INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

DATA SCIENCE APPLICATIONS IN POWER ENGINEERING								
II Semester: EPS								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
BPSE21	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Pre-requisite: DC Machines and Transformers, Power System Analysis								

I. COURSE OVERVIEW:

This course establishes the critical role of data science and machine learning in addressing modern challenges within the power generation industry, from climate change to operational efficiency. It provides a comprehensive foundation in data preparation, statistical analysis, and time-series manipulation to build robust datasets. The curriculum delves into core machine learning concepts, algorithms, and model evaluation techniques for both supervised and unsupervised learning. Finally, it applies these principles to practical industry use-cases like predictive maintenance, electrical load forecasting, and optimizing building energy management.

II. COURSE OBJECTIVES:

The students will try to learn

- **I.** To introduce the fundamental concepts of data science and machine learning.
- **II.** To understand the process of data preparation and analysis for engineering problems.
- **III.** To learn various machine learning algorithms and their applications.
- **IV.** To apply machine learning techniques to real-world problems in the power generation industry.
- **V.** To analyze specific case studies related to power system forecasting and maintenance

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1	Differentiate between data science, machine learning, and AI concepts and their relevance to engineering disciplines.
CO2	Analyze and prepare datasets for use in machine learning models, including handling outliers and performing feature engineering.
CO3	Apply various machine learning algorithms to solve regression and classification problems. Explain and evaluate the principles and control strategies for load frequency control in two-area power systems.
CO4	Understand and articulate the practical applications of machine learning within the power generation industry.
CO5	Develop and evaluate forecasting models for specific power system challenges, such as electrical consumption and wind power failures.

IV. COURSE CONTENT:

MODULE–I: INTRODUCTION TO DATA SCIENCE (9)

Introduction to data science: introduction to machine learning, overview of the power generation industry, artificial intelligence in the power generation industry, climate change and the power industry, machine learning for industry transition, mitigation of problems using machine learning.

MODULE–II: DATA SCIENCE, STATISTICS, AND TIME SERIES (9)

Preparing a clean dataset, measuring and storing data in control systems, data uncertainty, time-series analysis, data correlation, mathematical representation and modeling, data representation and significance, outlier removal, model goodness, feature engineering, dimensionality reduction, practical checklist for dataset preparation.

MODULE–III: MACHINE LEARNING (9)

Introduction to machine learning concepts, supervised and unsupervised learning, regression and classification, bias-variance trade off, model complexity, neural networks (feed-forward and recurrent), support vector machines (SVM), random forest, selforganizing maps (SOM), Bayesian networks, training a model, splitting datasets (training, testing, validation), cross-validation, assessing model performance, role of a domain expert, practical advice for a machine learning project.

MODULE–IV: MACHINE LEARNING IN THE POWER GENERATION INDUSTRY & ELECTRICAL CONSUMPTION FORECASTING (9)

Machine learning studies in power plants and for power users, predictive maintenance, forecasting supply and demand, modeling physical relationships, consumer modeling, practical applications of machine learning in the power industry, case study of electrical consumption forecasting in a medical clinic, integration with Building Management Systems, artificial neural network (ANN) implementation, multilayer perceptron ANN, backpropagation training algorithm, ANN inputs (loads, day type, time, weather), formal procedure for ANN parameter selection

MODULE–V: APPLICATIONS OF ANN AND FUZZY LOGIC- LOAD FLOW STUDIES (9)

Applications of ANN and Fuzzy Logic- Load flow studies - Economic load dispatch - Load frequency control – Single area system and two area systems - Reactive power control. Fuzzy control applications in wide area control – ANN in hybrid state estimation – ANN applications for power system protection.

V. TEXT BOOKS:

1. Machine Learning and Data Science in the Power Generation Industry: Best Practices, Tools, and Case Studies, edited by Patrick Bangert, Elsevier, ISBN: 9780128197424.
2. Machine Learning for Energy Systems, edited by Denis N. Sidorov, MDPI Books, Publication Date: December 2020, ISBN (Hardback): 978-3-03943-382-7, ISBN (PDF): 978-3-03943-383-4.
3. Data Science for Engineers, by Raghunathan Rengaswamy and Resmi Suresh, CRC Press, Publication Date: December 16, 2022, ISBN (Hardback): 9780367754266, ISBN (eBook): 9781003353584.

VI. REFERENCE BOOKS:

1. Application of Machine Learning and Deep Learning Methods to Power System Problems, edited by Morteza
   NazariHeris, Somayeh Asadi, Behnam Mohammadi-Ivatloo, Moloud Abdar, Houtan Jebelli, and Milad Sadat-Mohammadi, Springer International Publishing, 2021.
2. Real-World Applications of Artificial Intelligence and Machine Learning in Power Systems: A Code Approach,
   by T. Mariprasath and V. Kirubakaran, Nova Science Publishers, 2025.

VII. WEB REFERENCES:

1. https://www.ieee-pes.org/pes-technical-activities/smart-grid-emerging-technologies
2. https://scikit-learn.org/stable/
3. https://towardsdatascience.com/tagged/time-series
4. https://www.kaggle.com/learn

5. https://www.iea.org/reports/digitalisation-and-energy

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech talk topics
5. Assignments
6. Model question paper-I
7. Model question paper-II
8. Lecture notes
9. Power point presentations