

**Modern Education Society's
Nowrosjee Wadia College (AUTONOMOUS)**



NAAC Accredited A+ with CGPA 3.51

Affiliated to the
Savitribai Phule Pune University
(Formerly University of Pune)

Two Year M. Sc. Degree Program in Data Science
(Faculty of Science & Technology)
M. Sc. (Data Science)

**Choice Based Credit System Syllabus under NEP To be
implemented from Academic Year 2025-2025**

1. Preamble of the Syllabus

Data science combines the knowledge of mathematics, statistics and computer science to solve exciting data-intensive problems in industry and in many fields of science. In today's tech-driven world, access to vast amounts of information and ways to interpret it have taken priority than ever before. Real time processing of this huge data is also a major requirement in every walk of life. It also means we need more people who can organize and analyze that information- people who can use data to make change and help businesses. Data science employs a variety of instruments, scientific procedures, methods, and algorithms to glean insights from both structured and unstructured data. This Data Science program integrates scientific methods from statistics, computer science and data-based business management to extract knowledge from data and drive decision making. Our curriculum provides students with a rigorous course of study in big data technologies, applications and practices a pathway for student internships and full-time employment. Students are prepared to meet the challenges at the intersection between big data, business analytics, and other emerging fields. In compliance with the directives from the University Grants Commission, under the autonomous status of the college, the syllabus for Data Science at the post graduate level is designed as per the National Educational Policy (NEP 2020) curriculum framework. The present syllabus is prepared by the Board of Studies in Mathematics, Nowrosjee Wadia College, taking into consideration the present relevance and application of data science. While preparing this syllabus the U.G.C. model curriculum (LOCF) and existing syllabus given by Savitribai Phule Pune University is followed.

2. Objectives

- To equip students with statistical, mathematical reasoning, machine learning, knowledge discovery, problem solving, and visualization skills.
- To provide technology-oriented students specialized in data science stream with the capability in various areas of data science and business domains.
- Familiarize the students with suitable tools of mathematical and statistical analysis to handle issues and problems in data sciences.
- Enhance the ability of learners to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in data Science.
- Develops attitude and interest along with necessary skills among the students to encourage them to do research and work in industry.
- Encourage the students to develop a range of generic skills helpful in employment, internships and social activities.

3. Programme Outcomes

PO1: To apply ethical practices in everyday business activities and make well- reasoned ethical business and data management decisions.

PO2: To demonstrate knowledge of statistical data analysis techniques utilized in business decision making.

PO3: To apply principles of Data Science to the analysis of business problems.

PO4: To use data mining software to solve real-world problems.

PO5: To employ cutting edge tools and technologies to analyze Big Data

PO6: To apply algorithms to build machine intelligence.

PO7: To demonstrate use of team work, leadership skills, decision making and organization theory.

PO8: To enhance research culture and uphold scientific integrity and objectivity.

Programme Specific Outcome:

PSO1: Abstract thinking: Ability to understand the abstract concepts that lead to various data science theories in Mathematics, Statistics and Computer science.

PSO2: Problem Analysis and Design Ability to identify analyze and design solutions for data science problems using fundamental principles of mathematics, Statistics, computing sciences, and relevant domain disciplines.

PSO3: Modern software tool usage: Acquire the skills in handling data science programming tools towards problem solving and solution analysis for domain specific problems.

PSO4: Innovation And Entrepreneurship: Produce innovative IT solutions and services based on global needs and trends.

PSO5: Societal And Environmental Concern: Utilize the data science theories for societal and environmental concerns.

PSO6: Professional Ethics: Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practices.

PSO7: Conduct Investigations of complex computing problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO8: Individual and Team work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary environments.

PSO9: Applications in Multi-disciplinary domains: Understand the role of statistical approaches and apply the same to solve the real life problems in the fields of data science.

PS10: Project Management: Apply the research-based knowledge to analyse and solve advanced problems in data scienc

4. Eligibility

Graduate degree in Mathematics/ Statistics / Computer Science / Computer Application/ Engineering / Technology or any other discipline from a recognized university / institution with an equivalent qualification.

5. Duration of the Course:

The duration of the M.Sc. Data Science Program shall extend over 4 semesters (two academic years) of 15 weeks or more, each with a maximum of 90 actual working days of instruction in each semester.

6. Medium of instruction:

The medium of instruction shall be English.

7. Teaching Scheme:

- The course is a 2 year, 3 semesters full time under graduate course.
- The course follows the NEP (National Educational Policy 2020) pattern as per
- Government of Maharashtra G.R(s) as follows:

सांकेतांक २०२३०४२०१९२५२६६९०८

शासन निर्णय क्रमांक: एनईपी-२०२२/प्र.क्र.०९/विशि-३ शिकाना, दिनांक २० एप्रिल, २०२३

4 credit theory course = 60 hours (60 lectures)

2 credit theory courses = 30 hours (30 lectures)

2 credit practical course = 60 hours (4 hours/ week/ batch)

8. Abbreviations

OE: Open Elective

AEC: Ability Enhancement Course

VEC: Value Education Courses

CC: Co-Curricular Courses

IKS: Indian Knowledge System

OJT: On Job Training

FP: Field Project

VS: Vocational Skill Courses

CEP: Community Engagement Project

T: Theory

P: Practical

CE: Continuous Evaluation

SEE: Semester End Examination

F.Y.: First Year

S.Y.: Second Year


T.Y.: Third Year

M. Sc. (Data Science) Proposed Structure as per NEP 2020


YEAR	Level	Sem	Mandatory	Credit	Elective (select one)	RM	OJT/FP	RP	Cum Cr	Degree											
I	6	Sem I	Statistics for Data Science- I	4	Database Technologies (2T+2P)	4	—	—	22	PG Diploma (after 3 yr degree)											
			Mathematics for Data Science	4																	
			Python Programming for Data Science	2	R-Programming for Data Science (2T+2P)																
			LAB on Mathematics and Statistics for Data Science	2																	
			LAB on Python Programming	2																	
		Sem II	Statistics for Data Science- II	4	Data Mining and Data Ware housing (2T + 2P)						4	(Mini project) 4 credit	—	22							
			AI & Machine Learning	4																	
			Fundamental of Data Science	2	Optimization Techniques (2T + 2P)																
			LAB on Statistics for Data Science- II	2																	
			LAB on AI and Machine Learning using Python	2																	
		Cum. Cr. For PG Diploma			24-28											8	4	4	44		
		Exit Option: PG Diploma (40-44 credits) after three year UG Degree																			

II	6.5	Sem III	Big Data	4	Natural Language Processing and Computational Linguistics (4)	—	(Mini project) 4 credit	22	PG Degree after 3 yr degree) Or PG Degree (after 4 yr degree)					
			Data Visualization and Analytics	4	Design and Analysis of Algorithm (4)									
			Deep Learning	2										
			LAB on Deep Learning	2										
			LAB on Big data and data Visualization	2										
		Sem IV	Predictive Analysis and Generative AI	4						—	12 credit	22		
			Data Science Case Studies	4										
			Business Informatics	2										
		Cum. Cr. for 1 Yr PG Degree		22-26						8			10	44
		Cum. Cr. for 2 Yr PG Degree		46-54						16	4	4	10	88

Semester III


	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Data Science		
Major (Theory) Subject SEMESTER – III		
Year – II	Paper No- PDSMJ231	Credits 4
Semester-III	Name of Paper- Big Data	Hours :60
<p>Course Outcomes:</p> <p>CO1: Understand the fundamental concepts and challenges of Big Data analytics.</p> <p>CO2: Explain different data storage and processing technologies used in Big Data analytics.</p> <p>CO3: Apply data preprocessing techniques to clean and transform large datasets.</p> <p>CO4: Implement various data analysis algorithms and techniques on Big Data platforms.</p> <p>CO5: Visualize and communicate insights extracted from Big Data using appropriate tools.</p> <p>CO6: Evaluate the scalability and performance of Big Data analytics solutions.</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
Unit 1: Introduction to Big Data Analytics Definition and characteristics of Big Data Challenges in Big Data analytics Introduction to popular Big Data platforms and tools Sources of Big Data 3V's of Big Data (need for Hadoop) Varying data structures Applications of Big Data		10
Unit 2: Data Processing in Big Data Analytics & Hadoop Ecosystem Data ingestion and storage (Hadoop Distributed File System, NoSQL databases) Batch processing vs. real-time stream processing Introduction to Hadoop Hadoop Architecture History of Hadoop- Facebook, Dynamo, Yahoo, Google Hadoop Components: HDFS, Mapreduce Introduction to Pig, Hive, HBase, Mahout Apache spark Installation of single node cluster-installation of java Hadoop configuration		12

<p>Unit 3: Data Preprocessing in Big Data Analytics Data cleaning techniques Data transformation and feature engineering Handling missing values and outliers Real Time Analytics In-Memory Data Grid for real Time Analysis</p>	10
<p>Unit 4: Data Analysis and Mining in Big Data Analytics Overview of data analysis algorithms (classification, clustering, regression) Distributed machine learning algorithms Introduction to Apache Mahout</p>	8
<p>Unit 5: Big Data Visualization Visualizing Big Data with tools such as Tableau, D3.js Interactive visualizations for large datasets Best practices for presenting and communicating insights</p>	10
<p>Unit 6: Scalability and Performance in Big Data Analytics Techniques for scaling Big Data analytics solutions Performance optimization for Big Data platforms Evaluating the efficiency of Big Data analytics solutions</p>	10
<p>References:</p>	<ol style="list-style-type: none"> 1. Jeffrey Dean, Sanjay Ghemawat MapReduce: Simplified Data Processing on Large Clusters 2. Sanjay Ghemawat, Howard Gobioff, and Shun-Tak Leung The Google File System http://wiki.apache.org/hadoop/ 3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007. 4. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013) 5. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw- Hill/Osborne Media (2013), Oracle press. 6. Big Data Case Study by Bernard Marr –Willey Publications.


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Masters of Science with Major in Data Science		
Major (Theory) Subject SEMESTER – III		
Year – II	Paper No- PDSMJ232	Credits 4
Semester-III	Name of Paper- Data Visualization and Analytics	Hours :60
<p>Course Outcomes:</p> <p>CO1: Understand and create from the ground up business intelligence reports of expert calibre.</p> <p>CO2: Create and employ the same instruments that experts in data science and analysis use.</p> <p>CO3: Learn about the subtleties and uses of descriptive, predictive, and prescriptive analytics to improve your analytical abilities and make data-driven business choices in real time.</p> <p>CO4: Analyse a dataset to learn new things and share what you find with impactful Data visualizations.</p> <p>CO5: Apply data visualization techniques to real-world datasets for analysis and decision making.</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
Unit 1: Introduction to Data Visualization and Analysis Understanding the importance & Benefits of data visualization Principles of effective data visualization Challenges in data visualization Opportunities in data visualization Types of data visualizations (e.g., charts, graphs, maps) & their applications Data types and data structures Data cleaning and preprocessing Exploratory data analysis techniques		10
Unit 2: Data Visualization Tools and Software Introduction to popular data visualization tools (e.g., Tableau, Power BI, matplotlib, ggplot2, Looker Studio, HighCharts, Adobe Illustrator) Introduction to PowerBI, Use cases and BI Tools , Power BI components, Power BI Desktop, workflows and reports. Data Extraction with Power BI. SaaS Connectors, Working with Azure SQL database, Python and R with Power BI Power Query Editor, Advance Editor, Query Dependency Editor, Data Transformations, Shaping and Combining Data, M Query and Hierarchies in Power BI. Introduction to web-based visualization tools (e.g., D3.js, Plotly)		10

<p>Unit 3: Graphical Perception and Design Principles Design Principles and Advanced Visualization Techniques: Color theory and color palettes Typography and layout Accessibility and inclusivity in visualization design Interactive visualizations Network visualization Human perception and cognition in visualization Color theory and visualization aesthetics</p> <p>Static Data Visualization Techniques What is Static data Visualization? Key Components of Data Visualization Common Types of Data Visualization Visualization types in big data Examples of Data Visualization – Cinema, Art, Philosophy, Cartography etc.</p>	15
<p>Unit 4: Geographic Data Visualization Introduction to geographic data visualization geovisualization Visual variables Properties of visual variables The perception of visual variables Types of information and their visualization Map elements. Map composition Types of thematic maps: proportional symbol maps, point density maps, isoline maps and choropleth maps. Combining multiple layers How do you visualize geographic data? Mapping techniques and spatial analysis - Case studies in geographic data visualization</p>	10
<p>Unit 5: Time Series Visualization Characteristics of time series data Applications and domains where time series data are commonly used Challenges in visualizing time series data Decomposing time series data into trend, seasonal, and residual components Visualizing seasonal patterns and trends using decomposition techniques Analyzing and interpreting trends in time series data Candlestick charts for visualizing financial time series data Spectral plots and periodograms for analyzing periodicity in time series data Heatmaps and calendar heatmaps for visualizing time series data over time and across categories</p> <p>Techniques for analyzing temporal patterns Hands-on exercises with time series data visualization</p>	15

Recommended Readings:	<ol style="list-style-type: none">1. "The Visual Display of Quantitative Information" by Edward Tufte2. "Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic3. "Interactive Data Visualization for the Web" by Scott Murray - "Data Points: Visualization That Means Something" by Nathan Yau4. "Information Dashboard Design: Displaying Data for At-a- Glance Monitoring" by Stephen Few
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	Masters of Science with Major in Data Science	
Major (Theory) Subject SEMESTER – III		
Year – II	Paper No- PDSMJ233 Name of Paper- Deep Learning	Credits 2
Semester-III		Hours :30
<p>Course Outcomes:</p> <p>CO1: Understand the concepts neural network and deep learning.</p> <p>CO2: To study the different deep learning algorithms which are appropriate for various type of learning tasks in different domain.</p> <p>CO3: To make students understands tools and techniques required in handling large amount of data set.</p> <p>CO4: Implement deep learning algorithms to solve real world problem.</p> <p>CO5: Understand the importance of ethical considerations in the development and deployment of deep learning models. Identify potential ethical issues and biases that may arise in data collection, preprocessing, and model training.</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
Unit 1: Introduction to Deep Learning Introduction to Artificial Intelligence, Machine Learning, and Deep Learning. Historical overview and breakthroughs in Deep Learning. Gradient descent Stochastic Gradient descent Perceptron Multilayer Perceptron Back Propagation Heuristics for faster training. Nestors accelerated gradient descent. Key deep learning applications and real-world use cases		4
Unit 2: Convolutional Neural Networks (CNNs) Introduction to Artificial Neural Networks (ANNs) Understanding CNNs and their architecture. Perceptrons and Activation Functions. Backpropagation and Gradient Descent. Training neural networks with various optimization algorithms. Convolution, Pooling, and Strides CNN architectures (e.g., AlexNet, VGG, ResNet) Transfer Learning and Fine-tuning		7

<p>Unit 3: Recurrent Neural Networks (RNNs) Basics of RNNs and their sequential nature Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) Applications of RNNs (e.g., text generation, language translation)</p>	7
<p>Unit 4: Reinforcement Learning and Deep Reinforcement Learning Introduction to Reinforcement Learning (RL) Markov Decision Process (MDP) and Bellman Equation Q-Learning and Deep Q Networks (DQNs) Policy Gradients and Actor-Critic methods</p>	7
<p>Unit 5: Building Deep learning Environment and Hands-on Sessions DL environment setup locally, Basics of Tensorflow, Keras. Setting up a DL environment in the cloud AWS /GCP Run Tensorflow program on AWS cloud platform Implementing various deep learning models using popular frameworks (e.g., TensorFlow, PyTorch) Exploring datasets and data preprocessing techniques Fine-tuning pre-trained models and optimizing hyperparameters. Bias and Fairness Issues in Deep Learning Ethical Guidelines and Best Practices Responsible AI and societal Implications</p>	5
<p>References:</p>	<ol style="list-style-type: none"> 1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville 2. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal 3. "Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani 4. "Recurrent Neural Networks for Beginners" by Mohit Sewak 5. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto 6. "Recurrent Neural Networks in Action: Understanding, Implementing, and Debugging RNNs" by Daniel Slater, Alexis Combes, and Damien Poirier 7. "Ethics of Artificial Intelligence and Robotics" edited by Vincent C. Müller

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science with Major in Data Science	
Major (Theory) Subject SEMESTER – III		
Year – II	Paper No- PDSMJ234	Credits 2
Semester-III	Name of Paper- LAB on Deep Learning	Hours :60
<p>Course Outcomes:</p> <p>CO1: Design, implement, and evaluate deep learning models including ANN, CNN, and RNN using modern frameworks and from-scratch approaches for real-world datasets.</p> <p>CO2: Analyze model performance, optimization techniques, ethical considerations, and interpretability to develop responsible and effective deep learning solutions.</p>		
COURSE CONTENTS/ SYLLABUS		
1. Introduction to Deep Learning		
<p>1.1 Implement a basic feedforward neural network using Python and a deep learning framework like TensorFlow or Keras. Train the network on a simple dataset, such as the XOR problem, and analyze the model's performance.</p> <p>1.2 Build a multi-layer perceptron (MLP) to classify images from the MNIST dataset. Experiment with different architectures and activation functions to achieve higher accuracy.</p> <p>1.3 Implement gradient descent and backpropagation algorithms from scratch in Python to train a simple neural network. Compare the performance with the same model trained using a deep learning framework.</p> <p>1.4 Explore the impact of different optimization algorithms (e.g., Adam, RMSprop, SGD) and learning rates on the convergence of a deep neural network.</p> <p>1.5 Implement a simple autoencoder using Python and TensorFlow/Keras to perform dimensionality reduction on a dataset.</p>		
2. Neural Network Fundamentals		
<p>2.1 Build a simple feedforward neural network to classify handwritten digits from the MNIST dataset.</p> <p>2.2 Experiment with different architectures, activation functions, and optimization algorithms to achieve higher accuracy.</p>		

<p>2.3. Implement a multi-layer perceptron (MLP) neural network from scratch using Python and NumPy. Train the network on a synthetic dataset and visualize the decision boundaries.</p> <p>2.4 Design and train a convolutional neural network (CNN) to classify images from the CIFAR-10 dataset. Evaluate the model's performance and analyze common misclassifications.</p> <p>2.5 Implement a recurrent neural network (RNN) with Long Short- Term Memory (LSTM) cells to perform sentiment analysis on a text dataset. Analyze the model's predictions and discuss the importance of sequence modeling.</p>	
<p>3. Convolutional Neural Networks (CNNs)</p> <p>3.1 Build a CNN to classify images from the CIFAR-10 dataset. Experiment with different CNN architectures, including the number of convolutional layers, filter sizes, and pooling strategies, to achieve higher accuracy.</p> <p>3.2 Implement a CNN with transfer learning using a pre-trained model (e.g., VGG or ResNet) on the ImageNet dataset. Fine-tune the model for a specific image classification task on a smaller dataset and compare the performance with a CNN trained from scratch.</p> <p>3.3 Design and train a CNN to perform object detection on the COCO dataset. Utilize techniques like region proposal networks (RPNs) and non-maximum suppression (NMS) to improve the accuracy of object detection.</p> <p>3.4 Implement a basic CNN architecture to classify images from the CIFAR-10 dataset. Experiment with the number of convolutional layers, filter sizes, and pooling layers to optimize the model's performance.</p> <p>3.5 Visualize the feature maps generated by different layers of a CNN for specific input images. Interpret and discuss the learned features and their relevance to the task.</p> <p>3.6 Compare the performance of different activation functions (e.g., ReLU, tanh, sigmoid) in the convolutional layers of a CNN. Analyze the activation functions' impact on training speed and convergence.</p>	
<p>4. Recurrent Neural Networks (RNNs)</p> <p>4.1 Implement a basic RNN from scratch using Python and NumPy. Train the RNN on a synthetic sequential dataset and observe the model's performance.</p> <p>4.2 Build an RNN with LSTM cells to perform sentiment analysis on a text dataset. Experiment with different LSTM architectures and hyperparameters.</p> <p>4.3 Implement a character-level RNN language model to generate text. Train the model on a corpus of text data and generate sample text based on the learned patterns.</p> <p>4.4 Build a sequence-to-sequence (seq2seq) RNN for machine translation, such as translating English sentences to French or vice versa.</p> <p>4.5 Train an RNN with GRU cells to perform stock price prediction using historical time-series data. Evaluate the model's predictive accuracy and discuss the challenges of time-series forecasting.</p>	

<p>5. Ethical Considerations in Deep Learning</p> <p>5.1 Explore the use of differential privacy techniques to protect individual privacy in deep learning applications, such as medical data analysis or personalized recommendations.</p> <p>5.2 Examine the ethical implications of using facial recognition systems and discuss ways to address concerns related to privacy and surveillance.</p> <p>5.3 Investigate the role of explainable AI in deep learning models. Implement methods to interpret and explain the decisions made by a Complex deep learning model.</p> <p>5.4 Build a deep learning model for sentiment analysis and evaluate the potential impact of deploying such a model in social media platforms or online content moderation.</p> <p>5.5 Analyze the consequences of deploying AI-based recommendation systems in e-commerce or entertainment platforms and discuss potential pitfalls related to user privacy and information filtering.</p>	
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Masters of Science with Major in Data Science		
Major (Theory) Subject SEMESTER – III		
Year – II Semester-III	Paper No- PDSMJ235 Name of Paper- LAB on Big data and data Visualization	Credits 2 Hours :60
<p>Course Outcomes:</p> <p>CO1: Understand the fundamental concepts and challenges of Big Data analytics.</p> <p>CO2: Explain different data storage and processing technologies used in Big Data analytics.</p> <p>CO3: Apply data preprocessing techniques to clean and transform large datasets.</p> <p>CO4: Implement various data analysis algorithms and techniques on Big Data platforms.</p> <p>CO5: Visualize and communicate insights extracted from Big Data using appropriate tools.</p> <p>CO6: Evaluate the scalability and performance of Big Data analytics solutions</p>		
COURSE CONTENTS/ SYLLABUS		
<p>Assignment 1: Data Ingestion and Storage</p> <ul style="list-style-type: none"> - Set up a Hadoop cluster or use a cloud-based Big Data service. - Ingest a large dataset (e.g., CSV or JSON format) into the Hadoop Distributed File System (HDFS). - Explore different storage formats (e.g., Parquet, ORC) and analyze the impact on storage size and query performance. - Write MapReduce or Spark code to perform basic data transformations and store the processed data in a NoSQL database (e.g., MongoDB). <p>Assignment 2: Data Preprocessing and Cleaning</p> <ul style="list-style-type: none"> - Choose a large dataset from a public repository (e.g., Kaggle). - Apply data cleaning techniques such as handling missing values, outliers, and noise. - Use Apache Spark or a similar framework to parallelize the data processing tasks. - Split the dataset into training and testing sets for future analysis. <p>Assignment 3: Data Analysis and Mining</p> <ul style="list-style-type: none"> - Select a real-world dataset related to a specific domain (e.g., customer churn prediction, fraud detection). - Implement a machine learning algorithm (e.g., decision tree, logistic regression) using Apache Mahout or a similar library. - Split the dataset into training, validation, and testing sets. 		

- Evaluate the performance of the model using appropriate performance metrics (e.g., accuracy, precision, recall).

Assignment 4: Data Visualization

- Choose a large dataset with multiple dimensions and attributes.
- Use a visualization tool like Tableau or D3.js to create interactive visualizations.
- Explore different visualization techniques, such as histograms, scatter plots, and heatmaps.
- Present your findings and insights in a visually appealing and informative manner.

Assignment 5: Scalability and Performance Optimization

- Scale up your analysis from Assignment 3 to handle larger datasets.
- Evaluate the performance of the Big Data platform in terms of processing time and resource utilization.
- Identify bottlenecks and optimize the code (e.g., using data partitioning, caching) to improve performance.
- Compare the performance of different hardware configurations or cloud-based services for Big Data analytics.

Assignment 6: Case Study and Application

- Choose an industry or domain of interest (e.g., healthcare, finance, marketing).
- Identify a specific problem or challenge in that domain that can be addressed using Big Data analytics.
- Gather relevant datasets and perform exploratory data analysis.
- Apply appropriate data analysis and mining techniques to derive insights and solutions.
- Present your findings and recommendations in a comprehensive report or presentation.


Some case studies –

NOTE: It is expected to form teams and ask students to solve these case studies, discuss and work on solutions. (Refer Book Big Data Case Study by Bernard Marr – Willey Publications for solving case studies.)

In detail explanation for case studies below is given in the said book)


1. Case study on Facebook
2. Case Study on IoT Sensors
3. Case Study on Telecom Industry
4. Case Study on Banking
5. Case study on Amazon
6. Case Study on General Electric –By TCS
7. Case Study on Uber
8. Case Study on Netflix
9. CDC (Corona Virus and other Pandemics)
10. Any case study can be taken

Note: These assignments are just suggestions and can be modified based on the specific goals and resources available for the course

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	Masters of Science with Major in Data Science	
Major Elective (Theory) Subject SEMESTER – III		
Year – II	Paper No- PDSME236A	Credits 4
Semester-III	Name of Paper- Natural Language Processing and Computational Linguistics	Hours :60
<p>Course Outcomes:</p> <p>CO1: Apply the principles and Process of human languages such as English and other Indian Languages using computers</p> <p>CO2: Realize semantics and pragmatics of English language for text processing</p> <p>CO3: Create CORPUS linguistics based on digestive approach (Text Corpus method)</p> <p>CO4: Check a current methods for statistical approaches to machine translation.</p> <p>CO5: Perform POS tagging for a give natural language and select a suitable language modelling technique based on the structure of the language.</p> <p>CO6: Demonstrate the state-of-the-art algorithms and techniques for text-based processing of the natural language with respect to morphology.</p> <p>CO7: Develop a Statistical Methods for Real world Applications and Explore deep learning based on NLP.</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
Unit 1: Overview of NLP 1.1 What we do in NLP 1.2 Why NLP is hard 1.3 Empirical laws and text processing 1.4 Ambiguity and uncertainty in language 1.5 The Turing test 1.6 Introduction to NLTK (Natural Language Toolkit)		08


<p>Unit 2: Text processing and N-Gram Language models</p> <p>2.1 Introduction to Corpora, Corpora Analysis</p> <p>2.2 Word and sentence segmentation</p> <p>2.3 Edit distance – weighted edit distance, dynamic programming edit distance</p> <p>2.4 Spelling Correction – non-word spelling errors, real world spelling errors, noisy channel model-introduction, real-world spell correction.</p> <p>2.5 Introduction –Probabilistic language model and its application (speech recognition, machine translation, completion prediction)</p> <p>2.6 Probabilistic language modeling – chain rule- markov assumption</p> <p>2.7 N-Gram model – computing unigram, bigram, trigram probabilities, Evaluation of language models (extrinsic and intrinsic), smoothing – Laplace smoothing, Add-k smoothing</p>	14
<p>Unit3: Morphology and Context free grammar</p> <p>3.1 Morphology- Allomorphs, bound and free morphemes, stem and affixes, types of affixes content and functional morphemes, Inflectional and derivational morphology, Morphology processing, finite state automaton (FSA).</p> <p>3.2 Morphology analysis –Linguistic and engineering approach, Constituency, CFG definition –use and limitation.</p> <p>3.3 Chomsky Normal For Top-down parsing, bottom-up parsing.</p>	08
<p>Unit 4: Part of speech tagging</p> <p>4.1 The Concept of parts-of-speech, example, usage.</p> <p>4.2 The Penn Treebank Brown Corpus, Generative vs conditional models</p> <p>4.3 Hidden Markov Models for POS Tagging</p> <p>4.4Viterbi Algorithm, maximum entropy model, conditional random fields (CRF)</p>	10
<p>Unit 5: Lexical Semantics</p> <p>5.1 Introduction to lexical semantics (Homonymy, polysemy, synonsemy, antonymy, hypernymy, hyponymy, meronymy)</p> <p>5.2 Wordnet – synsets ,lemma vs synsets,word similarity – Thesaurus based word similarity ,path –based similarity ,concept probability models ,information content ,resnik similarity , linsimilarity ,jiang-conrath similarity , word sense disambiguation –random walk algorithm.</p>	10
<p>Unit 6: Application of NLP</p> <p>6.1 Machine Translation – Comparing Machine Translation and Human Translation: A case study</p> <p>6.2 Information Extraction – Extracting Information from Structure Normal Documents: A case study</p> <p>6.3 Text Summarization – Text Classification using Text Summarization: A case study</p> <p>6.4 Sentiment Analysis – Sentiment analysis using Python: A case study</p>	10

References:	<ol style="list-style-type: none">1. Daniel Jurafsky and James H. Martin "Speech and Language Processing", 3rd edition, Prentice Hall, 2009.2. NitinIndurkha, Fred J. Damerau "Handbook of Natural Language Processing", Second Edition, CRC Press, 2010.3. Hannes Hapke, "Natural language processing in action" MANNING Publications, 2019. Alexander Clark, Chris Fox, Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley-Blackwell, 2012.
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	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science with Major in Data Science	
Major Elective (Theory) Subject SEMESTER – III		
Year – II	Paper No- PDSME236B Name of Paper- Design and Analysis of Algorithms	Credits 4
Semester-III		Hours :60
<p>Course Outcomes:</p> <p>CO1: develop a solid foundation in algorithm analysis, including growth functions, summations, recurrences, and counting techniques</p> <p>CO2: familiarize students with fundamental sorting algorithms and their time complexities, such as insertion sort, heap sort, and merge sort.</p> <p>CO3: understand and apply the divide and conquer strategy to solve problems, including binary search, merge sort, quick sort, and Strassen's matrix multiplication.</p> <p>CO4: explore greedy algorithms and their applications in solving optimization problems, such as the fractional knapsack problem, job sequencing, minimum-cost spanning trees, and Huffman coding</p> <p>CO5: introduce dynamic programming as a problem-solving technique, covering topics such as matrix chain multiplication, longest common subsequence, 0/1 knapsack problem, and all pairs shortest path</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
Unit 1. Introduction 1.1 What is an Algorithm? 1.2 Algorithm Specification 1.3 Performance Analysis		10
Unit 2- Divide and Conquer 2.1 General Method 2.2 Binary Search 2.3 Finding the Maximum and Minimum 2.4 Merge Sort 2.5 Quick Sort- Performance Measurement 2.6 Strassen's Matrix Multiplication 2.7 Convex Hull- Some Geometric Primitives, the Quick Hull Algorithm, Graham's Scan.		18


Unit 3- The Greedy Method 3.1 The General Method 3.2 Knapsack Problem 3.3 Tree Vertex Splitting 3.4 Job Sequencing with Deadlines- Prim’s Algorithm, Kruskal’s Algorithm. 3.5 Optimal Storage of Tapes 3.6 Optimal Merge Patterns 3.7 Single-Source Shortest Paths	18
Unit 4: Dynamic Programming 4.1 The General Method 4.2 String Editing 4.3 0/1-Knapsack 4.5 Matrix Chain Multiplication Problem.	14
References	1. Computer Algorithms, E. Horowitz, S. Sahni, S. Rajasekaran, Computer Science Press, (1998). (1.1, 1.2, 1.3, 3.1, 3.2, 3.3, 3.4, 3.5.1, 3.7, 3.8.1, 3.8.2, 3.8.3, 4.1, 4.2, 4.3, 4.4, 4.5.1, 4.5.2, 4.6, 4.7, 4.8, 5.1, 5.6, 5.7) 2. Introduction to Algorithms, T. H. Cormen, C.E. Leiserson, R.L. Revest, C. Stein, Prentice-Hall of India Private Limited; Indian Edition (2nd Edition) edition (2003). (15.2 Matrix Chain Multiplication Problem) 3. Algorithm Design. Jon Kleinberg and Eva Tardos. Addison Wesley, 2005.

Semester IV


	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
Masters of Science with Major in Data Science		
Major (Theory) Subject SEMESTER – IV		
Year – II	Paper No- PDSMJ241	Credits 4
Semester-IV	Name of Paper- Predictive Analysis and Generative AI	Hours :60
<p>Course Outcomes:</p> <p>CO1: Use technical skills in predictive modelling to support business decision- making.</p> <p>CO2: Describe various techniques for predictive analysis and Fit predictive models for the sample data.</p> <p>CO3: Understand the evolution of AI and the significance of Deep Learning.</p> <p>CO4: Apply various Neural Network architectures for tasks like image recognition and sequence modeling.</p> <p>CO5: Analyze data preprocessing and training techniques for neural networks.</p> <p>CO6: Design practical solutions using advanced neural networks for diverse applications.</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
Unit 1. Fundamentals of Predictive Analysis 1.1 Analysis 1.2 Data analysis 1.3 Prediction 1.4 Predictive Analysis 1.5 Why Predictive Analysis? 1.6 Steps/Lifecycle of Predictive Analysis 1.7 Applications of Predictive Analysis 1.8 Predictive modeling and its features 1.9 Types of Predictive models 1.10 Tools for Predictive Analysis		04

<p>Unit 2: Predictive Modeling Techniques</p> <p>2.1 Factors for choosing Predictive Modeling Techniques</p> <p>2.2 Decision Trees –(CART Technique)</p> <p>2.3 Regression Techniques: Introduction</p> <p>2.4 Linear Regression</p> <p>2.5 Multiple Linear Regression,</p> <p>2.6 Logistic Regression</p> <p>2.7 Neural Networks:</p> <p>2.8 Introduction,</p> <p>2.9 Architecture of ANN : Artificial vs Biological Neurons, Input Layer, Hidden Layers and Output Layer</p> <p>2.10 Introduction to RNN,LSTM,CNN</p>	06
<p>Unit 3: Introduction to Time Series Analysis and Forecasting</p> <p>3.1 Time Series Analysis</p> <p>3.2 Time Series :Meaning and Utility</p> <p>3.3 Components of Time Series</p> <p>3.4 Time Series patterns</p> <p>3.5 Randomness and Cyclical Pattern in a Time Series</p> <p>3.6 Forecasting</p> <p>3.7 Forecast accuracy,</p> <p>3.8 Auto-regressive and Moving average models</p> <p>3.9 Casual models</p> <p>3.10 Regression analysis for forecasting</p>	10
<p>Unit 4: Predictive Model Evaluation and Deployment</p> <p>4.1 Introduction</p> <p>4.2 Model Validation</p> <p>4.3 Rule Induction Using CHAID</p> <p>4.4 Automating Models for Categorical and Continuous targets</p> <p>4.5 Comparing and Combining Models</p> <p>4.6 Evaluation Charts for Model Comparison</p> <p>4.7 MetaLevel Modeling</p> <p>4.8 Deploying Model</p> <p>4.9 Assessing Model Performance</p> <p>4.10 Updating a Model</p>	10
<p>Unit 5: Foundations of AI and Neural Networks</p> <p>5.1 History and evolution of AI/ML</p> <p>5.2 Deep learning revolution, Transfer learning</p> <p>5.3 History of Neural Natural Language Processing, Structure of Artificial Neural Networks.</p> <p>5.4 Steps in Training an Artificial Neural Network, Parameters and Hyperparameters, Backpropagation</p>	08

<p>Unit 6: Advanced Neural Network Architectures 6.1 Introduction to advanced architectures, Introduction to Generative AI Models: Generative Adversarial Networks (GANs), 6.2 Variational Autoencoders (VAEs), 6.3 Transformers, Attention Mechanism in detail Long Short-Term Memory Networks (LSTMs)</p>	08
<p>Unit 7: Data Preprocessing and Generative AI Applications 7.1 Probability and Statistics, Data Preprocessing Techniques, Model Training Techniques 7.2 AI Applications: Applications in Various Fields: Art and Creativity, Image and Video Generation, 7.3 Text Generation, Music Composition, Healthcare Finance. Real-world use cases and challenges in deploying generative AI models</p>	14
Reference	<ol style="list-style-type: none"> 1. Data Mining for Business Intelligence by Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, (Wiley, 3rd ed., 2016) 2. Predictive & Advanced Analytics (IBM ICE Publication) 3. Predictive Analytics and Data Mining By Vijay Kotu and Bala Deshpande 4. Predictive Analytics, Revised and Updated By Eric Siegel 5. Predictive Analytics: Data Mining, Machine Learning and Data Science for Practitioners, 2nd Edition By Dursun Del 6. "Generative AI for everyone: Understanding the essentials and applications of this breakthrough technology". Altaf Rehmani . 7. "Introduction to Generative AI" , Numa Dhamani, Kindle Edition, 2024. 8. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal. 9. "Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python, TensorFlow, and Keras" by Josh Kalin. 10. "Generative AI in Software Development: Beyond the Limitations of Traditional Coding" Jesse Sprinter, 2024.

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science with Major in Data Science	
Major (Theory) Subject SEMESTER – IV		
Year – II	Paper No- PDSMJ242 Name of Paper- Data Science Case Studies	Credits 4
Semester-IV		Hours :60
<p>Course Outcomes:</p> <p>CO1: Define steps for solving case studies of different domains.</p> <p>CO2 Illustrate analytical tool's features for problem solving, filtering data and visualization.</p> <p>CO3 Apply the data manipulation and transformation techniques to prepare data ready for processing.</p> <p>CO4 Analyze data with the help of visualization and predict results.</p> <p>CO5 Evaluate model performance and communicate results.</p> <p>CO6 Build a comprehensive end to end project.</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
1. Brief Introduction to Data Science 1.1 What is Data Science 1.2 Why Now? - The importance of Data Science in today's business environment. 1.3 Difference between Data Science, Business Intelligence and Data Analysis 1.4 Real World Applications of Data Science 1.5 Popular Tools and Languages to Apply Data Science 1.6 A Typical Data Science Team 1.7 Team Structures		12
2. Brushing Up on your MS Excel Skills 2.1 Basic Functions 2.2 Advanced Functions: Sorting, Filtering and Pivot tables, Charts and other visualization tools 2.3 Handling Date formats for time series analysis 2.4 Short Cut Keys, making simple Dashboards Making Data Work for You! 2.5 What can Data do? 2.6 Types of Data 2.7 Data Exploration 2.8 Data Sources and Risks		16

2.9 Data Cleaning, Manipulating Time Series Data 2.10 Data Storage and Retrieval		
3. Analysis, Prediction and Visualization 3.1 Generating Charts and plots to better understand the output, interpretation, prediction and conclusion 3.2 Creating Dashboards in Tableau 3.3 Creating a Story in Tableau 3.4 Creating Dashboards in MS Excel 3.5 Generate High End Presentations in MS PowerPoint		12
4. The Data Science Workflow 4.1 Understand the steps in the life cycle of a Data Science project 4.2 Theoretical Vs Applied Data Science		06
5. Case Study 5.1 Problem Statement – Domain and scope of the study 5.2 Data Source 5.3 Data Preparation 5.4 Choice of Model 5.5 Model Building 5.6 Type of tools to use 5.7 Analysis 5.8 Presentation		14
Reference	<ol style="list-style-type: none"> 1. Microsoft Excel Data Analysis and Business Modeling, By Wayne L. Winston, Published by Microsoft Press 2019 2. Ryan Sleeper, Practical Tableau, O'Reilly publication, 2019. 3. Python Data Science Hand Book - https://tanthiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf 	

	MODERN EDUCATION SOCIETY'S Nowrosjee Wadia College, Pune (Autonomous)	Academic Year 2025-2026
	Masters of Science with Major in Data Science	
Major (Theory) Subject SEMESTER – IV		
Year – II	Paper No- PDSMJ243	Credits 2
Semester-IV	Name of Paper- Business Informatics	Hours :30
<p>Course Outcomes:</p> <p>CO1: Understand role of IT in Business</p> <p>CO2: Explain Business Intelligence and its component framework</p> <p>CO3: Perform different OLAP cube operation</p> <p>CO4: Evaluate and assess risk in choosing a Business decision</p> <p>CO5: Develop efficient Dashboard for discover insights and drill down into the data</p>		
COURSE CONTENTS/ SYLLABUS		Lectures
<p>Unit 1: Business view of Information Technology applications – Business Enterprise Organization, Its functions and Core Business Processes IT in Business, E-Business, needs, challenges, Enterprise applications (CRM/ERP etc.), Information users and their requirements BI component framework, BI users, BI applications, BI roles and responsibilities</p>		04
<p>Unit 2: OLTP, OLAP and Enterprise reporting Introduction OLTP, Queries scope of OLTP, Advantages and Challenges of OLTP, One, Two and Three Dimensional Data, Queries scope of OLAP, Advantages of OLAP system OLAP Architectures-MOLAP, ROLAP, HOLAP OLTP Vs OLAP Data Models for OLTP and OLAP Role of OLAP tools in the BI architecture Multidimensional Data representation using Data Cube and its Operation-Slice, Dice, Rollup, Drill Down, Pivot, Drill-Across, Drill-Through. Enterprise Reporting (ER) perspectives, ER characteristics in OLAP, Balanced Scorecard, Dashboards, Scorecards Vs Dashboards</p>		06

<p>Unit 3: Decision Analysis Formulating Decision Problems Decision Strategies without Outcome Probabilities, Decision Strategies for a Minimize Objective Decision Strategies for a Maximize Objective Decisions with Conflicting Objectives, Decision Strategies with Outcome Probabilities, Average Payoff Strategy Expected Value Strategy Evaluating Risk, Decision Trees, Decision Trees and Monte Carlo Simulation Decision Trees and Risk Sensitivity Analysis in Decision Trees, The Value of Information Decisions with Sample Information Bayes's Rule Utility and Decision Making Constructing a Utility Function Exponential Utility Functions</p>	08
<p>Unit 4: Business Analytics Visualization Tool: Tableau</p> <p>Tableau Introduction and Architecture: Tableau suite and system requirements, Tableau architecture, Data in Tableau, Connecting to data, Managing data source metadata, Working with extracts instead of live connections, Creating and using extracts, Joins and blends Joining tables, Cross database joins, Blending data sources, Filtering data, Filtering discrete and continuous fields, Filtering dates, Other filtering options, Sets in Tableau, Views in Tableau. Formatting in tableau: Font, Alignment, Shading, Border, Lines, Fields, Title, Caption, Workbook-level, Worksheet-level, Field level formatting, Custom number and Date formatting</p> <p>Creating charts: Bar charts and its variations, Bullet chart, Bar-in-bar chart, Variations of date and time visualizations, Gantt Charts, Stacked bars, Treemaps, Area charts, Pie charts Circle charts ,Box and whisker plots, Histograms, Scatterplot, Dual axis and combination charts, Visualizing multiple axes to compare different measures, Visualizing distributions , Visualizing dates and times, Date parts, date values, and exact dates Introduction to calculations , An overview of Table Calculations, Creating and editing Table Calculations, Quick Table Calculations</p> <p>Data Story with Dashboards: Designing dashboards in Tableau, Building the views, manipulating objects on Dashboard, Creating the dashboard framework</p>	12
Reference	<ol style="list-style-type: none"> 1. Fundamentals of Business Analytics, 2nd Edition, R. N. Prasad, Seema Acharya, Wiley Publication 2. Data Science for Business, Foster Provost & Tom Fawcett, O'REILLY 3. Data Science Fundamentals and Practical Approaches, Gypsy Nandi, Rupam Sharma, BPB Publications, 2020 4. James, E.R. (2017). Business Analytics. UK: Pearson Education Limited. 5. Learning Tableau 2020: Fourth Edition by Joshua N. Milligan, published by Packt Publishing Lt

The Examination pattern for all Undergraduate (PG) courses.

EVALUATION PATTERN : For Two Credit Courses

1. Each course shall be evaluated with Continuous Evaluation (CE) and End Semester Examination (EE).
2. Continuous Evaluation shall be of 15 marks and End Semester Examination (EE) shall be of 35 marks.
3. To pass a course of 2credits, a student has to earn minimum 20 marks, provided that he/she should earn minimum 6 marks in Continuous Evaluation and minimum 14 marks in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.
4. For Internal evaluation (out of 15 marks), There has to be one written test of 10 marks (Mid-Semester Examination). For remaining 5 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc. (on approval of Head of the Department)
5. There shall be reevaluation of the answer scripts of End-Semester Examination (out of 35 marks) of theory papers only, but not of internal assessment papers as per Ordinance No. 134 A and B.

ATKT RULES

Minimum number of credits required to take admission to Second year of M. Sc. course is 31 (70%) (As same as SPPU).

AWARD OF GRADES AND GRADE POINTS

The mapping of percentage to letter grade and grade point is given in the following

Table 1 CGPA will be calculated as follows:

Table 1

Sr. No.	Grade Letter	Grade Point	Marks
1.	O (Outstanding)	10	90 ≤ Marks ≤ 100
2.	A+ (Excellent)	9	80 ≤ Marks ≤ 89
3.	A (Very Good)	8	70 ≤ Marks ≤ 79
4.	B+ (Good)	7	55 ≤ Marks ≤ 69
5.	B (Above Average)	6	50 ≤ Marks ≤ 54
6.	C (Average)	5	45 ≤ Marks ≤ 49
7.	D (Pass)	4	40 ≤ Marks ≤ 44
8.	F (Fail)	0	Marks < 40
9.	Ab (Absent)	0	

PERFORMANCE INDICES:

The performance of a student in a Semester is indicated by a number called the Semester Grade Point Average (SGPA). Similarly, the performance of a student in the Course is indicated by a number called the Course Grade Point Average (CGPA).

The End-Semester results and final result of the courses will contain SGPA and CGPA, respectively.

- i. **SGPA:** The SGPA is the weighted average of the grade points obtained by a student in all the courses during the Semester. That is

$$SGPA = \frac{\sum_{i=1}^P C_i G_i}{\sum_{i=1}^P C_i}$$

For example, suppose in a Semester, student has registered for five courses having credits C₁, C₂, C₃, C₄ and C₅ and suppose his/her grade points are G₁, G₂, G₃, G₄ and G₅, respectively. The SGPA is calculated as

$$SGPA = \frac{C_1 G_1 + C_2 G_2 + C_3 G_3 + C_4 G_4 + C_5 G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

SGPA is calculated correct up to two decimal places by rounding off.

- ii. **CGPA:** The CGPA is the weighted average of the grade points obtained in all courses (theory and Practicals) by students in all the courses in 6 semesters. It is calculated in the same manner as the SGPA.

RESULTS :

Based on the performance of the student in the Semester Examinations, Nowrosjee Wadia College will declare the results and issue the Semester Grade sheets. Also, the College will declare the results and issue the Grade sheets at the end of the course.

The class will be awarded to a student on the basis of CGPA. The award of the class shall be as per Table 2 and corresponding percentage calculation for the CGPA is given in Table No. 3

Table 2

Sr. No.	CGPA	Class of the degree awarded
1	9.50 or more than 9.50	OUTSTANDING (O)
2	8.50 or more but less than 9.50	EXCELLENT (A+)
3	7.50 or more but less than 8.50	VERY GOOD (A)
4	6.25 or more but less than 7.50	GOOD (B+)
5	5.25 or more but less than 6.25	ABOVE AVERAGE (B)
6	4.75 or more but less than 5.25	AVERAGE (C)
7	4.00 or more but less than 4.75	PASS (D)

Percentage of marks corresponding to CGPA is calculated by the formulae which are given in the following Table 3.

Table 3

GRADE	Formula for the percentage of marks
O	$20 \times \text{CGPA} - 100$
A+	$10 \times \text{CGPA} - 5$
A	$10 \times \text{CGPA} - 5$
B+	$12 \times \text{CGPA} - 20$
B	$5 \times \text{CGPA} + 23.75$
C	$10 \times \text{CGPA} - 2.50$
D	$6.6 \times \text{CGPA} + 13.6$

The above percentage calculations are illustrated in the following Table 4

Table 4

Some examples of CGPA to Percentage calculations

CGPA obtained	Formula	Percentage (%)	Grade
10	$20 \times 10 - 100 = 100$	100	O
9.75	$20 \times 9.75 - 100 = 95$	95	O
9.5	$20 \times 9.5 - 100 = 90$	90	O
9.0	$10 \times 9 - 5 = 85$	85	A+
8.0	$10 \times 8.0 - 5 = 75$	75	A
7.0	$12 \times 7.0 - 20 = 64$	64	B+
6.67	$12 \times 6.67 - 20 = 60.04$	60.04	B+
6.25	$12 \times 6.25 - 20 = 55$	55	B+
5.25	$5 \times 5.25 + 23.75 = 50$	50	B
4.75	$10 \times 4.75 - 2.50 = 45$	45	C
4.0	$6.6 \times 4.0 + 13.6 = 40$	40	D

While declaring the results, the existing ordinances are applicable. There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.

PATTERN OF THE QUESTION PAPER: Two Credits**i. Internal Examination:**

(Mid-Semester Examination of 10 marks, Duration: 30 Mins)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	5	Attempt any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 1 mark.)
Q. 2.	5	Solve any 1 out of 2 questions	Descriptive type questions (Each question carries 5 marks)

ii. End Semester Examination (EE):

Shall be of 35 marks, 2 hours duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	5	Solve any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 1 mark.)
Q. 2.	10	Solve any 5 out of 7 OR Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 3.	10	Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 4.	10	Solve any 2 out of 3 OR Solve any 1 out of 2	Descriptive type questions

EVALUATION PATTERN : For Four Credit Courses

- i. Each course shall be evaluated with Continuous Evaluation (CE) and End Semester Examination (EE).
- ii. Continuous Evaluation shall be of 30 marks and End Semester Examination (EE) shall be of 70 marks
- iii. To pass a course of 4credits, a student has to earn minimum 40 marks, provided that he/she should earn minimum 12 marks in Continuous Evaluation and minimum 28 marks in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.
- iv. For Internal evaluation (out of 30 marks), There has to be one written test of 20 marks (Mid-Semester Examination). For remaining 10 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc. (on approval of Head of the Department)

- v. There shall be revaluation of the answer scripts of End-Semester Examination (out of 70 marks) of theory papers only, but not of internal assessment papers as per Ordinance No. 134 A and B.

PATTERN OF THE QUESTION PAPER: Four Credits

i. Internal Examination:

(Mid-Semester Examination of 10 marks, Duration: 30 Mins)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	10	Attempt any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 2 marks)
Q. 2.	10	Solve any 1 out of 2 questions	Descriptive type questions (Each question carries 10 marks)

ii. End Semester Examination (EE):

Shall be of 70 marks, 2 hours and 30 Minutes duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	10	Solve any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 2 marks)
Q. 2.	20	Solve any 5 out of 7 OR Solve any 2 out of 3	Descriptive type questions
Q. 3.	20	Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 4.	20	Solve any 2 out of 3 OR Solve any 1 out of 2	Descriptive type questions