Nirma University
Institute of Technology
B.Tech (All programmes except Electrical Engineering)
Open Elective Course

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Course Code	**2EEOE03**
Course Title	**Introduction to Smart Grid**

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. compare conventional and smart power grid characteristics
2. apply engineering know-how to smart electrical grid
3. select and employ various sensing technologies, networking and communication technologies to electrical power grid
4. identify problems and offer solution using computational techniques

Syllabus: **Teaching Hours: 45**

Unit-1: Introduction to Conventional and Futuristic Electrical Power Systems **12**

Basics of electrical systems, laws of physics, applicability of KVL and KCL, formation of grid and concept of infinite bus, control of active and reactive power, control of voltage and frequency, generators and loads and their requirements, Infrastructure of conventional electrical networks, Main characteristics of conventional electrical networks, generation – transmission and distribution – Indian scenario, EHVAC and HVDC systems etc.

Comparison between Smart Grid and conventional electrical networks, Evolution of Electric Grid, motives behind developing the Smart Grid Network, Definitions, Characteristics and Benefits of the Smart Grid, Functions of Smart Grid Components, Key challenges for Smart Grid, Present development and International practices in Smart Grid

Unit-2: Smart Grid Systems **13**

Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Issues Associated with Sustainable Energy Technology, Electric Vehicles and Plug-in Hybrids, Impact of PHEV on the Grid, Environmental Implications – Climate Change, Implications of Climate Change. Storage Technologies, Benefits of Energy Storage Systems (ESS), prediction requirements in power systems and role of smart grids, analytics and data processing requirements, relevant case studies

Unit-3: Smart Grid Measurements and Communication Technologies **12**

Smart Meters – Key Components of Smart Metering, Smart Appliances, Advanced Metering Infrastructure (AMI), GIS and Google Mapping Tools, Communications Infrastructure and Protocols for Smart Metering, IoT and smart grids, Wireless Sensor Networks, Smart Grid Communication Technologies – Wireless and Wired, Cyber Attacks and Power System Security, Smart Grid Cyber Security, Protection in power systems and recent developments

Unit-4: AI, Machine Learning and Big Data in Smart Grids **08**

Concepts such as MINLP Approach for Network Reconfiguration and Dispatch in Distribution Systems, Multi-Objective Optimization Methods for Solving the Economic Emission Dispatch Problem, State Estimation Paradigm Based on Artificial Dynamic Models, Cloud Computing for Smart Grid, Data Storage, Data Access and Data Analysis, The State-of-the-Art Processing Techniques of Big Data etc.

Self-Study Component:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. Salman K. Salman, Introduction to the Smart Grid: Concepts, Technologies and Evolution, The Institution of Engineering and Technology (IET).
2. Ahmed F Zobaa (ed.), Alfredo Vaccaro (ed.), Computational Intelligence Applications In Smart Grids - Enabling Methodologies For Proactive and Self-Organizing Power Systems, Imperial College Press
3. Robert C. Qiu and Paul Antonik, Smart Grid using Big Data Analytics - A Random Matrix Theory Approach, Wiley
4. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Smart Grid: Technology and Applications, John Wiley & Sons.
5. James Momoh, Smart Grid: Fundamentals of Design and Analysis, John Wiley & Sons, IEEE Press
6. Clark W. Gellings, The Smart Grid, Enabling Energy Efficiency and Demand Response, CRC Press.
7. Ali Keyhani, Design of smart power grid renewable energy systems, Wiley IEEE
8. Siddhartha Kumar Khaitan, James D. McCalley, Chen-Ching Liu (ed.), Cyber Physical Systems Approach to Smart Electric Power Grid, Springer
9. Relevant recent literature, journal articles, web resources, standards and codes

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. academic year 2020-21 and onwards