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. What is the fundamental difference in power flow management between the Conventional Grid and the Smart Grid?

(a) DC vs. AC

(b) One-way vs. Two-way

(c) High voltage vs. Low voltage

(d) Centralized generation vs. Hydropower

ii. Which term refers to the grid's ability to automatically detect, isolate, and restore power after a fault?

(a) Power Quality

(b) Demand Side Management (DSM)

(c) Self-Healing Capability

(d) Synchro-Phasor Measurement

iii. Which component of Smart Grid architecture collects data from smart meters for billing and operational analysis?

(a) WAMS

(b) PMU

(c) MDMS (Meter Data Management System)

(d) Micro Grid

iv. What is the main benefit of using Storage Technologies (like BESS) in a Smart Grid?

(a) Replacing all existing transmission lines

(b) Mitigating the intermittent nature of renewable energy

(c) Increasing communication speed

(d) Enhancing cyber security

v. Which technology is commonly used to facilitate automated fault location and service restoration in the Distribution network?

(a) Transmission Automation

(b) Distribution Automation

(c) Internet of Things

(d) Two-way Digital Communication

vi. What is the key challenge arising from the massive deployment of IoT devices in the Smart Grid?

(a) Need for more centralized control

(b) Increased complexity in Cyber Security management

(c) Reduced reliance on communication

(d) Simplified planning aspects

vii. A primary advantage of a DC Smart Grid over an AC Smart Grid is:

(a) Easier fault detection

(b) Better suited for integrating DC sources (like PV) and DC loads

(c) Lower capital cost

(d) Faster communication speed

Answer any FOUR questions from Q.2 to Q.7. (4 *14 = 56 Marks)

Q. 2.

A. Provide a detailed comparative analysis between the Conventional Grid and the Smart Grid, covering aspects like reliability, control, and future scope. (7 Marks)

B. Describe the essential Components and Architecture of Smart Grid Design. Illustrate your answer with a comprehensive block diagram. (7 Marks)

Q. 3.

A. Define a Micro Grid. Explain its structure and discuss the benefits it offers in terms of reliability and resilience. (7 Marks)

B. Explain the working principle and importance of Synchro-Phasor Measurement Units (PMUs). Describe their role in Transmission Automation. (7 Marks)

Q. 4.

A. Define Smart Grid. Discuss the major Opportunities and Barriers associated with the implementation of Smart Grid technology. (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. 5.

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

B. Write a detailed note on Storage Technologies in the Smart Grid context. Explain their necessity for Renewable Integration. (7 Marks)

Q. 6.

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

B. Explain the role of Transmission Automation and Distribution Automation as fundamental components of Smart Grid designs. (7 Marks)

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

A. Key Challenges for Smart Grid

B. Advanced Metering Infrastructure (AMI)

C. V2G (Vehicle-to-Grid) concept

D. Wide Area Measurement Systems (WAMS)

E. Planning aspects of smart grid

Solutions & Model Answers for SAMPLE PAPER 2

MCQ Answer Key (Q. 1)

Q. No.	Correct Option
i.	(b) One-way vs. Two-way
ii.	(c) Self-Healing Capability
iii.	(c) MDMS (Meter Data Management System)
iv.	(b) Mitigating the intermittent nature of renewable energy
v.	(b) Distribution Automation
vi.	(b) Increased complexity in **Cyber Security** management
vii.	(b) Better suited for integrating DC sources (like PV) and DC loads

Short Answer Solutions (Q. 7)

- **A. Key Challenges for Smart Grid:** High upfront cost, regulatory barriers, complexity of data handling, **cybersecurity**, and ensuring interoperability between diverse technologies.
- **B. Advanced Metering Infrastructure (AMI):** The comprehensive system using smart meters and a communication network to enable two-way data flow between the utility and the customer. Essential for real-time monitoring and advanced tariffs.
- **C. V2G (Vehicle-to-Grid) concept:** A system where Electric Vehicles (EVs) not only draw power from the grid but can also feed stored energy back into the grid, acting as mobile, distributed storage during peak demand.
- **D. Wide Area Measurement Systems (WAMS):** A system using synchronized PMU data across a large geographic area to monitor grid stability, detect oscillations, and provide early warnings for potential blackouts.
- **E. Planning aspects of smart grid:** Includes forecasting future load and DG penetration, designing robust communication networks, selecting appropriate automation technology (AMI, DA), and ensuring compliance with standards and cyber security protocols.

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

- **Q. 2. A (Comparative Analysis):** (Similar to Q. 2. A, Paper 1, focusing on the centralized/distributed nature of control and generation).

- **Q. 2. B (Architecture/Block Diagram):** Focus on the integration of IT and OT. Draw a block diagram showing the main domains (Generation, Transmission, Distribution, Customer) and the central communication backbone linking them.

- **Q. 3. A (Micro Grid Definition/Benefits):** Define as a system that can island. Benefits include local power reliability (resilience), reduced power quality issues, and better management of local DG.
- **Q. 3. B (PMUs/Transmission Automation):** PMUs measure synchronized phasors (voltage/current). In Transmission Automation, PMUs provide critical real-time data to WAMS for stability monitoring, oscillation damping, and faster relay operations.
- **Q. 4. A (Opportunities and Barriers):** (Similar to Q. 2. B, Paper 1). Define Smart Grid first.
- **Q. 4. B (DSM/DR/EM):** (Similar to Q. 5. B, Paper 1). DSM is the overarching strategy. DR is the specific action taken (load reduction). EM is the use of technology for efficiency optimization.
- **Q. 5. A (IoT/Applications):** (Similar to Q. 6. A, Paper 1).
- **Q. 5. B (Storage/Renewable Integration):** Storage (e.g., BESS) is necessary to absorb surplus renewable energy (when wind/solar output is high) and release it when output is low, ensuring continuous, reliable power supply.
- **Q. 6. A (Cyber Security/Threats):** (Similar to Q. 6. B, Paper 1). Discuss why the shift to digital control makes the grid vulnerable.
- **Q. 6. B (Transmission and Distribution Automation):** Detail the distinct goals of each: TA focuses on wide-area stability (WAMS, PMUs) on the bulk power system, while DA focuses on local efficiency, reliability, and self-healing at the lower voltage levels.
