B.E (ELECTRICAL AND ELECTRONICS ENGINEERING)

Honors Degree Programme : MICRO GRID TECHNOLOGY

Semester	Subject Name	Credits
V	Elements of Smart Grid System and its operation	3
V	Renewable Energy Sources And Microgrid	3
VI	Smart Grid Communication Protocol	3
VI	Energy Storage Systems	3
VII	Analysis Of Power Converters And Controllers	3
VII	Grid Integration Of Electric Vehicles	3
VIII	Smart Grid Simulation Lab	2

Total Credits : 20

FIFTH SEMESTER

ELEMENTS OF SMART GRID SYSTEM AND ITS OPERATION

COURSE OBJECTIVES:

- To Study about Smart Grid technologies, different smart meters and advanced meteringinfrastructure.
- To familiarize the recent communication and security technologies in SmartGrid.
- To familiarize with the high performance computing for Smart Grid applications.

COURSE OUTCOMES:

- Ability to understand and analyze Smart grid operation, Advanced metering Techniques.

After the successful completion of the course students will be able to

COS No.	**Course Outcomes**	**Bloom's level**
CO1	Understand the fundamentals of smart power grids and its international& Indian scenarios.	Understand
CO2	Understand the automation process of substation and feeders	Understand
CO3	Understand the Distribution Automation,Outage management and PHEV	Understand
CO4	Explain advanced metering infrastructure and demand side management and the operation of transmission system with synchrophasormeasurement.	Understand
CO5	case studies of Load Forecasing, PMU placement and understand cloud computing in smart grid	Apply

UNIT I

INTRODUCTION TO SMART GRID

Basics of power systems, Evolution of Electric Grid- Concept and Definitions of smart grid - Need for Smart Grid - opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient and self- healing grid, Micro - grid and distributed energy resources, Power quality issues connection of renewable energy sources, National and International Initiatives in Smart Grid, Smart cities and pilot projects in India, Case study

UNIT II

SMART GRID TECHNOLOGIES (Transmission)

Technology Drivers, Smart energy resources, Smart sub stations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control.

UNIT III

SMART GRID TECHNOLOGIES (Distribution)

DMS, Fault Detection, Isolation and service restoration, Volt/VAr control, Outage management system (OMS), High - Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT IV SMARTMETERS AND ADVANCED METERING INFRASTRUCTURE

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT V

CASE STUDIES –

Smart grid experimentation plan for load forecasting- Optimal placement of Phasor Measurement Units (PMU) - Coordination between cloud computing and smart power grids - Development of power system models and control and communication software.

TEXT BOOKS:

1. Stuart Borlase " Smart Grid : Infrastructure, Technology and Solutions", CRC Press, 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jian zhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.
3. James Momoh, "Smart Grid: Fundamentals of Design and Analysis"- Wiley, IEEE Press, 2012.

REFERENCE BOOKS:

1. Vehbi C.Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P.Hancke, Smart Grid Technologies: Communication Technologies
2. Standards IEEE Transactions On Industrial Informatics, Vol.7,No.4, November, 2011.
3. Xi Fang, Satyajayant Misra, Guoliang Xue and DejunYang "SmartGrid–The New and Improved Power Grid: A Survey", IEEE Transaction on Smart Grids
4. A.G.Phadke and J.S. Thorp, "synchronized Phasor Measurements and their applications", Springer Edition, 2010. Online resources: 1. www.nptl.co.in 2. www.electrical4u.com

FIFTH SEMESTER

RENEWABLE ENERGY SOURCES AND MICROGRID

COURSE OBJECTIVES:

- To Study about different Renewable energy source
- To familiarize the Micro grid and its operation

COURSE OUTCOMES:

After completion of the course, the student will be able to

COS No.	**Course Outcomes**	**Bloom's level**
CO1	Understand different renewable energy sources	Understand
CO2	Evaluate dynamic models of wind energy system	Understand
CO3	Analyze and simulate control strategies for grid connected and off-grid systems	Understand
CO4	Understand components of AC and DC microgrids	Understand
CO5	Model and Analyze the behavior of Dynamic micro grids	Apply

UNIT 1

Introduction to Solar Energy:Impacts of large-scale integration of renewable Energy sources. Types of conventional and nonconventional dynamic generation technologies

Solar Photovoltaic Systems: Solar Resource, Generic Photovoltaic Cell, Equivalent Circuits, Cells to Modules to Arrays, I –V Curve, Impacts of Temperature and Insolation, Shading impacts on I–V curves, I–V Curves for different loads, MPPT, Grid-Connected Systems, Stand-Alone PV Systems, Dynamics of PV generation sources. Advances in PV controls.

UNIT II

WIND ENERGY SYSTEM:

Wind Energy-generating Systems, Power extraction in the Wind, Impact of Tower Height, Maximum Rotor Efficiency, Types of Wind Turbines, Fixed-speed Induction Generator (FSIG) based Wind Turbines, Doubly Fed Induction Generator (DFIG) based Wind Turbines, Fully Rated Converter-based (FRC) Wind Turbines, Dynamic modelling and analysis of wind energy system, Wind energy control system, Forecasting and techno- economic analysis of RES.

UNIT III

FUEL CELL:

Principles of Operation of Fuel Cells, Dynamic modelling and Simulation of PEM Fuel Cells, Solid Oxide Fuel Cells, Principles of Operation and modelling of Electrolysers, Power Electronic Interfacing Circuits for Fuel Cell Applications, Analysis and Control of Grid Connected Fuel Cell Power Generation Systems,Control of Stand Alone Fuel Cell Power Generation Systems, Hybrid Fuel Cell Based EnergySystem - Case Studies,

UNIT IV

CONCEPT OF MICROGRIDS:

Introduction to microgrid, the overview of the structure and architecture of microgrid, Need for islanding, Microgrid pilot projects and their outcomes.

AC and DC Micro grids: AC-microgrids: Control Mechanism of the DGs connected in microgrid. Virtual synchronous generator (VSG) and Droop control. Transient frequency response, active power Response, reactive power sharing and voltage regulation

DC-microgrids: DC microgrid control mechanism, droop control, issues in achieving active power sharing with impedance droop, remedies to achieve active power sharing. Dynamic modelling of individual components in AC and DC microgrids, state space modal analysis and influence of system parameters on the microgrid dynamics

UNIT V

STABILITY ANALYSIS AND CONTROL OF MICROGRIDS:,

Design of microgrid stabilizers to improve stability. AC-AC, AC-DC and DC-DC microgrid clustering, coordinated control schemes in multi-microgrids, Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids

Text Books:

1. Renewable and Efficient Electric Power Systems, G. Masters, IEEE- John Wiley and Sons Ltd. Publishers, 2013, 2nd Edition.
2. Integration of Renewable Sources of Energy, F. A. Farret, M. G. Simoes, Wiley, 2017, 2nd Edition.
3. Microgrids Architecture and control, N. D. Hatziargyriou, IEEE Press Series, John Wiley & Sons Inc, 2013, 1st Edition.
4. Microgrid Dynamics and Control, H. Bevrani, B. François, and T. Ise, John Wiley & Sons, 2017, 1st Edition.

Reference Books:

1. Cooperative Synchronization in Distributed Microgrid Control, Bidram, V. Nasirian, A. Davoudi, F. L. Lewis, Springer, 2017, 1st Edition.
2. Power System Stability and Control, P. Kundur, McGraw-Hill, Inc., 1994, 2nd Edition.
3. Solar Photovoltaic: Fundamentals, technologies & Applications, C. S. Solanki, PHI Publishers, 2019, 3rd Edition.
4. Wind Energy Generation Modelling and Control, O. Anaya-Lara, N. Jenkins, J. Ekanayake, P. Cartwright, M. Hughes, John Wiley & Sons Publishers, Ltd, 2009, 1st Edition.
5. Modelling and Control of Fuel Cells: Distributed Generation Applications, M. H. Nehrir, C. Wang, Wiley-IEEE Press, 2009, 1st Edition

SIXTH SEMESTER

SMART GRID COMMUNICATION PROTOCOL

COURSE OBJECTIVES:

- To Study about communication architecture and different Communication networks
- To familiarize the world wide communication standards

COURSE OUTCOMES:

After completion of the course, the student will be able to

COS No.	**Course Outcomes**	**Bloom's level**
CO1	Understand the communication Architecture of Smart grid	Understand
CO2	Understand the Elements of data communication networks and protocols	Understand
CO3	Understand the wire line communications for smart grid	Apply
CO4	Understand the wire less communications for smart grid.	Apply
CO5	Understand the different world wide communication standards for smart grid	Understand

UNIT I

COMMUNICATION NETWORK ARCHITECTURE FOR THE SMART GRID:

Introduction to Smart grid communications-Architecture Framework-Core Edge Architecture – Smart grid Network protocols – Smart grid domains and smart grid communication network - Premises Network- Neighbourhood Area network – Field Area Network – FAN protocol options Wide Area Network – Architecture – Role of communication infrastructure in smart grid – Customer premises-core communication network – Last mile connection– Automated Demand response – a case study

UNIT II

ELEMENTS OF COMMUNICATION NETWORKING FOR POWER SYSTEM PRACTIONERS:

Elements of Data Communication networks – Protocols and protocol layer –OSI reference Model - Data networking technologies – Physical Layer – Link layer – MPLS- Network layer IP – Network layer aspects of TCP/IP networks-TCP/IP protocol stack – QoS – IPv6,TCP/IP for wireless network - UDP – Networking standards

UNIT III

WIRE LINE COMMUNICATIONS IN SMART GRIDS:

Phone line technology- DSL overviews- DSL Scenarios- ADSL2+ and VDSL2 – C0axial cable technologies-Coax Scenarios – DOCSIS- Power line Technology-PLC Scenarios, channel and noise aspects- PLC Electromagnetic compatibility regulations- Narrow band PLC-broad band PLC-Evolution of PLC for Field area network

UNIT IV

WIRELESS COMMUNICATION IN SMART GRID:

Wireless Personal Area Networks – 802.15.4 Physical layer-802.15.4 Physical layer Medium Access Control sub layer – Zigbee network and Application layer – Wireless Local Area networks- Wi-Fi physical and MAC layer-Wireless metropolitan area networks- 802.16 Physical and MAC layer – Cellular networks- 5G mobile communication system – Satellite communications- Optical communications

UNIT V

SMART GRID COMMUNICATION STANDARDS:

Communication standards for substation Automation:IEC61850 – Communication for Telecontrol: IEC 60870-5 - 802.15.4 Physical layer - IEC 60834 Standards for Teleprotection Equipment - IEC 61970 Standards for Energy Management Services Application Program Interface (EMS-API) - IEC 61968—Application Integration at Electric Utilities—System Interfaces for Distribution Management Systems - IEC 62351 Standard for Cyber Security- IEEE C37.118.2-2011 Standard for Synchrophasor Data

Transfer - IEEE C37.118.2-2011 Standard for Synchrophasor Data Transfer - IEEE 1815-2012 Standard for Electric Power Systems Communications- Distributed Network Protocol (DNP3)

Text books:

1. Smart Grid Applications,communications and security by Lars Torsten Berger and Krzysztof Iniewski,Wiley publications
2. Communication networks for smart grid – Making smart grid Real, Kenneth C Budka,Jayant G Deshpande, Marina Thotta, Springer
3. Smart grids and their communication systems,Ersan Kabalci,Yasin Kabalci, Springer 4. Smart grid Communications and networking, Ekram Hossain,Zhu Han,H.Vincent poor,Cambridge University press

Reference Books:

1. Communication Challenges and Solutions in the Smart Grid, F. Bouhafs, M. Mackay and M. Merabti, Springer New York Heidelberg Dordrecht London, 2014, 1st Edition.
2. Simulation-Based Validation for Smart Grid Environments: Framework and Experimental Results, Wonkyu Han, Mike Mabey, Gail-Joon Ahn and Tae Sung Kim, Springer International Publishing Switzerland, 2014, 1st Edition.

SIXTH SEMESTER

ENERGY STORAGE SYSTEMS

COURSE OBJECTIVES:

- To study the different types of ESS
- To Analyse and model the characteristics of Energy storage systems

COURSE OUTCOMES:

After completion of the course, the student will be able to

COS No.	Course Outcomes	Bloom's level
CO1	Understand the characteristics of energy storage devices	Understand
CO2	Model and simulate the characteristics of energy storage systems	Understand
CO3	Explore the possibilities of deployment of energy storage systems in smart cites andelectric vehicles.	Understand
CO4	Evaluate and Suggest an efficient storage system in electric transportation.	Understand

UNIT I

INTRODUCTION:

Impacts and requirements of Electrical Energy Storage system, Classification of Energy Storage Systems, Energy costs and load analysis. Grid Applications of Energy Storage systems, Ancillary Services from Energy storage. Traditional generation costs and optimizations. Power flow and energy balancing in a wide area network. Economics of energy and power, tied electrical rates and demand response. Role of energy storage system in handling uncertainties with Renewable systems and in microgrids.

UNIT II

ELECTROCHEMICAL ENERGY STORAGE:

Batteries: Introduction to battery storage including lead acid, lithium ion, flow, and emerging battery technologies. Comprehensive analysis of design considerations and application specific needs. Impacts on system cost in terms of life cycle, environmental, and reliability of the end solutions.

UNIT III

ULTRA-CAPACITORS:

Introduction to ultra-capacitors including operation, applications, and emerging technologies. Topics include the usage in mobile applications and close proximity to renewable energy sources. Discussion of primary target market usage in today's energy and power sectors.

UNIT IV

Super Conducting Magnetic Energy Storage (SMES):

Introduction to Super Conducting Magnetic Energy Storage (SMES) operation, theory of usage and emergent research, with focus on large utility scale energy storage facilities.

Mobile and Fixed Energy Storage: Advantages and disadvantages of mobile vs. stationary energy storage, with focus on vehicle to grid applications and opportunities to leverage existing and emergent technology to provide additional grid support functions. Concept of time-of-day metering for storage planning and management.

UNIT V

MECHANICAL ENERGY STORAGE

Pumped Hydro: Models for pumped hydro capacity and availability, System cost, capacity, conversion efficiency, and siting

Compressed Gas: Compressed gas storage technologies as bulk energy storage. Models for compressed gas capacity, efficiency, and availability, System cost, capacity, conversion efficiency, siting and associated barriers, possible applications in carbon capture and appropriation.

Flywheel: Flywheel energy storage system, Models for flywheel capacity, availability, efficiency, and self-discharge, Applications in transportation, uninterruptible power supply (UPS), pulse power, and bulk storage, Selection and design of flywheels for safety and availability in various applications.

UNIT VI

THERMAL:

Introduction to thermal storage in residential and utility scale applications including molten salts, cold reservoirs, and phase change materials, Analysis of design considerations, material selection, and application specific constraints, Applications in renewable energy at utility scale solar and geothermal power production.

Text Books:

1. Microgrids and Active Distribution Networks, S. Chowdhury, S. P. Chowdhury, P. Crossley, IET Power Electronics Series, 2012.
2. Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali and Min Dai, John Wiley publishing company, 2010, 2nd Edition.

SEVENTH SEMESTER

ANALYSIS OF POWER CONVERTERS AND CONTROLLERS

COURSE OBJECTIVES:

- To study the different types of Power converters
- To study the Controllers for Micro grid operation
- To Analyse and design the control schemes for micro grid operation

COURSE OUTCOMES:

After completion of the course, the student will be able to

COS No.	**Course Outcomes**	**Bloom's level**
CO1	Appropriate Selection of switching devices and energy Transactive/ handlingcomponents for power converters realizations.	Understand
CO2	Suggest efficient control techniques for low and medium power converters	Understand
CO3	Synthesize advanced PID controller for load frequency control in Micro Grid	Understand
CO4	Design and evaluate optimal and adoptive control schemes for Microgrids.	Understand
CO5	Design and analyze nonlinear controllers for load frequency and voltage control in Microgrid.	Apply

UNIT I

DC-DC Converters:

Non-isolated DC-DC converters: buck, boost, buck-boost, CUK converters under continuous and discontinuous conduction operation - Isolated DC-DCconverters: forward, fly-back, push-pull, half-bridge and full-bridge converters - Relationship between I/P and O/P voltages- design of filter inductor and capacitors

Inverters: Single-phase and three-phase inverters- PWM techniques: single, multiple and sinusoidal PWM techniques- selective harmonic elimination, space vector modulation, current source inverter- High power inverters: Multi-pulse inverters, multi-level inverters - Diode-clamped, cascaded and Flying capacitor types, Carrier and Vector based multi-level modulation schemes -Concept of active power filters

UNIT II

FRONT-END (AC-DC) CONVERTERS:

Conventional methods of power factor improvements: Semi-converter, extinction angle control, symmetrical angle control – active front-end converters- Single phase: Boost, voltage doubler and PWM rectifiers –voltage and current controlled three-phase PWM rectifiers

UNIT III

ADVANCED PID CONTROL:

The PID controller-Filtering the derivative- Setpoint weighting- Integrator Windup- Controller degrees of freedom- Model based Design methods: Direct Synthesis (DS) method, Internal Model Control (IMC) method- Stability analysis- Robustness Measures-Feedforward design: Inversion based method- Cascade Control- Fractional PID- Case Study: Load frequency control (LFC) in Micro grid system.

UNIT IV

OPTIMAL CONTROL:

Cost function- Linear Quadratic regulator (LQR)-Algebraic Riccatti Equation (ARE)- Discrete time systems-Development of Kalman Filter: Predictor and Corrector form- Predictive Control: Dead Beat control, Generalized Predictive Control (GPC), Model Predictive Control (MPC): Problem formulation- Recursive feasibility-Stability of MPC- Case Study: Application of MPC to Micro Grid droop control

UNIT V

INTRODUCTION TO NONLINEAR SYSTEM AND ITS CONTROL:

Characteristics of nonlinear systems- Autonomous and Non-autonomous systems- Phase Plane analysis- Classification of Equilibrium Points- Limit Cycles Existence and its condition- Existence of Periodic Orbits- Lyapunov Stability– Nonlinear controller design: Feedback Linearization- Back stepping- Case Study: Nonlinear Load Frequency control design in Microgrid.

Text Books:

1. Power Electronics Handbook, M.H. Rashid, Butterworth-Heinemann, 2017, 4th edition
2. Power Electronics: Converters, Applications & Design**,** N Mohan, T.M. Undeland, WP.Robbins**,** John Wiley & Sons, 2003, 3rd edition
3. Linear System Theory and Design, C.T. Chen, Oxford University Press, 2013, 4th Edition.
4. Advanced PID Control, K. J. Astrom, T. Hagglund, ISA Publisher, 2006, 1st Edition

Reference Books:

1. Power Electronics: Essentials and Applications, Umanand, L, John Wiley India, 2009, 1st Edition
2. Fundamentals of Power Semiconductor Devices, Jayant Baliga B, Springer, 2008, 1st Edition Nonlinear Systems, Hassan K Khalil, Prentice - Hall International (UK), 2002, 3rdEdition
3. Model Predictive Control, E.F. Camacho, C.A.Bordons, Springer-Verlag London, 2007, 2nd Edition.
4. Optimal Control Systems, D. Subbaram Naidu, CRC Press, 2002, 1st Edition.
5. Modern Control Systems Theory, M. Gopal, New Age International Private Limited, 2014, 3rd Edition.
6. Predictive Control for linear and Hybrid Systems, F. Borrelli,A. Bemporad, M.Morari, Cambridge University Press, 2017, 1st Edition.

SEVENTH SEMESTER

GRID INTEGRATION OF ELECTRIC VEHICLES

COURSE OBJECTIVES:

- To understand the fundamentals of Electric Vehicle
- To Analyse the role of EV in smart grid environment

COURSE OUTCOMES:

After completion of the course, the student will be able to

COS No.	**Course Outcomes**	**Bloom's level**
CO1	Understand the Electric Vehicle concepts and its importance in power system.	Understand
CO2	Assess the role of EV in modern distribution system and smart grids	Understand
CO3	Understand the technology, design methodologies and control strategy of hybrid electricvehicles	Apply
CO4	Understand operation and importance of EVs in Grid Applications, grid balancing, ancillaryservices and demand response	Understand

UNIT I

FUNDAMENTALS OF ELECTRIC VEHICLES (EV)

Introduction to Electric Vehicle technology – Types –Fundamental issues related to electric vehicles (EVs) and hybrid electric vehicles (HEVs) – Interdisciplinary Nature of EVs – State of the Art of EVs – Advantages and Disadvantages – Challenges and Key Technologies of EVs – Challenges for EV Industry in India

UNIT II

ELECTRIC VEHICLE BATTERIES

Electric vehicle battery efficiency – type – capacity –charging/discharging –technical characteristics – performance – testing, EV battery for stationary applications (B2U).

UNIT III

CHARGING TECHNIQUES

Architecture/Components of EV charging station –EVSE (Electric Vehicle Supply Equipment) – Type of EV Chargers – Charging Methods – Automotive networking and communication, EV and EV charging standards.

UNIT IV

GRID APPLICATIONS

Concept of Vehicle to Grid (V2G/G2V)–Ancillary Services – peak saving – load-generation balance – Demand Response – Energy time shift – Energy Management strategies and its general architecture – integration of EVs in smart grid, social dimensions of EVs.

UNIT V

ADVANCED TOPICS

Different design and control aspects of electric drives and chargers for EVs and HEVs, Battery Charger Topologies, and Infrastructure for Plug-In-Electric and Hybrid Vehicles – Impact of Plug-in Hybrid Electric Vehicles on smart Grid/Distribution Networks – Sizing Ultra capacitors for Hybrid Electric Vehicles, concept of vehicle to Home (V2H), Effect of charging infrastructure on grid protection and control, Role of AMI/Smart Meters in EV Management.

Text Books:

1. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley-Blackwell, 2012, 2nd Edition.
2. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2016, 1st Edition.

Reference Books:

1. Electric Vehicle Battery Systems, Sandeep Dhameja, Elsevier, 2012, 1st Edition.
2. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, 2017, 1st Edition.
3. Electric & Hybrid Vehicles Design Fundamentals, Iqbal Hussain, CRC Press, 2011, 2nd Edition.
4. Hybrid electric Vehicles Principles and applications with practical perspectives, Chris Mi, M. Abul Masrur, D. Wenzhong Gao, A Dearborn, John Wiley & Sons Ltd. , 2017, 2nd Edition.
5. The automobile, In Electric Vehicles: Prospects and Challenges, T. Muneer and I. Illescas García, Elsevier, 2017, 1st Edition.
6. Plug in Electric Vehicles in Smart Grids, S. Rajakaruna, F. Shahnia, and A. Ghosh, Springer Singapore, 2015, 1st Edition.
7. Vehicle-to-Grid: Linking electric vehicles to the smart grid, J. Lu, and J. Hossain, IET, 2015, 1st Edition.

EIGHT SEMESTER

SMART GRID SIMULATION LAB

COURSE OBJECTIVES:

- To design and simulate the operation of solar and wind Energy sources
- To Analyse and simulate the control operation of micro grid

COURSE OUTCOMES:

At the end of course, student will be able to

CO1	Understand the operation of AC microgrid system power sharing and control
CO2	Analyze the hierarchical control for AC and DC microgrids.
CO3	Analyse the dynamic behavior of Micro grid system & its grid integrations issues
CO4	design a efficient controller for off-grid/grid fed Renewable Energyapplications

LIST OF EXPERIMENTS:

1. Simulation of Voltage and frequency control of a load connected inverter.
2. Modeling & FFT analysis on PCC- Inverter-based Micro grid with Droop Control Technique Using Matlab
3. Impact of droop gains on stability of the inverter based microgrids
4. Centralized Secondary control design for inverter-based AC microgrids.
5. Distributed secondary control for the inverter-based AC microgrids
6. simulation of Micro Grid Connected Solar PV System Using Matlab Simulink
7. Simulation of single phase grid connected inverter using MATLAB
8. Simulation of a Hybrid AC/DC Microgrid and It's Coordination Control
9. Simulink Model of Wind turbine based AC to DC Converter
10. Solar power generation for home using MATLAB Simulink

11. Design and Simulation of the PV Solar System and MPPT with PI Controller Based on P&O Algorithm
12. Hybrid (Solar + wind) Energy Generation Model in Simulink
13. Solar PV Battery Powered Electric Vehicle in MATLAB MATLAB
14. Simulation of V2G, G2V Operation in Electric Vehicle Charger (Single Phase Model)
15. Simulation of Wireless Digital Communication with MATLAB
16. Detection of islanding condition in grid consorted PV system using Passive methods Simulink model
17. Neural network based fault detection, location and classification in microgrid using MATLAB
18. Grid Integration of Hybrid Photovoltaic & Wind Power System using MATLAB
19. Design of virtual PMU in MATLAB
20. PSO Based Automatic Generation Control of Two Area Power System in SIMULINK
21. Study of Detect Attack in Cyber-Physical Systems Using Dynamic Watermarking