in front of the external examiners/internal examiners, staff and student colleagues. Prior to presentation student should carry the details of literature survey form standard references such as international journals and periodicals, recently published reference books etc. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and Head of the department/institute. The assessment shall be based on selection of topic its relevance to present context, report documentation and presentation skills.

Semester - III

603401: Power System Planning & Reliability

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

Examination Scheme
In Semester Assessment: 50
End Semester Assessments: 50

Prerequisites: Students should have gone through mathematics, power system, power system operation and control.

Course Objective:

1. To be familiar with load characteristics and its forecasting.
2. To acquire the mathematical knowledge based on probability analysis.
3. To give the student familiarities with the reliability indices based on IEEE standard 493 and 1366.
4. To give knowledge about generation planning with economic model design.
5. To give knowledge about transmission planning and understanding of Interregional transmission system in India.
6. To develop the ability to analyze and design the distribution system planning.

Course Outcome: After successful completion of this course, the student will be able to:

CO1 :- Evaluate load forecasting
CO2 :- Calculate reliability indices for utility, transmission and distribution system
CO3 :- Apply the knowledge of generation and transmission planning
CO4 :- Apply the knowledge of distribution planning

Unit 1: Load Forecasting:

Introduction; Factors Affecting Load Forecasting; Load Research; Load Growth Characteristics; Classification of Load and Its Characteristics; Load Forecasting Methods- (i) Extrapolation (ii) Co-Relation Techniques; Energy Forecasting; Peak Load Forecasting; Reactive Load Forecasting; Non-Weather sensitive load Forecasting; Weather sensitive load forecasting; Objectives and Factors affecting system planning; Short Term Planning; Medium Term Planning; Long Term Planning. [8 Hrs]

Unit 2: Mathematical Basics for Reliability Calculations:

Random variables; frequently occurring distribution functions (Binomial; Normal; Exponential; Gaussian); Markov Process; Regression analysis; Mathematical expectation probability concept. [6 Hrs]

Unit 3: Reliability:

Concept of Reliability; Failure analysis; Definitions of distribution system reliability and its indices (SAIDI, SAIFI, CAIDI, ASAI, ASUI); Definition of generation system reliability and its indices (LOLP; LOLE, EENS); Causes of interruption; Customer composite damage function (CCDF); Reliability cost. [8 Hrs]

Unit 4: Generation Planning:

Generation model; Functional economic analysis; Economic assessment method (Net Present Value method; Internal profit rate method; minimum cost method; annual equivalent value method); Capacity Expansion; Generation Optimization model; mathematical model of generation investment decisions & algorithms (Ranking algorithm; Steepest Descend method) Evaluation of Reliability for Generation Planning. [10 Hrs]

Unit 5: Transmission Planning:

Interregional transmission system in India; Analysis of causes of failure of transmission line; tower and substation equipment's; Role of construction monitoring of transmission projects; Long term transmission planning studies; Short term transmission planning studies; Evaluation of system & load point indices in a transmission network. [8 Hrs]

Unit 6: Distribution Planning:

Concept and Types of Distribution systems; Evaluation techniques; Causes of interrupts in distribution network & its equipment; Monitoring of distribution system through reconfiguration algorithm; Role of protective devices such as dis-connector, circuit breakers and isolators; Concept of partial load transfer; Effect of weather in distribution system planning; Evaluation of distribution system reliability indices. [8 Hrs]

Text Books:

1. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication.
2. Probability and Statistic for Engineers, Miler & Freund's, Pearson Education, Richard Johnson.
3. Electricity Economics & Planning – T.W.Berrie, Peter Peregrinus Ltd., London

Reference Books:

1. Modern Power System Planning – X. Wang & J.R. McDonald, McGraw Hill
2. Electrical Power Distribution Engineering - T. Gönen, McGraw Hill Book Company
3. Electrical Power Distribution A.S. Pabla, Tata McGraw Hill Publishing Company Ltd.

603402: POWER QUALITY ASSESSMENT AND MITIGATION

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hours / Week	In Semester Assessment: 50
Credits : 4	End Semester Assessment : 50

Course Objectives: - At the end of course, student will be able to

1. Understand important power quality attributes, various devices and methods of power quality measurements
2. Understand and learn to identify harmonics in systems
3. Learn various equipment of monitoring and assessment

Course Outcome: - At the end of course, student will be able to

CO1:- Identify the presence of power quality attributes
CO2:- Evaluate and measure various power quality attributes
CO3 :- Identify the sources of waveform distortion
CO4 :- Monitor and assess various types of power quality issues.

Unit1: Introduction
Importance of power quality, terms and definitions of power quality as per IEEE std. 1159.such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding.

[8Hrs]

Unit 2 : Flickers & transient voltages
RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Various means to reduce flickers. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages.

[8Hrs]

Unit 3 : Voltage sag, swells and interruptions
Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag.Major causes and consequences of voltage sags.Voltage sag characteristics.Voltage sag assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Measurement of voltage sag half cycle RMS, one cycle rms methods. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions.

[8 Hrs]

Unit 4 : Waveform Distortion I

Definition of harmonics, inter-harmonics, sub-harmonics.Causes and effect of harmonics. Voltage versus current distortion. Overview of fourier analysis. Harmonic indices and other indices for assessing impacts of harmonics.A.C. quantities under non-sinusoidal conditions.Triplen harmonics, characteristics and non-characteristics harmonics. Power assessment under waveform distortion conditions.

[8Hrs]

Unit 5 : Waveform Distortion II

Harmonics resonances - series and parallel resonances. Consequences of harmonic resonance.Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Modifying the system frequency response. Harmonic filtering, passive and active filters. IEEE Harmonic standard 519-1992.

[8 Hrs]

Unit 6 : Power Quality monitoring and assessment

Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality instrumentation. Selection of power quality monitors, selection of monitoring location and period. Selection of transducers. Harmonic monitoring , Transient monitoring, event recording and flicker monitoring. Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion.

[8 Hrs]

Text Books :

1. Understanding power quality problems, voltage sag and interruptions - M. H. J. Bollen IEEE press, 2000, series on power engineering.
2. Electrical power system quality - Pogei C. Dugan, Mark F. McGranghan, Surya santoso, H. Wayne Beaty, second edition, McGraw Hill Pub.

Reference Books:

1. Power system quality assessment - J. Arrillaga, M.R. Watson, S. Chan, John Wiley and sons.
2. Electric Power Quality - G. T. Heydt Stars in a circle Publications.
3. Power system harmonics: Computer modeling and analysis- Enriques Acha, Manuel Madrigal, John Wiley and sons Ltd.
4. Power System Harmonics – J. Arrillaga & N. Watson, John Wiley and sons.
5. IEEE STD 519-1992/ IEEE std 1159 IEEE recommended practices and requirements for harmonics control in electrical power system.

603403 M1(i) : RENEWABLE ENERGY

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs./Week	In-Semester Examination : 25 Marks
Credits : 4	End Semester Examination:50 Marks

Course Objectives: - At the end of course, student will be able to

1. Learn various renewable sources of power/energy such as solar , wind and others
2. Understand and learn important issues associated with grid integration of renewable energy sources.
3. Learn smart grid, technologies and communication network in smart grid

Course Outcome: - At the end of course, student will be able to

CO1:- Evaluate the potential of solar, wind and other sources of energy.
CO2 :- Apply smart grid concepts and technologies of smart grid

Unit 1
Solar Energy :.
Photovoltaic Systems: Introduction to the Major Photovoltaic System Types, Current–Voltage Curves for Loads, Grid-Connected Systems: Interfacing with the Utility, DC and AC Rated Power, The "Peak-Hours" Approach to Estimating PV Performance, Capacity Factors for PV Grid-Connected Systems¸ Grid-Connected System Sizing, Grid-Connected PV System Economics: System Trade-offs, Dollar-per-Watt Ambiguities, Amortizing Costs, Stand-Alone PV Systems, PV-Powered Water Pumping, PV systems – off grid systems and scope for inclusive growth of rural India. Grid autonomy. Calculation of system details [8 Hrs.]

Unit 2
Wind Energy : Wind Energy : wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Turbine rating blade design, turbine rating turbine design aspects, Choice of generators, electrical load matching, power control, Effect of wind speed variations, tower height and its effect, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation. Design consideration of wind farms and control [8 Hrs.]

Unit 3
Other Energy Sources:
Biomass – various resources, energy contents, technological advancements, conversion of biomass in other form of energy – solid, liquid and gases. Gasifiers, Biomass fired boilers, Co-firing, Generation from municipal solid waste, Issues in harnessing these sources. Hydro energy – feasibility of small, mini and micro hydel plants scheme layout economics. Tidal and wave energy, Geothermal and Ocean-thermal energy conversion (OTEC) systems – schemes, feasibility and viability. Fuel cell- types and operating characteristics, efficiency , energy output of fuel cell [8 Hrs.]

Unit 4

Grid Integration :

Stand alone systems, interconnection of distributor resources, concept of micro gird, formation of micro grid and economics hybrid with diesel, with fuel cell, solar-wind, wind –hydro systems, mode controller, load sharing, system sizing. Grid integration with the system: Interface requirements, Stable operation, Transient-safety, Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling.

Effect on power quality - harmonic distortion, voltage transients and sags, voltage flickers. Dynamic reactive power support. Systems stiffness. Energy storage, battery design, charging and charge regulators. Battery management, pumped storage, compressed air storages and ultra capacitors

[8 Hrs.]

Unit 5

Smart Grid :

Introduction to Smart Grid:, Concept of Smart Grid, Definitions, Need and Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid.

Smart Grid Technologies**:** Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation.

[8 Hrs.]

Unit 6

Communication Technology for Smart Grid:

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN), Phase Measurement Unit(PMU), 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. Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

[8 Hrs.]

Text Books :

1. Renewable energy technologies - R. Ramesh, Narosa Publication.
2. Energy Technology – S. Rao, Parulkar
3. Non-conventional Energy Systems – Mittal, Wheelers Publication.
4. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”,CRC Press
5. Renewable Energy Technologies – Chetan Singh Solanki, PHI Learning Pvt. Ltd.

Reference Books :

1. Wind and solar systems by Mukund Patel, CRC Press.
2. Solar Photovoltaics for terrestrials, Tapan Bhattacharya.
3. Wind Energy Technology – Njenkins, John Wiley & Sons,
4. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern.

5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill.
6. Solar Energy – S. Bandopadhyay, Universal Publishing.
7. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
8. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama,“Smart Grid: Technology and Applications”, Wiley
9. Jean Claude Sabonnadière, Nouredine Hadjsaïd, “Smart Grids”, Wiley Blackwell
10. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010
11. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press.
12. Mladen Kezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert “Substation Automation (Power Electronics and Power Systems)”, Springer
13. “SMART GRID Infrastructure & Networking”, KRZYSZTOF INIEWSKI, TATA McGRAW-HILL EDITION

603403 M1(ii): ADVANCE PROCESSORS AND APPLICATIONS

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs./Week	In-Semester Examination : 25 Marks
Credits : 4	End Semester Examination:50 Marks

Course Objectives:

After the completion of the course students will be able to

1. Understand the special features and architecture of Digital Signal Controller/processor.
2. Understand the memory mapping and data memory access.
3. Understand digital I/O operation.
4. Understand advance features like QEP, interrupt structure, ADC and PWM.

Course Outcomes:

CO1:Write an embedded C language programs for TMS 320F2812.
CO2: Use Code Composer Studio for programing TMS 320F2812.
CO3: Write programs for Digital Input output, Interrupts and ADC.
CO4: Connect trainer kit of TMS320F2812 to external devices.
CO5: Use advance features like PWM, QEP, inverter control for engineering applications

Unit 1

Introduction to the concept of digital signal processor, digital signal controller, basic architectures, essential features of digital signal processor/controller, Texas families of processors C2000, C5000, C6000, their features and applications. [6 Hrs]

Unit 2

Evolution of C2000 family, TMS 320F2812 block diagram, math units, data memory access, internal bus structure, ALU, instruction pipeline, memory map, code security module, interrupt response. [8 Hrs]

Unit 3

Digital input/output interface: GPIO register structure, digital I/O registers, clock module, watchdog timer, system control and status register. [8 Hrs]

Unit 4

Interrupt system: Interrupt lines, reset boot-loader, interrupt sources, maskable interrupt processing, peripheral interrupt expansion, C28x CPU timers, applications. [8 Hrs]

Unit 5

Event manager: Block diagram, timer operating modes, interrupt sources, GP timer registers, GP timer interrupts, event manager compare units, capture units, QEP unit, applications.

[10 Hrs]

Unit 6

Analog Digital Converter: ADC module overview, ADC in cascaded mode, ADC in dual sequencer mode, ADC conversion time, ADC register block, applications. [8 Hrs]

Text Books:

1. 'Programming and Use of TMS320F2812 DSP to Control and Regulate Power Electronic Converters'by Baris Bagci, Grin Verlag, 2007.
2. 'Digital Signal Processing' by Avatar Singh, S. Srinivassan, Cengage Learning, 2004.

References:

1. 'TMS320F2812 Digital Signal Processor: Implementation Tutorial' by Texas Instruments.
2. 'TMS320x281x DSP Event Manager (EV) Reference Guide' by Texas Instruments.

603403 M1(iii): ARTIFICIAL NEURAL NETWORK AND ITS APPLICATIONS IN POWER SYSTEMS

Teaching Scheme
Lectures: 4 Hrs./Week
Credits : 4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Course Objectives: - At the end of course, student will be able

1. To introduce to the fundamentals of artificial neural network along with its original source of development.
2. To inform about various architecture and learning rules of ANN
3. To inform about the single layer and multilayer perceptron models
4. To explore learning rules of feed forward network, self organizing map and radial basis function.
5. To study various applications of ANN

Course Outcome:- At the end of course, student will be able to

CO1: Understand the basics of ANN along with all properties
CO2: Understand, compare and select architectures of ANN
CO3: Understand, compare and select learning rules of ANN
CO4: Apply the knowledge of ANN for various applications

Unit 1:
Basics of Artificial Neural Network:
Biological neurons: Function of single biological neuron, function of artificial neuron, Basic terminology related to artificial neuron. Characteristics of ANN, Typical applications of ANN such as classification, pattern recognition, forecasting Properties, strength of NN [8Hrs]

Unit 2:
Different Architectures of ANN and Learning Processes:
Different architectures of Neural Network, types of activation function, concept of Learning with a Teacher, Learning without a Teacher, Learning Tasks (Any two learning methods and applications) [8 Hrs]

Unit 3:
Single Layer Network and Multi-layer Network :
Single Layer Perceptron: architecture – training algorithm, Least – Mean square algorithm, learning curves, Learning Rate, [8Hrs]

Unit 4:

Feed forward Neural Network: Fundamentals, Algorithms

Architecture, Back propagation algorithm, Concept of learning rate, momentum coefficient, sequential and batch mode of training, Generalization capacity, cross validation, Limitation of Back-propagation algorithm, accelerated convergence of back- propagation learning. [8 Hrs]

Unit 5:

Self Organizing Maps and Radial Basis Function Networks: Fundamentals, Algorithms Two basis feature-mapping model, competitive process, cooperative process, adaptive process self organizing map algorithm, properties Cover's theorem, Regularization theory, Regularization network, generalized Radial Basis Function Networks, properties of RBF network, learning strategies. [12 Hrs]

Unit 6:

Applications of ANN in Power System

Understanding of various applications of ANN in power system areas such as forecasting, classification, planning, operation, control and protection. [4 Hrs]

Text Books:

1. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson Education.

2. Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, "AI Techniques in Power System", IEE London U.K.

Reference Books:

2. Mohamed H. Hassoun, "Fundamentals of Artificial Neural Network", Practice Hall India.
3. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Network Using MATLAB 6.0", Tata McGraw Hill
4. S. Rajsekaram, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis & Applications", Practice Hall India

603403 M2(i): ARTIFICIAL INTELLIGENT TOOLS

Teaching Scheme	**Examination Scheme**
Lectures: 1 Hr/Week	In-Semester Examination : 25 Marks
Credit : 1	

Course outcome

At the end of this course student is able to

CO1: Model and design control scheme using fuzzy logic.

CO2: Apply genetic algorithm in power system optimization problem.

Unit 1: Fuzzy Logic System

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Selforganizing fuzzy logic control. Case studies and assignment based on applications of fuzzy logic. [7Hrs]

Unit 2 : Genetic Algorithm

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Concept on some other search techniques like tabu search and and-colony search techniques for solving optimization problems. GA application to power system optimization problem, Case studies: based on use of GA for optimization. [7Hrs]

Text Books:

1) M. Ganesh "Introduction to Fuzzy Sets and Fuzzy Logic", Prentice Hall, India.

2) Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.

Reference Books:

1) KOSKO B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.

2) KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.

3) Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.

603403 M2(ii):INTELLIGENT SENSORS AND INSTRUMENTATION

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Course outcome

At the end of this course student is able to

CO1: Design sensors and transducer for measurement of electrical and non electrical quantities and convert signals into analog or digital form.

CO2: Distinguish between primary sensors, IC technologies, micro and nano sensors.

Unit 1 : Introduction

Sensors: primary sensing principles and measurement variables, sensor performance characteristics and terminology. Instrumentation: transducer measurement circuit, signal conditioning circuit, Data conversion: DAC, ADC, virtual instrumentation with Lab View. [7 Hrs]

Unit 2 Smart Sensors

Primary sensors; excitation; compensation; information coding/ processing; data communication; standards for smart sensor interface. Recent trends in sensor technologies: Introduction; film sensors (thick film sensors, thin film sensors); semiconductor IC technology standard methods; Micro Electro-Mechanical Systems (micro-machining, some application examples); nanosensors. [7 Hrs]

Text books:

1) Barney, G. C., “Intelligent Instrumentation”, Prentice Hall, 1995.
2) D. Patranabis, “Sensors and Transducers”, PHI, 2003.

Reference Book:

1. Alan S. Morris, “Principles of Measurement & Instrumentation”, PHI Pvt. Ltd., 1999.

603403 M2(iii): HUMAN RIGHTS

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Course outcome
At the end of this course student is able to
CO1:Learn about policies, schemes and Constitution about Human rights
CO2: Learn roles of various entities about human rights

Unit 1:
Human Rights – Concept, Development, Evolution
- Philosophical, Sociological and Political debates
- Benchmarks of Human Rights Movement.

Human Rights and the Indian Constitution
- Constitutional framework
- Fundamental Rights & Duties
- Directive Principles of State Policy
- Welfare State & Welfare Schemes

Human Rights & State Mechanisms
- Police & Human Rights
- Judiciary & Human Rights
- Prisons & Human Rights
- National and State Human Rights Commissions [7 Hrs]

Unit 2 :
Human Rights of the Different Sections and contemporary issues
- Unorganized Sector
- Right to Environment,
-Globalization and Human Rights
- Right to Development,

Citizens' Role and Civil Society
- Social Movements and Non-Governmental Organizations
- Public Interest Litigation
-Role of Non Government organizations in implementation of Human rights.
- Right to Information

Human Rights and the international scene –Primary Information with reference to Engineering Industry
- UN Documents
- International Mechanisms (UN & Regional)
- International Criminal Court [7Hrs]

References:

1) Study material on UNESCO,UNICEF web site
2) HUMAN RIGHTS IN INDIA A MAPPING, Usha Ramanathan
Available at: http://www.ielrc.org/content/w0103.pdf
3) Introduction to International Humanitarian Law by Curtis F. J. Doebbler - CD Publishing , 2005.
4) Freedom of Information by Toby Mendel - UNESCO, 2008

603404: SEMINAR– II

Teaching Scheme
4 Hrs / week
Credits: 04

Examination Scheme
Term work: 50 Marks
Oral/ Presentation: 50Marks

Seminar II shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization and based on broader area of interest to facilitate to proceed for dissertation work, selected by him/her approved by the guide and authority. He/she should study basic theory related to the topic from standard references. A student is expected to perform the exhaustive literature review of the topic. The student should focus on understanding the state of art – concept, literature published at standard platforms to enable the finalization of objective of his/her ME dissertation. A guide should maintain weekly record of discussion related to the topic. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.

603405: PROJECT STAGE - I

Teaching Scheme	Examination Scheme
8 Hrs / week	Term work: 50 marks
Credits: 08	Oral: 50 Marks

Project work Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/block diagram/ PERT chart, etc.) simulation model, Layout & Design of the Set-up and results if obtained. As a part of the progress report of Project Stage-I, the student shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The project stage I is the progress presentation of dissertation work. The student should clearly present different stages in which dissertation work is to be completed, giving planning of the remaining part to be completed in Project Stage-II. Publication based on the work is desirable in the reputed national or international journal or in the proceedings of reputed and reviewed conferences. A guide should maintain record of discussion related to the topic, work carried out by the student. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department / Institute.

Semester IV

603406: SEMINAR- III

Teaching Scheme	Examination Scheme
5 Hrs / week	Term work: 50 Marks
Credits: 05	Oral/ Presentation: 50Marks

Seminar III shall preferably be an extension of seminar II. The content of report of seminar III will include development of the work till date along with relevant theory. A guide should maintain record of discussion related to the topic, work carried out by the student, action taken etc. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

603407: PROJECT WORK STAGE - II

Teaching Scheme	**Examination Scheme**
20Hrs / week	Term work: 150 marks
Credits: 20	Oral: 50 Marks

In Project Work Stage – II, the student shall complete the remaining part of the project which will consist of simulation, fabrication of set up required for the project, work station, conducting experiments and taking results, analysis & validation of results and conclusions. A student must publish minimum one paper based on the dissertation work in the reputed national or international journal or in the proceedings of reputed and reviewed conferences. Details of this publication should be mentioned in the final report. The dissertation work of candidate would be evaluated by the guide as well as panel of internal/external experts, before submitting it to the university so as to ensure basic minimum quality standard. A proper record of this evaluation is needed to be maintained. A guide should maintain record of discussion related to the topic, work carried out by the student, action taken etc. The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide, head of the Department and head of the Institute.