Approved in 37th BoA Meeting (29-10-2020)

Course Number: EE583

Course Name: Smart Grids

Credits: 3-0-0-3

Prerequisites: EE-303 (Power systems)

Intended for: UG/PG

Distribution: Elective for B. Tech (EE), M.S., M. Tech. & Ph.D.

Preamble: The proposed course is designed to provide the concepts of modern power system operations and the challenges associated with them. The focus of the course is to enable the students acquire knowledge on smart grids which includes different architectural designs, sensors, measurement technology, renewable energy sources and storage integration.

Course Outline: This course provides overview of fundamentals, design tools, current research, and the critical issues in the development and deployment of smart grids. The application of smart grid technologies in different types of power sectors such as power generation, transmission and distribution will be taught with discussion on its applicability and advantages to the Indian power grid. The course will also emphasize on renewable energy source integration in present grids and explore issues in operation, analysis, management, control, protection and monitoring. In addition, there will be focus on sensing, metering and communication of smart grid data with cyber security aspects.

Course Modules with Quantitative lecture hours:

Introduction – 3 hours
Smart Grid: Concept, architecture, standards and protocols, Smart Grid in Indian Grid context.

Power System Operations – 6 hours
Load flow for smart grids, voltage stability assessment, and state estimation

Communication Infrastructure – 4 hours
Communication standards, requirements for data links, data quality, cyber security: state of the art, risks and mitigation

Wide Area Measurement Systems (WAMS) – 3 hours
Phasor measurement units (PMU), WAMS architecture, applications of WAMS for power system operation improvement: advantages and disadvantages

Integration of Renewable Energy Sources and Energy storage – 8 hours
Renewable energy sources, penetration and variability issues, environmental implications, demand response, electric vehicles, energy storage techniques: battery, pumped hydro, modelling of storage devices.

Smart Devices – 5 hours
FACTS, STATCOM, HVDC, fault current limiters

Protection and Security – 5 hours
Intelligent protection, contingency analysis and classification, security, outage management, remedial action schemes, special protections schemes

Meters and Sensors – 4 hours
Hardware, demand side integration, communication standards and protocols, smart meters, automatic meter reading (AMR), advanced metering infrastructure (AMI)

Microgrids – 3 hours
System operation, consumer energy management

Hardware in Loop (HIL) testing – 1 hours
HIL requirements, advantages and disadvantages.

Text book:

1. S. F. Bush, *Smart Grid: Communication-enabled intelligence for the electric power grid*, John Wiley and Sons, Ltd., 2014.
2. I. S. Jha, S. Sen, R. Kumar, D. P. Kothari, *Smart Grid Fundamentals & Applications*, New Age International Publishers, 2019.

References:

1. J. Momoh, *Smart Grid: Fundamentals of design and analysis*, John Wiley and Sons, Ltd., 2012.
2. B. M. Buchholz, Z. Styczynski, *Smart Grids – Fundamentals and Technologies in Electricity Networks*, Springer, 2014.
3. C. W. Jennings, *The Smart Grid: Enabling Energy Efficiency and Demand Response*, Fairmont Press Inc., 2009.
4. N. Hatziargyriou, *Microgrids: Architectures and Control*, John Wiley and Sons, Ltd., 2014.

Similarity Content Declaration with Existing Courses:

S. No.	Course Code	Similarity Content	Approx. % of Content
1.	EE603	Renewable energy sources, penetration and variability issues,	6

Proposed by: **Pratim Kundu** School of Computing and Electrical Engineering

Pratim Kundu