



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3172419

Subject Name: Smart Grid and Power Electronics

Semester – VII

Type of course: Professional Elective Course V

- Prerequisite:** 1. Basic Power System Engineering (3142404)
2. Basic Power Electronics Devices, Circuits and Application (3142409)
3. Power Electronics Circuits – I (3152407)
4. Power Electronics Circuits –II (3162413)

Rationale: This course mainly focuses on background and fundamental building blocks of smart grid with stringent emphasis on practical applications in the existing power system network. This course provides overview of smart grid and its potential in different types of power sectors such as power generation, transmission and distribution in Metro, Urban/Semi urban and remote locations of India. This also emphasizes on renewable energy source integration in present grids as well as in micro and nano grids as part of the course and explores its issues in operation, analysis, management, control, protection, and monitoring. In addition to it, this further provides detailed utility level analysis in terms of energy management, network analysis and operation of renewable based smart grids.

Teaching and Examination Scheme:

| Teaching Scheme | | | Credits C | Examination Marks | | | | Total Marks |
|-----------------|---|---|--------------|-------------------|--------|-----------------|--------|----------------|
| L | T | P | | Theory Marks | | Practical Marks | | |
| | | | | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 1 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

Content:

| Sr. No. | Course Content | Total Hrs. |
|---------|--|------------|
| 1 | Introduction: Introduction to Smart Grid, Architecture of Smart Grid, Smart Grid standards and policies, Smart Grid control layer and elements, Role of Power Electronics | 5 |
| 2 | Distributed generation resources, Smart Grid components control elements, Smart Grid Technologies, Plug-in-Hybrid Vehicles (PHEV). | 5 |
| 3 | State Estimation for low voltage networks, Smart Grid Monitoring, Phasor measurement units, Phasor estimation, Dynamic Phasor estimation. | 5 |
| 4 | Islanding detection, Islanding relays, Fault Detection, Isolation, and Service Restoration. Digital relays for Smart Grid protections; relay co-ordination. | 6 |
| 5 | Modelling of AC Smart Grid components, Modelling of DC Smart Grid components, Modelling of DC Smart Grid components, Modelling of storage devices. | 6 |
| 6 | Operation and control of AC Smart Grid, Operation and control of DC Smart Grid, Simulation, and case study of AC microgrid. | 6 |
| 7 | Simulation and case study of DC microgrid, Operation and control of hybrid Smart Grid, System analysis of AC/DC Smart Grid, Simulation, and case study of hybrid microgrid | 6 |
| 8 | Demand side management of Smart Grid, Demand response analysis of Smart Grid, Energy Management, Smart Grid test bed | 6 |



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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 |
| 20 | 30 | 20 | 20 | 05 | 05 |

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. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
3. Janaka Ekanayake, N. Jenkins, K. Liyanage, J. Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.
4. Jean Claude Sabonnadiere, Nouredine Hadjsaid, "Smart Grids", Wiley Blackwell.
5. Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc.
6. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities", Island Press.
7. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.
8. Bhavesh Bhalja, R. P. Maheshwari and N. G. Chothani, "Protection and Switchgear, Oxford University Press, New Delhi, India, 2nd Edition, 2015.
9. Smart Grid: Technology and Applications by Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama wiley India

Course Outcome:

After learning this course, the students should be able:

| Sr. No. | CO statement | Marks % weightage |
|---------|--|-------------------|
| CO1 | understand the functions and components of smart grid. | 40 |
| CO2 | Understand working of smart grid. | 25 |
| CO3 | model AC / DC smart grid. | 25 |
| CO4 | simulate smart grid. | 10 |

List of Open-Source Software/learning website:

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