Department of Electrical and Electronics Engineering

COURSE MODULE OF THE COURSE TAUGHT FOR THE SESSION AUG-NOV: 2025-26

Course Syllabus with CO's

Faculty Name: Shreeshayana R			**Academic Year: 2025-26**				
Department: Electrical and Electronics Engineering							
Course Code	Course Title	Core/Elective	Prerequisite	Contact Hours			Total Hrs/ Sessions
				L	T	P	
BEE714D	Big Data Analytics in Power Systems	Professional Elective	Power System-I	3	-	-	40 Hours
Objectives	Course objectives: 1. To define big data and to explain big data application and analytics to power systems. 2. To explain the role of big data in smart grid communications and optimization of big data in electric power systems. 3. To explain security methods for the infrastructure communication and data mining methods for theft detection in power systems. 4. To explain the application of unit commitment method in the control of smart grid. 5. To explain protection algorithm for transformer based on data pattern recognition						

Topics Covered as per Syllabus

MODULE-1

Introduction: Big Data, Future Power Systems.

Big Data Application and Analytics in a Large - Scale Power System: Introduction, General Applications of Big Data, Algorithms for Processing Big Data, Application of Big Data in Power Systems.

Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding

MODULE-2

Role of Big Data in Smart Grid Communications: Introduction, The Grid Modernization, The Grid Interconnection with the Internet of Things, Data Traffic Pattern in a Smart Grid Environment, The Massive Flow of Information in a Smart Scenario ,The Volume of Generated Data in a Smart Distribution System: A Case of Study.

Big Data Optimization in Electric Power Systems: Introduction, Background, Scientometric Analysis of Big Data, Big Data and Power Systems, Optimization Techniques Used in the Big Data Analysis.

Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding

MODULE-3:

Security Methods for Critical Infrastructure Communications: Introduction, Effects of Successful Communication System Threats, General Communication System Operations, Industrial Control Networks and Operations, High-Level Communication System Threats, Cyber Threats and Security.

Data - Mining Methods for Electricity Theft Detection: Introduction, Transmission and Distribution System Losses, Electricity Theft Methods, Data Mining and Electricity Theft, Issues and Directions in Electricity Theft-Related Data-Mining Research.

Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding, L3 – Applying

MODULE-4

Unit Commitment Control of Smart Grids: Introduction, Renewable Energy Resources, The Unit Commitment Problem, A Multi-agent Architecture, Illustrative Example.

Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding, L3 – Applying

MODULE-5

Transformer Differential Protection Algorithm Based on Data Pattern Recognition: Big Data and Power System Protection, Methods for Differential Protection Blocking, Principal Component Analysis, Curvilinear Component Analysis (CCA), PCA Applied to Discriminate Between Inrush and Fault, Currents in Transformers, Application of the CCA as a Base for a Differential Protection System Under Study, Results.

Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding, L3 – Applying

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List of Text Books
Big Data Analytics in Future Power Systems, **Ahmed F. Zobaa and Trevor J. Bihl, CRC Press 2019. 2019.**
List of Additional Reference Books/URLs, Text Books, Notes, Multimedia Content, etc
1. **Big Data Analytics for Power Systems** – Big Data Analytics in Power Systems 2. **Application of Big-Data Analytics in Power System Protection**-Lec-37: Application of Big-Data Analytics in Power System Protection

Module	Key Topic	Resource / Reference Link	Use in Course
1	Big Data & Future Power Systems	Big Data Application in Power Systems – Book	Overview of Big Data concepts, algorithms, and applications in power grids
1	Big Data Analytics in Large-Scale Power System	Overview Paper – Kamińska-Chuchmała, 2019	Introduces general applications and prediction techniques for power systems
2	Smart Grid & IoT Integration	IoT-aided Smart Grid Survey	Explains modernization, data traffic patterns, and IoT-based communication
2	Big Data Analytics in Smart Grids	Big Data Analytics in Power Systems – Survey	Covers data processing, storage, and optimization in smart grids
3	Cybersecurity & Communication Threats	Smart Grid Cybersecurity Survey	Describes critical communication threats and preventive measures
3	Smart Meter Data & Theft Detection	Smart Meter Data Analytics Review	Explains data-mining methods for theft detection and loss reduction
3	Meter Data Management (MDM)	Meter Data Management – Wikipedia	Basic understanding of MDM and its use in analytics & theft detection
4	Unit Commitment & Multi-agent Systems	Multi-level UC Problem Paper	Explains UC problem, renewable integration, and MAS control
4	Multi-agent Systems in Power Distribution	MAS in Smart Grids	Supports L3-level application and simulation study
5	Transformer Differential Protection & PCA/CCA	Transformer Protection Research Example	Demonstrates fault vs inrush discrimination using PCA/CCA
5	Substation Design & Estimation	Refer IEEE/IEC Standard Guides & Single Line Diagrams	Practical understanding of equipment, symbols, and earthing for substations

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

Activity Assignment 1: Case Study on Big Data Applications in Power Systems

Objective:

To enable students to **identify and understand** real-world applications of Big Data in large-scale power systems.

1. 17 Groups (4 members in one group). Each group will **select a case study** on Big Data applications in the following areas:
    - Smart grid monitoring and optimization
    - Renewable energy integration
    - Power demand forecasting
    - Fault detection and predictive maintenance
2. Prepare a **3–4 page report** including:
    - **Problem addressed** in the power system
    - **Big Data tools/techniques** used
    - **Key outcomes** and **benefits**
3. Submit the report and **present in 5 minutes per group**.

Bloom's Level: L1 – Remembering, L2 – Understanding

Expected Outcome:

Students will **relate theoretical concepts** to **practical applications** in real-world power systems.

Activity Assignment 2: Data Analysis & Algorithm Simulation for Smart Grid

Objective:

To **apply Big Data algorithms** to understand data flow and optimization in smart grid systems.

Instructions:

1. 17 Groups
2. Provide **sample power system datasets** (load demand, voltage, current, and weather data).
3. Each group will:
    - Identify **data traffic patterns** and **massive data flow** in a smart grid.
    - Use **Python/MATLAB/Excel** to demonstrate a **simple algorithm** such as:
        - Load forecasting using **moving average**
        - Fault pattern detection using **correlation or clustering**
4. Submit:
    - **Code/Excel sheet with analysis**
    - **One-page summary of findings**

Bloom's Level: L2 – Understanding, L3 – Applying

Expected Outcome:

Students will **visualize data flow**, **analyze trends**, and **apply algorithms** for power system optimization.

Activity Assignment 3: Security Threat & Electricity Theft Detection Analysis

Objective:

To **evaluate communication threats and electricity theft detection** using data-mining approaches.

Instructions:

1. 17 Groups
2. Each group will perform:
    - **Research on one cyber threat** to critical infrastructure communications.

- **Study an electricity theft case** and identify **data-mining methods** used for detection (Decision Tree, Clustering, etc.).

3. Prepare a **Poster or Infographic** including:
   - Type of cyber threat / theft method
   - Impact on the grid
   - Suggested **preventive measures**
4. Conduct a **class exhibition** where each group explains their poster in **3 minutes**.

Bloom's Level: L2 – Understanding, L3 – Applying

Expected Outcome:

Students will **analyze vulnerabilities**, **propose mitigation methods**, and **connect theory to practical security challenges** in power systems.

Course Outcomes	**At the end of the course the student will be able to:** CO-1: Interpret the role of big data and machine-learning methods applicable to power systems and in particular to Smart Grid communications. [L2] CO-2: Apply optimization methods which are suitable for big data models in power systems. [L3] CO-3: Identify various cyber security issues, electricity theft detection and mitigation that exist in IoT-enable future power systems. [L3] CO-4: Identify renewable energy planning concerns associated with planned future power systems that have high renewable penetration. [L3]

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

The Correlation of Course Outcomes (CO's) and Program Outcomes (PO's)

Course Code:	**BEE714D**	**TITLE:** Big Data Analytics in Power Systems							Faculty Member: **SHREESHAYANA R**			
List of Course Outcomes	**Program Outcomes**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO-1	2	-	-	-	2	-	-	-	2	-	-	2
CO-2	2	2	-	-	2	-	-	-	2	-	-	2
CO-3	2	2	-	-	2	-	-	-	2	-	-	2
CO-4	2	2	-	-	2	-	-	-	2	-	-	2

Note: 3 = Strong Contribution 2 = Average Contribution 1= Weak Contribution - = No Contribution

The Correlation of Course Outcomes (CO's) and Program Specific Outcomes (PSO's)

Course Code:	**BEE714D**	**TITLE:** Big Data Analytics in Power Systems	Faculty Member: **SHREESHAYANA R**
List of Course Outcomes	**Program Specific Outcomes**		
	PSO1		**PSO2**
CO-1	2		
CO-2	2		-
CO-3	2		-
CO-4	2		-

Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution - = No Contribution