SAMPLE PAPERS

DIPLOMA FIFTH SEMESTER EXAMINATION 2025 (JUT)

SMART GRID TECHNOLOGY

DIPLOMA WALLAH

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Full Marks: 70 marks | Time: 3 Hours

Instructions:

- Question No. 1 is compulsory.
- Answer any **FOUR** questions from the remaining (Q.2 to Q. 7 marks).

GROUP A: Multiple Choice Questions (Compulsory)

Q. 1. Choose the correct option for the following (7 *2 = 14 Marks)

i. Which technology is primarily responsible for enabling two-way communication between utility and consumers?

(a) Transmission Automation

(b) Conventional Metering

(c) Advanced Metering Infrastructure (AMI)

(d) Synchro-Phasor Measurement Units (PMUs)

ii. The concept of "Self-Healing Grid" is directly associated with:

(a) Centralized Generation Control

(b) Distribution Automation

(c) Wide Area Measurement Systems (WAMS)

(d) Traditional SCADA systems

iii. Which entity primarily uses a GPS time stamp for synchronization?

(a) Smart Meter

(b) Micro Grid Inverter

(c) Power Line Carrier (PLC) Modem

(d) Synchro-Phasor Measurement Unit (PMU)

iv. What is the main objective of Demand Response (DR) under Demand Side Management (DSM)?

(a) Increasing overall energy consumption

(b) Reducing or shifting power use during peak demand periods

(c) Maximizing renewable energy export

(d) Monitoring meter health

v. Micro Grids can operate in which mode, independent of the main utility grid?

(a) Distributed Mode

(b) Island Mode

(c) Centralized Mode

(d) Radial Mode

vi. The primary challenge posed by the integration of Electric Vehicles (EVs) to the grid, without smart management, is:

(a) Increased reactive power flow

(b) Cybersecurity

(c) High localized peak demand loading

(d) Communication failure

vii. Which type of communication is often used for interconnecting physical objects like sensors and appliances in the Smart Grid?

(a) IoT (Internet of Things)

(b) Transmission Automation

(c) Fibre Optics (Point-to-Point)

(d) SCADA system

Q. 2.

A. Provide a detailed comparative analysis between the Conventional Grid and the Smart Grid, focusing on differences in communication, generation, and control. (7 Marks)

B. Discuss the major Opportunities and Barriers associated with the implementation of Smart Grid technology. (7 Marks)

Q. 3.

A. Define Smart Grid. Explain the concept and main elements of the Smart Grid structure with a suitable description. (7 Marks)

B. Describe the essential Components of Smart Grid Architecture. Explain the role of Advanced Metering Infrastructure (AMI) in this architecture. (7 Marks)

Q. 4.

A. Define a Micro Grid. Explain its structure and different modes of operation (grid-connected vs. islanded mode). (7 Marks)

B. Write a detailed note on Storage Technologies used in the Smart Grid. Discuss how Electric Vehicles (EVs) and PHEVs interact with and influence the grid infrastructure. (7 Marks)

Q. 5.

A. Explain the working principle and importance of Synchro-Phasor Measurement Units (PMUs). Describe how PMUs are utilized in a Wide Area Measurement System (WAMS). (7 Marks)

B. Define Demand Side Management (DSM). Elaborate on the concepts of Demand Response (DR) and Energy Management within the DSM framework. (7 Marks)

Q. 6.

A. Define the Internet of Things (IoT). Elaborate on the various key Applications of IoT in Smart Grid operations. (7 Marks)

B. Why is Cyber Security crucial for the Smart Grid? Discuss the potential cyber security threats faced by the grid. (7 Marks)

Q. 7. Write short notes on any FOUR of the following: ($4 \times 3.5 = 14$ Marks)

A. Enablers of the Smart Grid

B. Transmission Automation

C. Two-way digital communications paradigm

D. Renewable Energy Technologies (as DG)

E. Ancillary Services Planning

Solutions & Model Answers for SAMPLE PAPER 1

MCQ Answer Key (Q. 1)

Q. No.	Correct Option
i.	(c) Advanced Metering Infrastructure (AMI)
ii.	(b) Distribution Automation
iii.	(d) Synchro-Phasor Measurement Unit (PMU)
iv.	(b) Reducing or shifting power use during peak demand periods
v.	(b) Island Mode
vi.	(c) High localized peak demand loading
vii.	(a) IoT (Internet of Things)

Short Answer Solutions (Q. 7)

- **A. Enablers of the Smart Grid:** Technologies that make the Smart Grid possible. Key enablers include: advanced sensing/measurement (PMUs, smart meters), integrated communication networks, advanced control methods, and sophisticated components.
- **B. Transmission Automation:** Using digital control and communication systems (like WAMS) to automatically monitor, analyze, and control the high-voltage transmission network for greater security, stability, and reliability.
- **C. Two-way digital communications paradigm:** The core communication philosophy of the Smart Grid, allowing data (e.g., meter readings, sensor data) to flow from the edges to the center, and control signals/commands to flow from the center back to the edges (devices/customers) simultaneously.
- **D. Renewable Energy Technologies (as DG):** Small-scale power generation (e.g., solar PV, small wind) connected locally in the distribution network. They reduce transmission losses and provide environmental benefits, but require smart grid controls to manage their intermittent nature.
- **E. Ancillary Services Planning:** Planning for essential services (like frequency regulation, voltage support) required to maintain system reliability and power quality. In the Smart Grid, DGs and storage are planned to participate in providing these services actively.

Model Answers for Long Questions (Q. 2 - Q. 6)

- **Q. 2. A (Comparative Analysis):** Focus on comparing the unidirectional vs. bidirectional flow, centralized vs. distributed control, manual vs. automated

restoration, limited vs. extensive sensing/communication, and non-real-time vs. real-time monitoring.

- **Q. 2. B (Opportunities and Barriers):**
    - *Opportunities:* Improved reliability (self-healing), reduced environmental impact, efficient energy usage, consumer engagement, improved security.
    - *Barriers:* High capital costs, lack of standards/interoperability, complexity of integration, and regulatory/policy constraints.
- **Q. 3. A (Smart Grid Definition/Structure):** Define the grid as digitized, automated, and interconnected. Structure should cover the five main domains: Generation, Transmission, Distribution, Customers, and Operations/Markets.
- **Q. 3. B (Architecture/AMI):** Describe how the architecture integrates IT (data) and OT (power flow). AMI is the central platform for customer interaction, enabling two-way data exchange, remote operations, and Time-of-Use tariffs.
- **Q. 4. A (Micro Grid Definition/Modes):** Define as a local power system capable of islanding. Modes: **Grid-Connected Mode** (operates in parallel with the main utility, drawing/supplying power) and **Island Mode** (disconnected from the main grid, supplying local loads autonomously).
- **Q. 4. B (Storage/EVs):** Storage technologies (BESS, etc.) store energy for load leveling and frequency regulation. EVs/PHEVs are flexible loads; V2G capability allows them to act as storage, injecting power during peaks, managed by smart charging controls.
- **Q. 5. A (PMUs/WAMS):** PMUs measure synchronized voltage/current phasors using GPS time stamps (high accuracy). WAMS uses aggregated PMU data across a wide area to monitor system stability, detect oscillations, and facilitate rapid control action in transmission.
- **Q. 5. B (DSM/DR/EM):** DSM is a program to influence customer demand. **DR** is a component of DSM, actively reducing/shifting load in response to market signals or grid needs. **EM** is using systems (like Home Energy Management Systems) to optimize energy usage for efficiency.
- **Q. 6. A (IoT/Applications):** IoT involves interconnected physical devices using communication networks. *Applications:* Real-time asset performance monitoring, remote control of distribution devices, smart home energy management, and data collection from sensors.
- **Q. 6. B (Cyber Security/Threats):** Crucial because grid control relies on IT systems; a breach risks physical damage or blackouts. *Threats:* Denial of Service (DoS), data manipulation attacks (false data injection), and unauthorized access to control systems (e.g., SCADA).