DATA SCIENCE AND MACHINE LEARNING FOR MODERN POWER SYSTEMS

PE-IV:EPS								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BPSC21	**Elective**	3	0	0	3	30	70	100
Contact Classes: 45	**Total Tutorials: Nil**	**Total Practical Classes: Nil**				**Total Classes: 45**		

I. COURSE OVERVIEW:

This subject will explain how data is generated in power systems and how are new technologies impacting the amount and quality of datasets. It will also help the students to understand popular data processing and analytic techniques. This course also provides the fundamental of machine learning and their application in modern power system operations. Writing term paper will help students to choose appropriate methods based on objective and dataset.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Fundamentals of Data Science and its application in power system.
II. Data regression state estimation and forecasting.
III. The application of machine learning in power system.
IV. How to formulate the case study.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:		
CO 1	**Summarize** the basics of power system and smart grid technology for understanding the performance of data driven system	Understand
CO 2	**Make use of** Singular Value Decomposition (SVD), and Monte Carlo simulation for state estimation and detection of anomalies in power system	Apply
CO 3	**Examine** data regression, data fitting and chi-square test by using the statistical studies for complex power analysis	Analyze
CO 4	**Analyze** the statistical proficiency and model identification for interference of data-based models of power system.	Analyze
CO 5	**Evaluate** the performance of smart grid/renewable energy/power system to study different data models.	Evaluate
CO 6	**Adapt the** operation, control and maintenance work for addressing the real time problems in the field of Power system/smart grid	Analyze

IV. SYLLABUS

MODULE –I: INTRODUCTION (09)

Phasor Analysis of basic circuits, Conservation of Power, Complex Power calculation, Introduction of Smart Grid, Cyber security and Cyber-attack, model-based system, data driven system, Neural Nets, Error calculation, Challenges and Opportunities in the Power System

MODULE –II: DATA SCIENCE IN POWER SYSTEM (09)

Introduction to Data Availability in Power Systems, Dimension of the variable, High Dimensional Space, Singular Value Decomposition (SVD), Application of SVD in Power System Anomaly Detection, Application of SVD in Bad Data Processing for State Estimation, Monte Carlo simulation.

MODULE –III: DATA REGRESSION, STATE ESTIMATION, FORECASTING(10)

Definition of Data Regression, State Estimation, Forecasting, Types of regression, Linear Regression with Least Squares, Data fitting, state estimation, Chi-square test, Forecasting, Demand forecasting.

Types of forecasting, Statistical Time Series, Application of Time Series Analysis in Renewable Energy Forecasting, Application of Time Series Analysis in Distribution Systems, Model Identification

MODULE –IV: MACHINE LEARNING IN POWER SYSTEMS Classes (08)

Importance of machine learning in Power system, examples of machine learning in power system forecasting, Support vector machine (SVM) and kernels, kernel optimization, Model selection, Model selection criteria, Description length, feature selection, Combining classifiers, Boosting, margin, and complexity, Margin and generalization, mixture models, Mixtures and the expectation maximization (EM) algorithm, EM, regularization, Clustering, Spectral clustering, Markov models, Bayesian networks, Learning Bayesian networks, Probabilistic inference.

MODULE –V: MACHINE LEARNING APPLICATIONS IN POWER SYSTEMS (09)

Introduction for Energy Disaggregation, Human Behavior Feature Extraction-Time-dependent State Transition Probability Matrix, Individual Load Tracking, Case study, Residential Customer Baseline Load Estimation, Contribution of Machine learning in CBL.

V. Text Books:

1. Mohamed A. El-Sharkawi "Electric Energy: An Introduction".
2. Glover, Sarma and Overbye, "Power System Analysis and Design".
3. Kutner, Nachtsheim and Neter, "Applied Linear Regression Models".

VI. Reference Books:

1. Goodfellow, Bengio and Courville, "Deep Learning".

VII. Web References:

1. https://smartgridcenter.tamu.edu/index.php/data-science-and-machine-learning-for-modern-power-systems-online-video-course/

VIII. E-Text Books:

1.https://scholar.smu.edu/cgi/viewcontent.cgi?article=1049&context=engineering_electrical_etds