SMART GRID: BASICS TO ADVANCED TECHNOLOGIES

PROF. N.P. PADHY
Department of Electrical Engineering
IIT Roorkee

PROF. PREMALATA JENA
Department of Electrical Engineering
IIT Roorkee

INTENDED AUDIENCE : UG/PG/PhD students, Industries and academic professionals

PRE-REQUISITES : Basic Understanding of Power System and Power Electronics Engineering

INDUSTRY SUPPORT : State Power Transmission and Distribution companies, DISCOMs, TRANSCO, POWER GRID, Private sector: ABB, Schneider, Siemens, etc.

COURSE OUTLINE :

This course covers the fundamental aspects of the smart grid and its application to the existing power system. It introduces state-of-the-art smart grid technologies like electric vehicles, AC/DC microgrids, energy storage, phasor measurement unit, cyber security, etc. In addition, the course talks about the trends, modeling, planning, operation, and control of energy storage technologies. Further, it discusses the architecture, operation, and control strategy of AC, DC, and hybrid AC-DC microgrids. This course also emphasizes on renewable energy sources integration into the present grid and microgrids, and further explores its operation, analysis, management, control, protection, and monitoring issues. The laboratory-scale demonstrations have been provided to validate a few concepts covered in this course.

ABOUT INSTRUCTOR :

Prof. Narayana Prasad Padhy received the Ph.D. degree in power systems engineering from Anna University, Chennai, India, in 1997. He is working as Professor (HAG) with the Department of Electrical Engineering, Indian Institute of Technology (IIT) Roorkee, Roorkee, India. He is currently the Director of the Malaviya National Institute of Technology (MNIT), Jaipur, India and the mentor director of the Indian Institute of Information Technology (IIIT) Kota. Earlier he has served as Dean of Academic Affairs, Institute, NEEPCO, 92 Batch and Ravi Mohan Mangal Institute Chair Professors at IIT Roorkee. He is the National lead of many national and international projects such as DSIDES, ID-EDGe, and HEAPD. He is also part of other international projects, namely Indo-US UI-ASSIST and Indo-UK ZED-I. He has published more than 200 research articles in reputed international journals and conference proceedings. His research interests include power system analysis, demand-side management, energy market, network pricing, AC–DC smart grid, and application of machine learning techniques in power systems. Dr. Padhy is also a Fellow of the Indian National Academy of Engineers (INAE), Fellow Institution of Electronics and Telecommunication Engineers, India, Fellow Institution of Engineering and Technology, UK, and Fellow of Institution of Engineers, India. He was the recipient of the IEEE smart cities jury award 2022, IEEE PES Outstanding Engineers Award 2018, Boyscast Fellowship and the Humboldt Experienced Research Fellowship in the year 2005 and 2009, respectively.

Prof. Premalata Jena (Senior Member IEEE, Young Associate, INAE) received the M. Tech and Ph. D degree in Power System Engg. from the Department of Electrical Engineering, Indian Institute of Technology Kharagpur, Kharagpur, India, in 2006 and 2011 respectively. She is currently working as an Associate Professor in the Department of Electrical Engineering, Indian Institute of Technology, Roorkee, India since 2012. She has executed various sponsored research projects sanctioned by DST, SERB, CPRI, MHRD and THDC INDIA Ltd. She has published several research articles in reputed international journals and conference proceedings. Dr. Jena is a recipient of SERB POER Fellowship from SERB, DST in 2022. Dr. Jena is a recipient of the Women Excellence Award-2017 from DST, New Delhi. Dr. Jena is a recipient of the Young Engineer Award, Indian National Academy of Engineering, and POSOCO Power System Award, Power Grid Corporation of India Ltd., India, in 2013. Her research interest includes power system protection, Electric Vehicle, Grid Integration issues of Electric Vehicle, Optimal sizing and placement of batteries, Cybersecurity issues in Smart Grid, AC, DC, and Hybrid AC-DC microgrid protection issues due to the integration of renewable sources and electric vehicles with the existing power grid.

COURSE PLAN:

Week 1:

- Introduction to Smart Grid-I.
- Introduction to Smart Grid-II.
- Architecture of Smart Grid system
- Standards for Smart Grid system
- Elements and Technologies of Smart Grid System-I

Week 2:

- Elements and Technologies of Smart Grid System-II
- Distributed Generation Resources-I
- Distributed Generation Resources-II
- Distributed Generation Resources-III
- Distributed Generation Resources-IV

Week 3:

- Introduction to energy storage devices
- Different types of energy storage technologies
- Analytical modelling of energy storage devices
- Optimal sizing and siting of storages
- Battery management system (BMS)

Week 4:

- Wide area Monitoring Systems-I
- Wide area Monitoring Systems-II
- Phasor Estimation-I
- Phasor Estimation-II
- Digital Relays for Smart Grid Protection

Week 5:

- Islanding Detection Techniques–I
- Islanding Detection Techniques –II
- Islanding Detection Techniques –III
- Smart Grid Protection-I
- Smart Grid Protection-II

Week 6:

- Smart Grid Protection-III
- Smart Grid Protection-IV
- Modelling of storage devices
- Modelling of DC smart grid components
- Operation and control of AC Microgrid-I

Week 7:

- Operation and control of AC Microgrid -II
- Operation and control of DC Microgrid -I
- Operation and control of DC Microgrid -II
- Operation and control of AC-DC hybrid Microgrid -I
- Operation and control of AC-DC hybrid Microgrid -II

Week 8:

- Phasor measurement unit placement
- Cyber security and resiliency
- Virtual inertia and ancillary support
- Demand side management of smart grid
- Demand Response Analysis of smart grid

Week 9:

- Demonstration of solar power generation
- Demonstration of wind power generation
- Demonstration of Battery Management System
- Demonstration of EV charging system
- Hierarchical control techniques in hybrid ac-dc microgrid

Week 10:

- Simulation and case study of AC Microgrid
- Simulation and case study of DC Microgrid
- Simulation and case study of AC-DC Hybrid microgrid
- Demonstration of parallel inverter operation in AC microgrid
- Harmonic effects and its mitigation techniques

Week 11:

- Energy management
- Design of Smart Grid and Practical Smart Grid Case Study-I
- Design of Smart Grid and Practical Smart Grid Case Study-II
- System Analysis of AC/DC Smart Grid
- Demonstration of grid-connected DC microgrid

Week 12:

- Demonstration of energy management in microgrid
- Demonstration of PHIL experimentation for symmetric and asymmetric fault analysis of grid-connected DFIG wind turbine.
- Demonstration of ancillary support from virtual synchronous generator
- Demonstration on peak energy management using energy storage system.
- Conclusions