



**FIRST SEMESTER 2023-2024**

Course Handout Part II

Date: 11-08-2023

In addition to part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

Course No. : ECE/EEE/INSTR F424  
Course Title : *Smart Grid for Sustainable Energy*  
Instructor-in-Charge : Dr. Pratyush Chakraborty

**Scope and Objective of the Course:**

Concern over carbon emission, climate change, and energy sustainability is motivating a large global effort to integrate renewable energy into the power grid on a large scale. Handling variability of renewable generation is a key challenge for the system. We need to optimize the resources and processes at both economic and engineering sides of the power system. Considering all these in mind, the course aims to introduce different techno-commercial challenges and opportunities of the modern power system, also known as smart grid. The students will be able to analyze the problems of the future power grid and learn some recent developments in this multi-disciplinary field.

**Textbooks:**

1. Smart Grid Fundamentals and Applications: I S Jha, Subir Sen, Rajesh Kumar, D.P. Kothari, New Age International Publishers
2. Smart Grid: Communication- Enabled Intelligence for the Electric Power Grid: Stephen F Bush, Wiley-IEEE Press

**Reference books**

1. Power Generation, Operation, and Control: Wood and Wollenberg, Wiley and Sons
2. Power System Stability and Control: Kundur, Tata McGraw-Hill Edition
3. Integration of Distributed Generation in the Power Systems, M. H. Bollen, Fainan Hassan, Wiley, IEEE pub.

**Course Plan:**

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Textbook/Reference Book
1-3	Introduction to Smart Grid	Definition, Structure, and Importance	Chapter 1 of TB1, TB2
4-5	Introduction to Smart Grid	Global Standards, Policies, Control Layers, and Elements	Chapter 1 of TB1, TB2



6-9	Renewable Power Generation	Need for Renewable Power Generation, Broad Classification, Technology for various Renewable Power Generation (Solar, Wind, Biomass etc.)	<b>Chapter 8 of TB2 and Class Notes</b>
10-11	Energy Storage	Need for Energy Storage, Broad Classification, Various Storage Technologies (Electrochemical, Electrical, Mechanical etc.)	<b>Chapter 5 of TB1</b>
12	Incentives for Renewable Integration	Pricing and Billing Mechanisms – Time-of-use pricing, Feed-in-tariff, Net metering,	<b>Class Notes</b>
13-14	Optimization Primer	Need, Definition, Types, Lagrange Multiplier, KKT Conditions	<b>Class Notes</b>
15-18	Smart Grid Economics	Unit Commitment, Economic Dispatch, Automatic Generation and Control	<b>Chapter 3,5 of RB1</b>
19-20	Electricity Markets	Deregulation of Economics, Energy and Reserve Markets	<b>Class Notes</b>
21-23	Game Theory Primer	Need and Types, Non-cooperative Games, Nash Equilibrium, Price of Anarchy, Cooperative Games, Core	<b>Class Notes</b>
24-27	Demand Response (DR)	Definition and Need, Types, Controllable Load Models, Price based DR, Incentive-based DR	<b>Chapter 7 of TB2, Class Notes</b>
28-30	Hybrid Electric Vehicle/E-mobility	Need, Types, Vehicle to Grid Technology	<b>Chapter 6 of TB1</b>
31-32	Energy Aggregation in Electricity Market	Wind Energy Aggregation: a Coalitional Game Approach	<b>Class Notes</b>
33-35	Residential Community with Solar and Energy Storage units	Community Energy Aggregation using Coalitional Games under Net Metering and TOU Pricing	<b>Class Notes</b>
36-37	Sensing, Control and Communication Technologies	Smart Grid Communication, Advanced Smart Metering infrastructure	<b>Chapter 3 of TB1</b>
38-40	Application of Data Science in Smart Grid	Availability of Big Data in Power Systems, Applications, Importance and Limitations	<b>Chapter 7 of TB1, Class Notes</b>

### Evaluation Scheme:



Component	Duration	Weightage (%)	Marks	Date & Time	Nature of Component
Quiz (Best out of two)	-	15%	30	To be announced	Closed Book
Mid Semester Examination	90 Minutes	30%	60	13/10 - 4.00 - 5.30PM	Closed Book
Group Project	-	20%	40	To be announced	Open Book
Comprehensive Exam	180 Minutes	35%	70	19/12 AN	Closed Book
<b>Total</b>		100%	200		

**Chamber Consultation Hour:** To be announced in the class

**Notices:** All the official notices related to this course will be uploaded on CMS.

**Make-up Policy:** There will be make-up for the Mid-Semester and End-Semester examination subject to prior approval taken from the IC. No make-up will be allowed for Quiz.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Dr Pratyush Chakraborty**  
INSTRUCTOR-IN-CHARGE

