Nirma University

Institute:	**Institute of Technology, School of Engineering**
Name of Programme:	**B.Tech. in Electrical Engineering**
Semester:	**VII**
Course Code:	4EE206IE25
Course Title:	**Introduction to Smart Grid**
Course Type:	**Interdisciplinary Minor - (Elective Course-II)**
Year of Introduction:	**2025 – 2026**

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Course Learning Outcomes (CLOs):

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

1. compare conventional and smart power grid characteristics (BL4)
2. apply engineering know-how to smart electrical grid (BL3)
3. select and employ various sensing technologies, networking and communication technologies to electrical power grid (BL4)
4. identify problems and offer solution using computational techniques (BL5)

Unit	Contents	Teaching hours (Total 45)
Unit –I	**Introduction to Conventional and Futuristic Electrical Power Systems** Basics of electrical systems, laws of physics, applicability of KVL and KCL, formation of grid and concept of infinite bus, 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 – smart switchgear, digital substations, reclosure systems etc; Key challenges for Smart Grid, Present development and international practices in Smart Grid	13
Unit –II	**Smart Grid Systems** 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), Protection in power systems and recent developments	12

Unit III	–	**Smart Grid Measurements and Communication Technologies** Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU), Smart Meters – Key Components of Smart Metering, Smart Appliances, Advanced Metering Infrastructure (AMI), GIS and Google Mapping Tools, Intelligent Grid Automation, Substation automation equipment, Home and Building Automation Classification of Power System Communication according to their functional requirements, Communications Infrastructure and Protocols for Smart Metering, IoT and smart grids, Smart Grid Communication Technologies – Wireless and Wired, Cyber Attacks and Power System Security, Smart Grid Cyber Security	14
Unit IV	-	**AI, Machine Learning and Big Data in Smart Grids** 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, The State-of-the-Art Processing Techniques of Big Data, prediction requirements in power systems and role of smart grids	06

Self-Study:

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

Tutorial:
This shall consist of at least 6 tutorials based on the above syllabus.

Suggested Reading:

1. Salman K. Salman, *Introduction to the Smart Grid: Concepts, Technologies and Evolution*, The Institution of Engineering and Technology (IET).
2. Clark W. Gellings, *The Smart Grid, Enabling Energy Efficiency and Demand Response*, CRC 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. 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.
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