



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)

Subject Code: 2970906

Semester – VII

Subject Name: Smart grids

Type of course: Professional Elective Course

Prerequisite: Power System Analysis, basics of internet

Rationale:

This course mainly focuses on basic fundamentals of smart grid for its implementation in the existing power system network. This course provides overview of smart grid and its applications in potential sectors of Modern power systems. It also provides detailed utility level analysis in terms of energy management, network analysis and operation of smart grids. The course also explores issues in management, control, protection and monitoring of grid with renewable energy source integration as well as in micro grids at remote location.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|-----------|-----------------|-----------|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE Viva (V) | PA (I) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 0 | 0 | 100 |

Co

| Sr. No. | Content | Total Hrs |
|---------|--|--------------|
| 1 | Basics of Load and Generation, Grid operation, Concepts of Power Flow Analysis, Economic Dispatch and Unit Commitment. Introduction to Smart Grid, Difference between conventional & smart grid, Architecture of Smart Grid, Smart Grid standards, Policies Applications, Smart Grid control layer and elements, Smart Grid Initiative for Power Distribution Utility in India. | 05 |
| 2 | Power Line Communications, Two-way Digital Communications Paradigm, Network Architectures, IP-based Systems, Advanced Metering Infrastructure, Fiber Optical Networks, Wide Area Network WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Bluetooth, Zig-Bee, GPS, Geographic Information System (GIS), Broadband over Power line (BPL). | 08 |
| 3 | Distributed generation resources, Advantages and disadvantages of DG, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid Smart Grid components control elements, Smart Grid Technologies | 08 |
| 4 | Micro Grids, Concept of micro grid, need & applications of micro grid, formation of micro grid, Modelling of AC Smart Grid components, Modelling of DC Smart Grid components, Modelling of storage devices, issues of interconnection, Operation, protection & control of micro grid. Simulation and case study of AC micro grid Islanding, need and benefits, different methods of islanding detection. | 08 |
| 5 | Load dispatch centers, Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self-Healing Systems, Applications and Challenges, , wide-area monitoring system (WAMS), Phasor | 08 |



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| | measurement units PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; smart grid system monitoring, Phasor estimation, Dynamic Phasor estimation. | |
| 6 | Demand side management of Smart Grid, Demand response analysis of Smart Grid, Pricing and Energy Consumption Scheduling, Controllable Load Models, Dynamics and Challenges, Electric Vehicles and Vehicle-to-Grid Systems, Demand Side Ancillary Services Energy Management, Practical study of Smart Grid. | 08 |

Suggested Specification table with Marks (Theory): (For BE only)

| Distribution of Theory Marks | | | | | |
|------------------------------|-----------|-----------|-----------|-----------|-----------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 15 | 30 | 30 | 15 | 10 | 00 |

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Ekanayake J., Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications.
2. Momoh J., Smart Grid: Fundamentals of design and analysis, John Wiley & Sons.
3. Smart Grid: Technology and Applications by Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama Wiley India
4. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.

Course Outcomes:

After completing the course, students will be able to;

| Sr. No. | CO statement | Marks % weightage |
|---------|---|-------------------|
| CO-1 | Summaries various aspects of the smart grid Technologies, Components, Architectures and Applications | 25 |
| CO-2 | Study and compare modern communication infrastructure and justify the feasibility of the same for smart grid applications. | 25 |
| CO-3 | Analyze Micro grid and distributed generation as a part of modern hybrid power system with advantages and challenges in smart grid operations | 25 |
| CO-4 | Use of load modeling techniques, Demand Side Ancillary Services Energy Management in Pricing and Energy Consumption Scheduling in smart grid operations | 25 |



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List of Open Source Software/learning website:

<https://nptel.ac.in/courses/108/107/108107113>