

# EE6622: TOPICS IN SMART GRIDS

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## Effective Term

Semester A 2025/26

## Part I Course Overview

### Course Title

Topics in Smart Grids

### Subject Code

EE - Electrical Engineering

### Course Number

6622

### Academic Unit

Electrical Engineering (EE)

### College/School

College of Engineering (EG)

### Course Duration

One Semester

### Credit Units

3

### Level

P5, P6 - Postgraduate Degree

### Medium of Instruction

English

### Medium of Assessment

English

### Prerequisites

Nil

### Precursors

Nil

### Equivalent Courses

Nil

### Exclusive Courses

Nil

## Part II Course Details

### Abstract

This course offers a comprehensive examination of smart grid technologies, which are transforming the landscape of electrical power systems. It includes the advanced infrastructure that enables real-time monitoring, efficient energy

distribution, and integration of renewable energy sources. Key topics include the deployment of advanced metering infrastructure, the interaction between electric vehicles and the grid, energy storage solutions, the importance of cybersecurity in maintaining grid integrity, etc. Students will gain insights into grid automation, microgrids, smart grid communication networks, and the application of big data and machine learning for optimizing grid operations.

### Course Intended Learning Outcomes (CILOs)

| CILOs |  | Weighting (if DEC-A1 DEC-A2 DEC-A3 app.) |   |   |   |
|-------|--|--|---|---|---|
| 1     | Demonstrate a comprehensive understanding of the fundamental concepts, components, and benefits of smart grid systems compared with traditional power grids.   | 20                                       | x |   | x |
| 2     | Power distribution system analysis, steady state, balanced and unbalanced system analysis.   | 20                                       | x | x | x |
| 3     | Analyse the challenges and solutions related to the integration of renewable energy sources, such as solar and wind, into the smart grid, and assess their impact on grid stability and efficiency.              | 20                                       | x | x |   |
| 4     | Evaluate the technologies and strategies for energy storage and electric vehicle integration within the smart grid, including the principles of V2G (Vehicle-to-Grid) technology and demand response mechanisms. | 20                                       | x | x |   |
| 5     | Apply big data analytics and machine learning techniques to smart grid operations.   | 20                                       |   | x | x |

#### A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

#### A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

#### A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

### Learning and Teaching Activities (LTAs)

| LTAs | Brief Description | CILO No.  | Hours/week (if applicable) |            |
|------|-------------------|---|----------------------------|------------|
| 1    | Lecture           | The students will learn key concepts of smart grid systems  | 1, 2, 3, 4, 5              | 2 hrs/wk   |
| 2    | Tutorials         | The students will work out key calculations in smart grid problems based on questions and problem solving | 2, 3                       | 0.5 hrs/wk |

|   |            |   |      |            |
|---|------------|---|------|------------|
| 3 | Laboratory | The students will gain hands-on experience for the smart grid optimization problems | 3, 4 | 0.5 hrs/wk |
|---|------------|---|------|------------|

**Assessment Tasks / Activities (ATs)**

|   | ATs                           | CILO No. | Weighting (%) | Remarks ("- " for nil entry) | Allow Use of GenAI? |
|---|-------------------------------|----------|---------------|------------------------------|---------------------|
| 1 | Project                       | 2, 3, 5  | 10            | -                            | No                  |
| 2 | Quiz                          | 1, 2     | 20            | -                            | No                  |
| 3 | Assignments (laboratory etc.) | 3, 4     | 10            | -                            | No                  |

**Continuous Assessment (%)**

40

**Examination (%)**

60

**Examination Duration (Hours)**

2

**Minimum Continuous Assessment Passing Requirement (%)**

30

**Minimum Examination Passing Requirement (%)**

30

**Additional Information for ATs**

Remark:

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.

**Assessment Rubrics (AR)****Assessment Task**

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 &amp; thereafter)

**Criterion**

Achievements in CILOs

**Excellent**

(A+, A, A-) High

**Good**

(B+, B, B-) Significant

**Fair**

(C+, C, C-) Moderate

**Marginal**

(D) Basic

**Failure**

(F) Not even reaching marginal levels

**Assessment Task**

Coursework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

**Criterion**

Achievements in CILOs

**Excellent**

(A+, A, A-) High

**Good**

(B+, B, B-) Significant

**Fair**

(C+, C, C-) Moderate

**Marginal**

(D) Basic

**Failure**

(F) Not even reaching marginal levels

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**Assessment Task**

Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

**Criterion**

Achievements in CILOs

**Excellent**

(A+, A, A-) High

**Good**

(B+, B) Significant

**Marginal**

(B-, C+, C) Basic

**Failure**

(F) Not even reaching marginal levels

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**Assessment Task**

Coursework (for students admitted from Semester A 2022/23 to Summer Term 2024)

**Criterion**

Achievements in CILOs

**Excellent**

(A+, A, A-) High

**Good**

(B+, B) Significant

**Marginal**

(B-, C+, C) Basic

**Failure**

(F) Not even reaching marginal levels

**Additional Information for AR****Constructive Alignment with Programme Outcomes****PILO**

1,2,3,4

3

**How the course contribute to the specific PILO(s)**

The course requires the analysis and the project design of smart grid including power and ICT systems, and therefore provides many opportunities for students to solve engineering problems by applying knowledge of mathematics, science, and engineering.

Students are required to complete laboratory experiments as well as project to gain practical hands-on experience.

**Part III Other Information****Keyword Syllabus**

## 1. Advanced Metering Infrastructure (AMI)

Understand the role of smart meters and data acquisition technologies in enabling real-time energy consumption monitoring and communication, enhancing consumer energy management and grid efficiency.

## 2. Renewable Energy Integration

Analyze the challenges associated with integrating renewable energy sources like solar and wind into the grid, and study the technological and operational solutions that mitigate these challenges to ensure stable energy supply.

## 3. Electric Vehicles (EVs)

Investigate the infrastructure required for EV charging, the potential of Vehicle-to-Grid (V2G) technology, and how demand response strategies can optimize the interaction between electric vehicles and the grid.

## 4. Energy Storage Systems

Study various battery technologies and their applications in maintaining grid stability and efficiency, particularly in the context of balancing the intermittent nature of renewable energy sources.

## 5. Microgrids and Distributed Generation

Explore the design and operational principles of microgrids, understanding the benefits of decentralized energy systems and how they integrate with the main grid to enhance energy reliability and resilience

## 6. Big Data and Machine Learning in Smart Grids

Learn how big data analytics and machine learning techniques are applied to optimize grid operations, including predictive maintenance, energy distribution optimization, and enhancing overall grid performance.

**Reading List****Compulsory Readings**

| Title |     |
|-------|-----|
| 1     | Nil |

**Additional Readings**

| Title |  |
|-------|--|
| 1     | Ekanayake, J. B., Jenkins, N., Liyanage, K. M., Wu, J., & Yokoyama, A. (2012). Smart grid: technology and applications. John Wiley & Sons. |