DEPARTMENT OF ELECTRICAL ENGINEERING

M.Tech. in Power Systems Engineering
FIRST SEMESTER

S. No.	Board of Study	Subject Code	Subject	Periods per week			Scheme of exam			Total Marks	Credit L+(T+P)/2
				L	T	P	Theory/Practical				
							ESE	CT	TA		
1.	Electrical Engg.	EE226101	Power System Dynamics and Stability	3	1	-	100	20	20	140	4
2.	Electrical Engg.	EE226102	Computer Methods in Power System	3	1	-	100	20	20	140	4
3.	Electrical Engg.	EE226103	Digital Power System Protection	3	1	-	100	20	20	140	4
4.	Electrical Engg.	EE226104	Flexible AC Transmission System (FACTS)	3	1	-	100	20	20	140	4
5.	Refer Table-I		Elective-I	3	1	-	100	20	20	140	4
6.	Electrical Engg.	EE226191	Problem Solving Approach using MATLAB	-	-	3	75	-	75	150	2
7.	Electrical Engg.	EE226192	Protection Simulation Lab	-	-	3	75	-	75	150	2
TOTAL				**15**	**5**	**6**	**650**	**100**	**250**	**1000**	**24**

Table -I

Elective- I			
Sr. No.	**Board of Study**	**Subject Code**	**Subject**
1	Electrical Engg.	EE226121	Power Electronics for Renewable Energy System
2	Electrical Engg.	EE226122	Application of DSP to Power System
3	Electrical Engg.	EE226123	Smart Grid Technology

Lecture T- Tutorial P- Practical ESE- End Semester Exam
CT- Class Test TA- Teachers Assessment

Note(1)– 1/4th of total strength ofstudents subject tominimumoftwentystudentsisrequiredtoofferan elective in the college in a Particular academicsession.

Note(2)–

Choiceofelectivecourseoncemadeforanexaminationcannotbechangedinfutureexaminations.

M. Tech (Power System Engineering)

Subject Code	Power System Dynamics and Stability	L = 3	T = 1	P = 0	Credits = 4
EE226101	ESE	CT	TA	Total	ESE Duration
Evaluation Scheme	100	20	20	140	3 Hrs

COURSE OBJECTIVES	COURSE OUTCOMES
1. To understand the concept ofdynamic model of synchronousmachine. 2. To study the multi-machine simulationof dynamicmodels. 3. To understand the concepts of thesmall signalstability. 4. To investigate the physical and mathematical aspect of energyfunction methods. To discuss the concept of voltage stability and sensitivity analysis.	1. The understanding of dynamic modelof synchronous machine will bedeveloped. 2. Simulation study of multi-machinedynamic model will be delivered. 3. The concepts of small signal stability willbe understood. 4. The different aspect of energyfunction methods will beinvestigated. The concept of voltage stability and sensitivity analysis will be understood.

UNIT – I Introduction to PowerSystemStability **CO1**

Power System Operation and Control.Stability problems faced by power systems, Impact on power system operation and control.

Analysisof Dynamical Systems: Concept of Equilibrium, Small and Large Disturbance Stability. Single Machine Infinite Bus System, Modal Analysis of Linear Systems, Analysis using NumericalIntegrationTechniques. **[10Hrs]**

UNIT – II Modelingof ASynchronousMachine **CO2**

Physical Characteristics, Rotor Position Dependent model, Park's Transformation, Model with Standard Parameters, Steady State Analysis of Synchronous Machine, Short Circuit Transient Analysis of a Synchronous Machine, Synchronous Machine Connected to Infinite Bus. **[10Hrs]**

UNIT – III ExcitationSystems **CO3**

Simplified View of Excitation Control, Control Configurations, Typical Excitation Configurations, Excitation Control System Definitions, Voltage Regulator, Excitation System response, State – Space Description of the Excitation System, State Space Representation of the Excitation system,

Effect of Excitation on Stability: Effect of Excitation on Generator Power limits, Effect of the Excitation System on Transient Stability, Effect of Excitation on Dynamic Stability, **[10Hrs]**

UNIT – IV Stability Issuesin InterconnectedPowerSystems **CO4**

Single Machine Infinite Bus System, Multi-machine Systems, Stability of Relative Motion, Frequency Stability: Centre of Inertia Motion, Concept of Load Sharing: Governors, Single Machine Load Bus System: Voltage Stability,TorsionalOscillations. **[10Hrs]**

UNIT – V EnhancingSystemStability: **CO5**

Planning Measures, Stabilizing Controllers (Power System Stabilizers), Operational Measures-Preventive Control,EmergencyControl. **[10Hrs]**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1)	Power System Dynamics	K.R. Padiyar	2002	B.S. Publications, Hyderabad,
2)	Power System Stabilityand Control	PrabhaKundur	1993	Mc-Graw HillInc, New York
3)	Power system control and stability	P.M. Anderson and A.A. Fouad	2nd edition, 2002	B.S. Publications Hyderabad,
	Power System Dynamics and Stability	Peter W. Sauer &M. A. Pai,	2008	Prentice Hall

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1)	Power System Dynamics: Stability and Control	K.R. Padiyar	1st edition 2004	Anshan
2)	Power System Stability	E.W. Kimbark	Vol. 2, 2000	IEEE press, N.Y,
3)	Power System Voltage Stability	Taylor C.W	1993	Mc-Graw Hill Inc, New York

Subject Code EE226102	Computer Methods in Power System	L= 3	T = 1	P = 0	Credits= 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objectives	Course Outcomes
This course will cover the 1. Modeling issues and analysis methods for the power flow, short circuit, contingency and stability analyses, required to be carried out for the power systems. 2. Necessary details of numerical techniques to solvenonlinear algebraic as well as differential equations willalsobeincluded. 3. Different types of stability phenomena have been observed in the power systems, which need to becritically analyzed, utilizing appropriate dynamic model of thesystem.	Onsuccessfulcompletion ofthecourse,thestudent willbeableto: **CO1**:-Develop proper mathematical models for analysis of a selected problem like load flow study or fault analysis. **CO2**:-Student able to analysis of different type fault in a power system. **CO3**:-Student able to understands different load flow techniques. **CO4:**-Student able to understand stability analysis of power system **CO5**:- Student able to understand the power system security concepts.

UNIT– INetworkequations: CO1

Network equations, graph theory, Bus admittance matrix by step by step method, primitive network, bus incidence matrix, formation of Y_{bus} by singular transformation, bus impedance matrix by inversion of Y_{bus}, algorithm for bus impedance matrix, addition of a branch, addition of link, modification of $Z_{bus}$by changesinprimitivenetwork. Conceptofusingthesematricesforloadflowstudyandfaultstudy.**[8Hrs]**

UNIT– IIFault Analysis: CO2

Fault Analysis, [ZBUS] Building algorithm, sequence matrices, Symmetrical and Unsymmetrical Short-Circuit Analysis of Large Power Systems, Phase Shift in sequence quantities due to transformers. **10Hrs]**

UNIT– III LoadFlowStudy: CO3

Introduction, power systemequations, solution technique ieGauss Seidel, Newton Raphson and fast decoupled load flow, incorporation of voltage controlled busses, representation of transformer, introduction to optimal loadflowtechnique. [**10Hrs]**

UNIT– IVTransientStabilityStudies: CO4

Introduction, swing equation, machine equations, power system equations, solution techniques, example of transient stability calculations, exciter and governor control system, description of transient stability program. **[10Hrs]**

UNIT– VPowerSystemSecurity: CO5

Introduction, Factors affecting Security, State Transition Diagram, Contingency Analysis Using Network Sensitivity Method and AC Power Flow Method, Correcting the Generation Dispatch Using Sensitivity Methods, Introduction toStateEstimation. **[10Hrs]**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1)	Computer Aided Power System Analysis.	George L. Kusic	1989.	Prentice Hall of India (P) Ltd.
2)	Power System Analysis	Arthur R. Bergen, Vijay Vittal	2nd Edition 1999	Prentice Hall of India (P) Ltd.

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1)	Power System Analysis	A. Sadat	2000	McGraw Hill Co. Ltd
2)	Modern Power System Analysis	I.J. Nagarath, D.P. Kothari	1994	Tata McGraw-Hill, New Delhi
3)	Computer Aided Power System Analysis & Control	A.K. Mahaianabis, D.P. Kothari, S.I. Ahson	1988	Tata McGrawHill New Delhi

Subject Code EE226103	Digital Power System Protection	L=3	T= 1	P = 0	Credits=4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objective	Course Outcomes
1. To illustrate concepts oftransformer protection. 2. To describe about the various schemesof over- currentprotection. 3. To analyze distance and carrierprotection. 4. To familiarize the concepts ofBusbar protection and Numericalprotection. 5. To distinguish all kinds of relays for protection of Generators, Transformersand feeder bus bars fromover voltages and other hazards.	Upon the completion of the subject, the student will be able to 1. Describe the necessity for the protection ofalternators, transformers and feeder bus bars from over voltages and other hazards 2. Illustrate neutral grounding, and how over voltages canbe generated and how system can beprotected against lightning and switching transient over voltages with various protective means. 3. Identify operation and control of numerical basedrelays.

UNIT–I Protective Relaying

Qualities of relaying, Definitions, Codes, Standards, Characteristic Functions, Classification, analog-digital-numerical, schemes and design, factors affecting performance, zones and degree of protection, faults types and evaluation, Instrument transformers for protection.

UNIT-II Static Relays: Basic static relay units, sequence networks, fault sensing data processing units, FFT and Wavelet based algorithms, Phase& Amplitude Comparators, Duality, Zero Crossing/Level Defectors, Relay Schematics and Analysis, Over Current Relay, Instantaneous/Inverse Time –IDMT Characteristics; Directional Relays; Differential Relays, Restraining Characteristics; Distance Relays: Types,Characteristics;

UNIT-IIIProtection of Power System Equipment: Generator, Transformer, Generator, Transformer Units, Transmission Systems, Bus-bars, Motors; Pilot wire and Carrier Current Schemes; System grounding, ground faults and protection, Load shedding and frequency relaying, Out of step relaying, Re-closing and synchronizing.

UNIT-IV Numerical relays: Characteristics, Functional Diagrams, architecture, algorithms, Microprocessor & DSP based relays, sampling, aliasing, filter principles, Integrated and multifunction protection schemes, SCADA based protection systems, FTA, Testing of Relays.

UNIT-V Real Time Operating Systems:

AC Circuit Breakers : Current interruption, Transient Recovery Voltage (TRV) , Rate of rise of TRV, Resistance switching, Damping of TRV, Opening Resistors, Inductive & Capacitive current interruptions , Currentchopping, Rated characteristics of Circuit breakers, Types of Circuit Breakers, Testing of High Voltage AC Circuit Breakers

Text Books:

S.No.	Title	Authors	Edition	Publisher
1)	Power System Protection & Switchgear	B. Ram	2011	McGraw Hill
2)	Digital Power System Protection	S.R.Bhide	2014	PHI
3)	The art and science of protective relaying	C.R. Mason	1964	Wiley India Pvt. Ltd

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1)	Digital Protection- Protective Relaying from Electromechanical to Microprocessor	L. P. Singh	1997	New Age International
2)	Power system protection static relays with microprocessor	T.S.Madhav Rao	1989	Tata McGraw
3)	Protective Relaying, Principles and Applications	Blackburn, J. Lewis	1986	Marcel Dekker, Inc

SubjectCode EE226104	Flexible AC Transmission System	L= 3	T = 1	P = 0	Credits= 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objectives	Course Outcomes
• To understand the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers & theirbenefits • To recall the objectives of Shunt and Seriescompensator. • To explain control of STATCOM and SVC and their comparison And the regulation ofSTATCOM • To analyze the functioning and control of GCSC, TSSC, TCSC andSSSC • To analyze the functioning and control of combined Compensators(IPFC& UPFC)	On successful completion of the course, the student Will be able to: • Choose proper controller for the specificapplication based on system requirements. • Understand various systems thoroughly and their requirements. • Interpret the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stabilityEnhancement. • Detect the Power and control circuits of Series Controllers GCSC, TSSC , TCSC,SSSC • Detect the Power and control circuits of combined Compensators(IPFC&UPFC)

UNIT–IFactsConcepts **CO1**

Fundamentals of AC power transmission, Transmission problems and needs, Overview of stability, Power Flow in AC System, FACTS Concept and General System Considerations , Definitions on FACTS, Basic types ofFACTSControllers. **[8Hrs]**

UNIT–IIStaticShuntCompensators: **CO2**

Concept of Static Shunt Compensators, variable impedance type shunt compensators (TCR, TSC, FC-TCR, TSC-TCR) - circuit diagram, principle of operation, working, waveforms / characteristics. Switched converter type shunt compensator (SVC and STATCOM) - circuit diagram, principle of operation, working, waveforms / characteristics SVC and STATCOM, and its control scheme .Comparison between SVC and STATCOM **[10Hrs]**

UNIT–IIIStaticSeriesCompensators **CO3**

Concept of series compensation, variable impedance type series compensators (GCSC, TSSC, TCSC, SSSC), Switching converter type series compensators - circuit diagram, principle of operation, working, waveforms/characteristics, control schemes forseriescompensators. **[10Hrs]**

UNIT–IVCombinedCompensators **CO4**

Combined Series-Series FACTS compensators and other special purpose of Interline power flow controller (IPFC) - objectives and need, principle of operation.

Combined Series-Shunt FACTS compensators and other special purpose of Unified Power flow Controller (UPFC) - objectives and need, principle ofoperation. **[10Hrs]**

UNIT–VPhaseAngleRegulators **CO5**

Objectives of Static voltage and phase angle regulators, power flow control, improvement of transient stability,

Power oscillation damping, thyristor-controlled voltage and phaseangleregulators. **[10Hrs]**

TextBooks:

S. No.	Title	Authors	Edition	Publisher
1)	Reactive Power Control in Electric Systems	T.J.E Miller	2003	John Wiley & Sons
2)	FACTS Controllers in Power Transmission and Distribution	K.R.Padiyar	2007	NewAge International

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1)	Understanding FACTS: Concepts and Technology of Flexible AC	N.G. Hingorani& L. Gyugyi	2000	IEEE Press

M. Tech (Power System Engineering)
First Semester

Subject Code	Problem Solving Approach using MATLAB	L = 0	T = 0	P = 3	Credits = 2
EE226191	ESE	CT	TA	Total	ESE Duration
Evaluation Scheme	75	--	75	150	--

List of Experiments

1. Introduction to MATLAB and other Simulation software
2. Determination of time response of an R-L-Ccircuit.
3. Z-bus and Y-bus formulation and theirinversion.
4. Load flow studies (Gauss-Siedle method, Newton Raphsonmethod)
5. Flow study with Fast DecoupledMethod.
6. Fault analysis (balanced andunbalanced)
7. Solution of Swing equations by modified Euler'smethod.
8. Simulating Power Systems with Simulink
9. Solution of Power System equations using Modified Euler'sMethod.
10. Solution of Swing equations using Runge – Kutta method(RK4).

Subject Code	Protection Simulation Lab	L=0	T=0	P =3	Credits= 2
EE226192	ESE	CT	TA	Total	ESEDuration
Evaluation Scheme	75	-	75	150	-

List of Experiments

- Ratio Test of a C.T and determination oferror.
- Determination of knee point voltage of aCT.
- Summation Transformercharacteristics.
- Study of CT Connection for E/Fprotection.
- Study of Open delta PT Connection for earth faultindication.
- Protection of 3 ph. Alternator (simulationstudy).
- Protection of 3 ph. Induction Motor (simulationstudy).
- Over current / under voltage / Negative sequence Relay Characteristics (simulationstudy).
- Simulation of Transmission lineprotection.
- Study of differential protection of transformer (simulationstudy).

M. Tech (Power System Engineering)
Elective Subjects

Subject Code EE226121	Power Electronics For Renewable Energy System	L=3	T =1	P=0	Credits=4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	

Course Objectives	Course Outcomes
-> To Provide knowledge about the stand alone and grid connected renewable energy systems. -> To equip with required skills to derive the criteria for the design of power converters for renewable energy applications. -> To analyze and comprehend the various operating modes of wind electrical generators and solar energy systems. -> To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems. -> To develop maximum power point tracking algorithms.	Onsuccessfulcompletion ofthecourse,thestudent willbeableto: **CO1**:-Examine the various types of renewable energy sources **CO2**:-Acquiring the knowledge about the performance of IG, PMSG, SCIG and DFIG **CO3**:-Ability to fabricate different power converters namely AC to DC , DC to DC and AC to AC converters for renewable energy sources **CO4:**-Analyze various operating modes of wind electrical generators and solar energy system **CO5**:-Strengthen the knowledge about maximum power point tracking algorithms

UNIT–I Introduction: **CO1**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewableenergysystems. **[8Hrs]**

UNIT– II Electrical Machines For RenewableEnergy Conversion: **CO2**

Reference theory fundamentals-principle of operation and analysis: IG(Induction Generators), PMSG(Permanent Magnet Synchronous Generator), SCIG(Squirrel-Cage Induction Generator) and DFIG (Doubly-FedInductionGenerator). **[8Hrs]**

UNIT– III Power Converters: **CO3**

Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phaseAC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters.**[8Hrs]**

UNIT– IV Analysis Of Wind AndPvSystems: **CO4**

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system- Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integratedsolarsystem. **[8Hrs]**

UNIT– V Hybrid RenewableEnergySystems: **CO5**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power PointTracking(MPPT). **[8Hrs]**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1)	Wind Electrical Systems	S. N. Bhadra, D.Kastha, S.Banerjee	2005	Oxford University Press
2)	Non-conventional Energy sources	B.H.Khan	2009	Tata McGraw-hill Publishing Company, New Delhi

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1)	Power electronics Hand book	Rashid .M. H	2001	Academic press
2)	Variable speed generators	Ion Boldea	2006	Taylor & Francis group
3	Non conventional energy sources	Rai. G.D	1993	Khanna publishes
4)	Wind energy system	Gray, L. Johnson	1995	Prentice Hall of India (P) Ltd.
5)	Introduction to Modern Power Electronics	Andrzej M. Trzynnadlowski	2nd edition, 2012.	Wiley India Pvt. Ltd

Subject Code EE226122	Application of DSP to Power System	L= 3	T = 1	P = 0	Credits= 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

CourseObjectives	CourseOutcomes
This course will cover the 1.Comprehend characteristics of various types of signalprocessing. 2.Analyze and process signals using wavelet transformtechniques. 3.Analyze linear estimation of signals and applications. 4.Illustrate the study of adaptive signal processing.	Onsuccessfulcompletion ofthecourse,thestudent willbeableto: **CO1**:-Design multi rate signal processing of signals through systems. **CO2**:-Perform statistical analysis and inferences on various types of signal processing. **CO3**:-Design 2-D and 3-D signals and systems. **CO4:**-Perform different types of application on linear estimation on signals. **CO5**:-Design filters to suit specific requirements for specific applications.

UNIT– I MultirateSignalProcessing: **CO1**

Decimation, Interpolation, DFT filter banks, QMF filter banks, Multiresolution Signal analysis, Wavelet theoryof sub-band decompositions, Sub-band coding and wavelet transforms, application of wavelet transforms.**[8Hrs]**

UNIT– II HomomorphicSignalProcessing: **CO2**
Homomorphic system for convolution, properties of complex spectrum, Applicationsof homomorphicdeconvolution. **[10Hrs]**

UNIT– III Multi-DimensionalSignalProcessing: **CO3**
Review of convolution and correlation, 2-D signalsandsystems. **[10Hrs]**

UNIT– IV Linear estimation of Signalsandapplications: **CO4**
Random Signals, Linear prediction and applications (deconvolution, least square filters). Recursive estimation and Kalmanfilters. **[10Hrs]**

UNIT– VAdaptiveSignalProcessing: **CO5**
Adaptive filtersand itsapplications. **[10Hrs]**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1)	Multirate Systems and Filter Banks	P.PVaidyanathan	1993	Prentice Hall of India (P) Ltd.
2)	Introduction to DSP	Proakis, Manolakis	1994	PHI Publishers

Reference Books:

S. No.	Titlee	Authors	Edition	Publisher
1)	Introduction to Wavelet Transforms	Barrus, Gopinath, Guo	1998	Prentice – Hall, New Jersey
2)	Discrete Time Signal Processing	A V Oppenheim, R W Schafer	1994	PHI Publishers

Subject Code EE226123	Smart Grid Technology	L= 3	T = 1	P = 0	Credits= 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

CourseObjectives	CourseOutcomes
This course will cover the To understand various Power quality issues in Microgrid and introduction to Smart Gridtechnologies. 3. To understand Renewable Energy and its storage options for smart gridtechnologies. 4. To understand Smart Grid measurement & communicationtechnology.	Onsuccessfulcompletion ofthecourse,thestudent willbeableto: **CO1**:-Understand the concept and evolution of smart grid. **CO2**:-Smart grid communication and measurement technologies like Phasor Measurement Unit(PMU),Smart meters, Wide Area Monitoring system (WAMS)etc. **CO3**:-Understanding the concept of micro Grids and Distributed EnergyResources. **CO4:**-Power quality issues in microgridslike modelling and stability analysis, regulatory standards and economics and basic smart gridconcepts. **CO5**:-know about the information and Communication Technology For Smart Grid

UNIT– I Introduction toSmart grid **CO1**

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies in SmartGrid. **[8Hrs]**

UNIT– II Smart Grid Communications andMeasurementTechnology: **CO2**

Communication and Measurement -Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS) -Advanced metering infrastructure- GIS and Google Mapping Tools, IP-based Systems,NetworkArchitectures. **[10Hrs]**

UNIT– III Micro Grids and DistributedEnergyResources: **CO3**

Conceptofmicrogrid,need &applicationsofmicrogrid,formationofmicro grid,issuesofinterconnection, protection & control of micro grid. Islanding, need and benefits, different methods of islandingdetection. DistributedEnergyResources:Smallscaledistributedgeneration,DistributedGenerationTechnology,Internal Combustion Engines, Gas Turbines, Combined Cycle Gas Turbines, Micro turbines, Fuel Cells, Solar Photovoltaic, Solar thermal, Wind power, Geothermal, - all sources as a DG. Advantages and disadvantages ofDG.

UNIT– IV:Power Quality Management inSmartGrid: CO4

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. **[10Hrs]**

UNIT– V: Information and Communication Technology ForSmartGrid: CO5

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Broadband over Power line (BPL). Adaptive filtersandapplications. **[10Hrs]**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1)	The Smart Grid: Enabling Energy Efficiency and Demand Response	Clark W. Gellings,	1993	CRC Press
2)	"Smart Grid: Technology and Applications"	JanakaEkanayake, N. Jenkins, K. Liyanage, J. Wu, Akihiko Yokoyama	1994	Wiley India Pvt. Ltd

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1)	Smart Grid: Fundamentals of design and analysis	James A.Momoh	2012	John Wiley & sonsInc
2)	Smart Grid: Integrating Renewable, Distributed & Efficient Energy	Fereidoon P. Sioshansi	2012	Academic Press