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**Nilkamal School of Mathematics, Applied Statistics & Analytics**

# M.Sc Data Science

- **Program Educational Objectives (PEOs)**
- **Program Outcomes (POs)**
- **Course Outcomes (COs)**

# Program Educational Objectives (PEOs):

1. **Professional Skills**
2. **Career Growth**
3. **Higher Studies**

# Program Outcomes (POs):

**PO-1**: Knowledge in Mathematics and Computer Science: Understand the basic concepts, fundamental principles and the scientific theories related to Data Science.

**PO-2**: Abstract thinking: Ability to absorb and understand the abstract concepts that lead to various advanced theories in Mathematics, Statistics and Computer science.

**PO-3**: Modelling and solving: Ability in modelling and solving problems by identifying and employing the appropriate existing theories and methods.

**PO-4**: Advanced theories and methods: a) Understand advanced theories and methods to design solutions for complex data science problems. b) Applications in Engineering and Sciences: Understand the role of mathematical sciences and apply the same to solve the real life problems in fields of data science.

**PO-5**: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO-6**: Research-related skills: a) Capability for inquiring about appropriate questions relating to the concepts in various fields of Data Science. b) To know about the advances in various branches of Data Science.

**PO-7**: Information/digital literacy: Capability to use appropriate software to solve problems from courses from Data Science.

**PO-8**: Self-directed learning: Ability to work independently and do in-depth study of various notions of Data Science.

**PO-9**: Lifelong learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PO-10**: Application skills: Ability to apply the acquired knowledge in all aspects.

**PO-11**: Moral and ethical awareness/reasoning: Ability to identify unethical behavior such as fabrication, falsification or misrepresentation of data and adopting objective, unbiased and truthful actions in all aspects.

# Courses and Course Outcomes (COs):

**Mathematics for Data Science**

- **CO-1**: To define and apply the basic concepts of information theory
- **CO-2**: To learn the principles and applications of information theory in communication systems
- **CO-3**: Develop a deep understanding of statistical inference and hypothesis testing, including the principles of one-sample hypothesis testing and the use of different types of distributions in statistical analysis

**Database Management System**

- **CO-1**: To provide students with a foundational understanding of database management systems
- **CO-2**: To introduce students to the concept of data warehousing, data mining, and data analysis
- **CO-3**: To provide hands-on experience in designing and implementing database systems
- **CO-4**: To prepare students for careers in data management and analysis

**Supervised Machine Learning**

- **CO-1**: To provide students with a foundational understanding of supervised machine learning algorithms and their applications
- **CO-2**: To teach students how to use Scikit-Learn and other relevant tools to preprocess data and build machine learning models
- **CO-3**: To enable students to evaluate and compare the performance of different machine learning models
- **CO-4**: To introduce students to ensemble techniques and other advanced topics in supervised machine learning
- **CO-5**: To prepare students for further study or research in supervised machine learning and related fields

**Story Telling with Data**

- **CO-1**: To introduce students to basics of Structure thinking
- **CO-2**: Apply structured thinking frameworks to analyze complex problems and develop effective solutions
- **CO-3**: Develop skills in statistical analysis, data collection and management, and data visualization
- **CO-4**: Learn effective communication techniques to present data insights to different audiences.
- **CO-5**: To equip the students with dashboard preparation and implication of dashboard in business decisions.

**Research Methodology**

- **CO-1**: Frame business problems as data science projects and identify business rules and constraints.
- **CO-2**: Collect, clean, explore, and visualize data for a data science Case Studies.
- **CO-3**: Build and evaluate models and deploy and monitor them
- **CO-4**: Develop effective data science reports that communicate insights to different audiences.
- **CO-5:** Work collaboratively in teams to develop and present data-driven solutions to real world problems

**Mathematics for Data Science & Database Managements Systems Lab**

- **CO-1**: Understand and apply key mathematical concepts such as linear algebra, probability, statistics, and optimization to solve data-driven problems.
- **CO-2**: Construct Entity-Relationship (ER) diagrams, normalize databases, and implement relational schemas for efficient data storage and retrieval.
- **CO-3**: Execute queries, manage transactions, create indexes, and use stored procedures to manipulate and optimize database performance.
- **CO-4**: Apply mathematical models and database management techniques to process, analyze, and retrieve data efficiently in various data science applications.

**Supervised Machine Learning & Story Telling with Data Lab**

- **CO-1**: Learn key concepts of supervised machine learning, including regression and classification algorithms, model training, and evaluation.
- **CO-2**: Implement models such as linear regression, decision trees, and support vector machines using Python or R.
- **CO-3**: Utilize storytelling techniques and visualization tools like Matplotlib, Seaborn, and Power BI to communicate insights effectively.
- **CO-4**: Evaluate models using performance metrics, hyper parameter tuning, and feature engineering to improve accuracy.
- **CO-5:** Translate complex machine learning results into meaningful narratives to drive data-informed decision-making.

**Cloud Computing**

- **CO-1**: Learner will be able to develop and launch applications in the cloud environment
- **CO-2**: Explore various frameworks and APIs that are used for developing cloud-based applications
- **CO-3**: Handling data in Cloud environment
- **CO-4**: Running ML Applications on AWS Sagemaker

**Unsupervised Machine Learning**

- **CO-1**: Explore different unsupervised learning algorithms, including clustering and dimensionality reduction.
- **CO-2**: Evaluate unsupervised learning algorithms and use them to enhance machine learning solutions
- **CO-3**: Understand clustering algorithms, including K-means, hierarchical clustering, and density-based clustering
- **CO-4**: Learn dimensionality reduction techniques such as PCA, t-SNE, and auto encoders for feature extraction.
- **CO-5**: Familiarize with deep unsupervised learning concepts such as auto encoders, GANs, and VAEs for data analysis.

**Big Data Technologies**

- **CO-1**: To provide students with a foundational understanding of Big Data Analytics and its technologies and tools in the context of Data Science
- **CO-2**: To teach students how to store and process Big Data using Hadoop and Spark for Data Science
- **CO-3**: To prepare students to use text and stream analytics in Big Data for Data Science
- **CO-4**: To expose students to case studies and applications of Big Data Analytics in Data Science.
- **CO-5**: To prepare students for further study or research in Big Data Analytics and related fields in Data Science

**Analysis and Forecasting of Time Series**

- **CO-1**: To introduce the fundamental concepts of time series analysis and forecasting
- **CO-2**: To provide hands-on experience in analyzing and modeling time series data
- **CO-3**: To equip students with the skills to use appropriate techniques for forecasting and evaluate their performance
- **CO-4**: To enable students to apply time series analysis in various domains

**Research Discourse-I**

- **CO-1**: Understand the principles of academic research, including problem identification, hypothesis formulation, and literature review.
- **CO-2**: Analyze existing research papers, evaluate methodologies, and identify gaps for potential research contributions.
- **CO-3**: Explore qualitative and quantitative research methods, data collection techniques, and statistical analysis tools.
- **CO-4**: Develop skills in structuring research papers, writing abstracts, and presenting findings effectively.
- **CO-5**: Understand ethical considerations in research, plagiarism prevention, and collaborative research approaches.

**Cloud Computing & Unsupervised Learning Lab**

- **CO-1**: Learn fundamental cloud services, deployment models, virtualization, and resource management in platforms like AWS, Azure, or Google Cloud.
- **CO-2**: Utilize cloud-based storage, computing, and big data frameworks (such as Hadoop or Spark) for scalable data processing.
- **CO-3**: Explore clustering (K-Means, DBSCAN, Hierarchical Clustering) and dimensionality reduction (PCA, t-SNE) for pattern recognition in data.
- **CO-4**: Implement security best practices, cost optimization, and efficient cloud resource utilization for data science applications.

**BDA and Analysis & Forecasting of Time Series Lab**

- **CO-1**: Learn fundamental concepts of big data, including storage, processing, and analysis using tools like Hadoop, Spark, and NoSQL databases.
- **CO-2**: Explore time series components, stationarity, autocorrelation, and feature engineering to prepare data for forecasting.
- **CO-3**: Apply statistical and machine learning-based models such as ARIMA, SARIMA, Exponential Smoothing, and LSTMs for predictive analysis.
- **CO-4**: Leverage cloud computing and big data technologies to process and analyze time-dependent data for real-world applications.

**Data Privacy and Security**

- **CO-1**: Understanding of security requirements within an organization
- **CO-2**: How to inspect, protect assets from technical and managerial perspectives
- **CO-3**: To Learn various offensive strategies to penetrate the organizations security
- **CO-4**: To learn various tools that help in offensive security testing.

**Deep Learning & Generative AI**

- **CO-1**: Learn the fundamental principles of deep learning
- **CO-2**: Identify the deep learning algorithms for various types of learning tasks in various domains.
- **CO-3**: Implement deep learning algorithms and solve real-world problems.
- **CO-4**: Understand generative AI deeply, including its historical development

- **CO-5**: Understand what it will take – from both technology and culture - to make AI work in your organization.

**Natural Language Processing**

- **CO-1**: Apply foundational NLP techniques in practical settings
- **CO-2**: Utilize advanced NLP methods for data analysis.
- **CO-3**: Leverage modern NLP technologies like Transformers and GPT for innovative solutions
- **CO-4**: Apply NLP for applied areas and incorporate ethical considerations into NLP applications.

**Modern Application Development**

- **CO-1**: Learn how to frame business problems as data science projects and identify business rules and constraints
- **CO-2**: Develop skills in data collection, cleaning, exploration, visualization, transformation, and quality assessment.
- **CO-3**: Learn how to build and evaluate models, deploy, and monitor them.
- **CO-4**: Develop critical thinking and problem-solving skills in the context of data science.
- **CO-5**: To prepare the students for Industry Internship/Research Project that they are expected to do in fourth semester.

**Data Security & Deep Learning Lab**

- **CO-1**: Learn fundamental principles of data security using graph databases, access control, and encryption techniques within Neo4j.
- **CO-2**: Utilize Neo4j's role-based authentication, fine-grained access control, and encryption to protect graph-based data.
- **CO-3**: Apply deep learning models to graph data, leveraging frameworks like TensorFlow and PyTorch with Neo4j.
- **CO-4**: Use graph-based machine learning techniques to detect cybersecurity threats, fraud, and network intrusions.
- **CO-5**: Develop end-to-end solutions combining Neo4j with deep learning for fraud detection, recommendation systems, and cybersecurity.

**Block chain in AI**

- **CO-1**: Create a basic block chain using consensus algorithm
- **CO-2**: Implement a bitcoin transaction and mining mechanism
- **CO-3**: Implement Ethereum block chain contract.
- **CO-4**: Role of Block chain and AI in Wealth Management and Credit Scoring
- **CO-5**: Compliance and Fraud Detection using Block chain and AI

**NLP & Block Chain Lab**

- **CO-1**: Learn key concepts of NLP, including tokenization, stemming, lemmatization, named entity recognition (NER), and sentiment analysis.
- **CO-2**: pply deep learning techniques such as transformers, LSTMs, and BERT for text classification, language generation, and information extraction.
- **CO-3**: Understand the fundamentals of block chain, smart contracts, cryptographic hashing, and consensus mechanisms.
- **CO-4**: Implement block chain-based solutions for secure data transactions, identity management, and tamper-proof records

**Trends in Data Science**

- **CO-1**: Students will be able to learn how Support Vector Machines (SVM) work, and will experience these models when looking at both baseball and wearable data
- **CO-2**: Explore the details behind reinforcement learning and see how it is used in trading
- **CO-3**: Create technical indicators in Python and combine them with ML models for optimization
- **CO-4**: Evaluate the profitability and the predictability of the models to understand their limitations and potential.