**Syllabus**

**M.Sc. Data Science**

**Affiliated Colleges**

**Programme Code: \*\***

**2025-2026 onwards**

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**BHARATHIAR UNIVERSITY**

**(A State University, Accredited with “A++” Grade by NAAC,**

**Ranked 21st among Indian Universities by MHRD-NIRF)**

**Coimbatore - 641 046, Tamil Nadu, India**

**BHARATHIAR UNIVERSITY - COIMBATORE 641046**

**DEPARTMENT OF COMPUTER SCIENCE (Effective from the academic Year 2025 - 2026)**

**MISSION**

* Build a strong foundation in computer science with a focus on data science and emerging technologies.
* Promote innovation and interdisciplinary learning for real-world applications.
* Inculcate professional ethics, human values, and social responsibility.
* Prepare students for successful careers in industry, entrepreneurship, and higher education.

**1. Eligibility for Admission to the Programme**

Candidates for admission to the first-year programme leading to the Degree of Master of Science in Data Science (M.Sc. DS) will be required to possess:

A pass in any UG (any Computer Science Stream) / B.Sc. Mathematics or its equivalents / B.Sc. Statistics or its equivalents / B.Sc. Electronics or its equivalents.

**2. Duration of the Programme**

The programme shall be offered on a full-time basis. The programme will consist ofthree semesters of course work, laboratory work and internship training / mini project and the fourth semesterconsist of major project work.

**3. Regulations**

The general Regulations of the Bharathiar University Choice Based Credit SystemProgramme are applicable to this programme.

**4. The Medium of Instruction and Examinations**

The medium of instruction and Examinations shall be in English.

**5. Submission of Record Notebooks for Practical Examinations & Project Viva-Voce.**

Candidates taking the Practical Examinations should submit Bonafide Record NoteBooks prescribed for the Examinations. Otherwise, the candidates will not be permitted to takethePractical Examinations.

Candidates taking the Project Viva Examination should submit Project Reportprescribed for the Examinations. Otherwise, the candidates will not be permitted to take theProject Viva-voce Examination.

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| **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)** |
| **The M.Sc. Data Science programme defines the achievements that graduates are expected to attain within five to seven years after graduation** |
| **PEO1** | Excel in his/her professional career and/or pursue higher education and research by effectively applying knowledge in data science. |
| **PEO2** | Graduates will be capable to become leaders, equipped with managerial and analytical skills essential for data driven decision making |
| **PEO3** | Graduates are prepared to demonstrate expertise in statistical methods and modern data analytics tools to meet industry demands. |
| **PEO4** | Graduates will be engaged in lifelong learning and contribute to research and development in the field of data analytics. |
| **PEO5** | Graduates will apply data science concepts and techniques to solve real-world problems and communicate the solutions effectively.  |

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| **PROGRAMME SPECIFIC OUTCOMES (PSOs)** |
| **Upon successful completion of the M.Sc. Data Science programme, the students will be able to** |
| **PSO1** | Demonstrate core competencies in science, mathematics, and data science fundamentals to meet dynamic global industrial demands. |
| **PSO2** | Design sustainable data-driven solutions that address societal challenges. |
| **PSO3** | Apply industry-relevant skills to function effectively as a professional data scientist. |
| **PSO4** | Develop domain-specific tools for data storage,analysis, and visualization. |
| **PSO5** | Independently conduct research and investigations to solve practical, real-world problems using data science methodologies. |

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| **PROGRAMME OUTCOMES (POs)** |
| **On successful completion of the M. Sc. Data Science programme, students will be able to:** |
| **PO1** | Acquire and apply comprehensive knowledge of data science concepts in relevant domains. |
| **PO2** | Analyse problems, identify appropriate computational resources, and implement solutions effectively. |
| **PO3** | Design innovative solutions to complex computational problems, addressing specific needs with consideration for environmental and societal impacts. |
| **PO4** | Independently generate innovative ideas and solve complex real-time problems while adhering to professional, ethical, legal, and social standards. |
| **PO5** | Select and apply modern tools and technologies for solving complex problems across various domains, understanding their benefits and limitations. |
| **PO6** | Collaborate effectively in multidisciplinary teams within the computing industry to achieve common goals. |
| **PO7** | Communicate technical information effectively, present research findings, and produce professional-quality documentation and reports. |
| **PO8** | Identify and address ethical, legal, and societal concerns in computing environments, and apply responsible professional practices |
| **PO9** | Analyse the impact of computing technologies on individuals, organizations, and society at both local and global levels. |
| **PO10** | Demonstrate and apply data science principles in multidisciplinary contexts, effectively managing projects and resources. |

**BHARATHIAR UNIVERSITY:COIMBATORE 641 046**

**M.Sc. Data Science (Affiliated Colleges)**

*(Effective for the candidates admitted during the academic year -2025–2026 and Onwards*

**SCHEME OF EXAMINATIONS – CBCS PATTERN**

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| **Course Code** | **Title of the Course** | **Credits** | **Hours** | **Maximum Marks** |
| **Theory** | **Practical**  | **CIA**  | **ESE**  | **Total** |
| **Semester I** |
| **13A** | Core I: Database Management System | **4** | **4** |  | **25** | **75** | **100** |
| **13B** | Core II: Probability & Statistics | **4** | **4** |  | **25** | **75** | **100** |
| **13C** | Core III: Principles ofData Science | **4** | **4** |  | **25** | **75** | **100** |
| **13D** | Core IV: Python Programming | **4** | **4** |  | **25** | **75** | **100** |
| **1EA/B/C** | Elective I | **4** | **4** |  | **25** | **75** | **100** |
| **13P** | Practical I: Database Management System Lab | **4** |  | **5** | **40** | **60** | **100** |
| **13Q** | Practical II: Python Programming Lab | **4** |  | **5** | **40** | **60** | **100** |
|  | **Total** | **28** | **20** | **10** | **205** | **495** | **700** |
| **Semester II** |
| **23A** | Core V: Artificial Intelligence | **4** | **4** |  | **25** | **75** | **100** |
| **23B** | Core VI: Machine Learning | **4** | **4** |  | **25** | **75** | **100** |
| **23C** | Core VII: Exploratory Data Analysis  | **4** | **4** |  | **25** | **75** | **100** |
| **23D** | Core VIII:Multivariate Data Analysis | **4** | **4** |  | **25** | **75** | **100** |
| **2EA/B/C** | ElectiveII | **4** | **4** |  | **25** | **75** | **100** |
| **23P** | Practical III: Machine Learning Lab  | **4** |  | **5** | **40** | **60** | **100** |
| **23Q** | Practical IV: Exploratory Data Analysis Lab | **4** |  | **5** | **40** | **60** | **100** |
|  | **Total** | **28** | **20** | **10** | **205** | **495** | **700** |
| **Semester III** |
| **33A** | Core IX: Big Data Analytics | **4** | **4** |  | **25** | **75** | **100** |
| **33B** | Core X: Deep Learning | **4** | **4** |  | **25** | **75** | **100** |
| **33C** | Core XI: Data Security and Privacy | **4** | **4** |  | **25** | **75** | **100** |
|  | Health And Wellness | **1** | **1** |  | **100$** | **-** | **100** |
| **3EA/B/C** | Elective III | **3** | **3** |  | **25** | **75** | **100** |
| **33P** | Practical V:Data Visualization Lab  | **4** |  | **5** | **40** | **60** | **100** |
| **33Q** | Practical VI: Deep Learning Lab | **4** |  | **5** | **40** | **60** | **100** |
| **33V** | Practical VII: MiniProject& Viva | **2** |  | **4** | **25** | **25** | **50** |
|  | **Total** | **26** | **16** | **14** | **305** | **445** | **750** |
| **Semester IV** |
| **43V** | Project and Viva Voce | **8** | **--** | **--** | **50** | **150\*** | **200** |
|  | **Total** | **8** | **--** | **--** | **50** | **150** | **200** |
|  | **Grand Total** | **90** |  |  | **765** | **1585** | **2350** |
| **ONLINE COURSES** |
| **1** | #SWAYAM/ MOOC / NPTEL | **2** |  |  |  |  |  |
| **2** | #Value Added Course | **2** |  |  |  |  |  |

\*Project Evaluation–100 marks &Viva-Voce–50 marks in ESE

# During II or III Semester (Optional)

$ Split for CIA 100 Marks

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| **PART** | **DESCRIPTION** | **MARKS** |
| A | Report | 40 |
| B | Attendance | 20 |
| C | Activities (Observation During Practice) | 40 |
| **Total** | **100** |

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| **Elective I**  |
| **A** | Design and Analysis of Algorithm |
| **B** | Business Intelligence |
| **C** | IOT Analytics |
| **Elective II** |
| **A** | Web Analytics |
| **B** | Natural Language Processing |
| **C** | Sentiment Analysis |
| **Elective III** |
| **A** | Social Media Analytics |
| **B** | Cloud Analytics |
| **C** | Digital Marketing Analytics |

**SEMESTER – I**

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| **Course Name** | **CORE 1: DATABASE MANAGEMENT SYSTEM** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic knowledge of data management concepts | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To understand the fundamental principles of database systems. |
| **2** | To developtheabilitytodesigndatabasesthatefficientlystoreandretrieve data. |
| **3** | To equip students with foundational knowledge for further study in advanced database topics. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Understand and applyfundamental database models and normalization. | **K2 / K3** |
| **CO2** | Apply and analyze SQL operations for database management. | **K3 / K4** |
| **CO3** | Analyse and evaluate transactions, concurrency and security mechanisms. | **K4 / K5** |
| **CO4** | Apply and analyse NoSQL databases and compare with relational models. | **K3 / K4** |
| **CO5** |

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| Analyze and evaluate MongoDB design and indexing strategies. |

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 | **K4 / K5** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |
| **Unit–I** | **Database Concepts and Database Design** | **Hours:09** |
| Database Concepts:A Relational approach: Database – Relationships – DBMS – Relational Data Model – Integrity Rules – Theoretical Relational Languages. Database Design: Data Modeling and Normalization: Data Modeling – Dependency – Database Design – Normal forms – Dependency Diagrams – De-normalization – Another Example of Normalization. |
| **Unit–II** | **DDL and DML Operations** | **Hours:10** |
| Tables: DDL - Naming Rules and Conventions – Data Types – Constraints – Creating Oracle Table – Displaying Table Information – Altering an Existing Table – Dropping, Renaming, Truncating Table – Working with Table: Data Management and Retrieval: DML – adding a new Row/Record – Customized Prompts – Updating and Deleting an Existing Rows/Records – retrieving Data from Table – Arithmetic Operations – restricting Data with WHERE clause – Sorting - Functions and Grouping: Built-in functions –Grouping Data.  |
| **Unit–III** | **Advanced Database Concepts** | **Hours:09** |
| Multiple Tables: Joins and Set operations: Join – Set operations. Advanced Features: Objects, Transactions and Data Control: Views – Sequences –Synonyms – INDEX – Transactions – Locking Rows for Update – Controlling Access  |
| **Unit – IV** | **NoSQL Databases** | **Hours: 09** |
| Database Revolutions: First generation, second generation, third generation. NoSQL: Limitations of Relational Data Model – ACID vs BASE – Types of NoSQL Database – CAP Theorem - Document Databases: XML and XML databases – XML Tools and Standards – XML Databases – XML Support in Relational Databases - JASON Document Databases – Database Frameworks. |
| **Unit – V** | **MongoDB Data Model** | **Hours: 09** |
| Introduction – Collections and documents – Schemas in MongoDB – Embedded Documents Vs. References – MongoDB Data Types – Array Fields in MongoDB - Data Modelling Techniques - Indexing for MongoDB Data Models - Handling Large Datasets in MongoDB - Data Integrity and Validation in MongoDB - Handling Multi-Document Transactions - Geospatial Data Modelling in MongoDB - Time Series. |
| **Unit – VI** | **Contemporary Issues** | **Hours: 02** |
| Expert lectures, Online seminars and Webinars |
| **Total Lecture Hours** | **48 Hours** |
| **Text Book(s)** |
| **1** | Database Systems using Oracle, Nilesh Shah, 2nd edition, PHI. |
| **2** | Guy Harrison, Next Generation database: NoSQL New SQL and Big Data, 2015, 1st Edition, Apress. |
| **Reference Book(s)** |
| **1** | Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”,Seventh Edition, McGraw Hill, 2020. |
| **2** | Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, Fourth Edition, McGraw-Hill Education, 2015. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | https://onlinecourses.swayam2.ac.in/ntr25\_ed136/ |
| **2** | https://onlinecourses.swayam2.ac.in/aic20\_sp36/ |
| **3** | https://www.scaler.com/topics/course/dbms/ |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **S** | **M** |  **L** | **M** | **L** | **M** | **L** | **M** | **L** |
| **CO2** | **S** | **S** | **S** | **M** | **S** | **M** | **M** | **L** | **L** | **M** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **M** | **M** |
| **CO4** | **S** | **S** | **M** | **M** | **S** | **L** | **L** | **M** | **M** | **M** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **M** | **M** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CORE II: PROBABILITY & STATISTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basics of Mathematics and Statistics | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To understand the fundamental concepts of probability and statistics. |
| **2** | To impart knowledge about Random Variable, Probability Distributions, Correlation, Regression and Estimation |
| **3** | To identify thevariousTesting of Hypothesis |
| **Expected Course Outcomes** |
| Onthesuccessfulcompletion ofthecourse,student willbeable to: |
| **CO1** | Interpret basic probability concepts and apply them to solve problems. | **K2** |
| **CO2** | Implement sampling designs and assess estimation errors in finite populations | **K3** |
| **CO3** | Analyze statistical inferential methods for small-sample tests. | **K4** |
| **CO4** | Analyze statistical inference techniques for large samples | **K4** |
| **CO5** | Analyze statistical techniques for experimental designs and variance analysis. | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |
| **Unit – I** | **Probability**  | **Hours: 10** |
| Probability – Introduction, Meaning and Application of Probability – Addition and Multiplication theorem- Bayes theorem – Practical problems.  |
| **Unit – II** | **Sampling Methods** | **Hours: 9** |
| Sampling from finite population – simple random sampling, stratified random sampling and systematic sampling- estimation of mean, total and their standard errors. Sampling and non- Sampling errors (concepts only). |
| **Unit – III** | **Hypothesis Testing – Small Sample Methods** | **Hours: 8** |
| Test of Hypothesis: Type I error and II errors- one tailed and two tailed test -Test of significance – standard error.Small Sample Tests: Student t-distribution (test for single mean, two means and paired t-test), $χ2$ - test for goodness of fit, $χ2$-test for independence of attributes. |
| **Unit – IV** | **Hypothesis Testing – Large Sample Methods** | **Hours: 10** |
| Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems.  |
| **Unit – V** | **Analysis of Variance and Experimental Designs** | **Hours: 9** |
| Analysis of Variance: one way, two classifications- fundamental principles of experimentation CRD, RBD and LSD, analysis of co-variance. |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expertlectures,onlineseminars– webinars |
| **Total Lecture Hours** |  **48** |
| **Text Book(s)** |
| 1 | Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008. |
| 2 | S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012. |
| 3 | S.P. Gupta and M.P. Gupta, Business Statistics– Sultan Chand & Sons Educational Publishers – New Delhi., 18th Edition -2014 |
| 4 | J.K. Sharma, Business Statistics, Pearson Education India, 2007. |
| **Reference Book(s)** |
| 1 | S. Ross, A First Course in Probability, Pearson Education India, 2002. |
| 2 | W. Feller, An Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968 |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | <https://onlinecourses.nptel.ac.in/noc25_ma95/preview> |
| 2 | <https://onlinecourses.nptel.ac.in/noc25_mg158/preview> |
| 3 | https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2022/ |
| 4 | https://ocw.mit.edu/courses/18-443-statistics-for-applications-spring-2015/ |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **S** | **L** | **S** |
| **CO2** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **S** | **L** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **L** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **S** | **L** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CORE III: PRINCIPLES OF DATA SCIENCE** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | 4 | **0** | 0 | 4 |
| **Pre-Requisite** | Fundamentals of Data Bases | **Syllabus:2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To provide a strong foundation for data science and its application area. |
| **2** | To understand the underlying core concepts and emerging technologies in data science. |
| **3** | To develop applied experience with data science software, programming, applications and processes |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Understand the fundamental concepts and terminology of datascience | **K2** |
| **CO2** | Apply data analysis techniques for processing and exploring large datasets. | **K3** |
| **CO3** | Analyze and evaluate methodologies, algorithms, and analytics workflows to extract insights  | **K4 / K5** |
| **CO4** | Evaluate machine learning algorithms used in datascience. | **K5** |
| **CO5** | Apply and analyze data science tools to solve real-world data problems | **K3 / K4** |
| **K1- Remember** | **K2-Understanding** | **K3-Apply** | **K4-Analyze** | **K5-Evaluate** | **K6-Create** |

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| **Unit*–* I** | **Introduction to Data Science** | **Hours: 10** |
| Definition – Basic Terminology- Why Data Science - Data science Venn diagram- Data Science case studies. Types of Data: Flavors of data - Structured versus Unstructured data- Quantitative versus Qualitative data- The Four Levels of Data- The Five steps of Data Science. |
| **Unit*–* II** | **Data Process and Exploration** | **Hours:9** |
| Introduction: Prior Knowledge-Data Preparation – Modeling – Applications-Data Exploration: Objectives of Data Exploration – Datasets- Descriptive statistics. Data Visualization: Introduction- Types of Data visualization- Technologies for visualization - Various visualization techniques - The Five Cs of Data Visualization. |
| **Unit*–* III** | **Data Modelling and Analytics** | **Hours: 9** |
| Data Science Process Overview: Data science classification-Data Science Algorithms- Business Intelligence and Data Science- Components of Data Science. Data Science Methodology- Analytics for Data Science- Data Analytics Examples- Data Analytics Life Cycle- Data Discovery- Data preparation- Model Planning- Model Building Operationalization |
| **Unit*–* IV** | **Data Science Methods and Machine Learning** | **Hours: 9** |
| Regression Analysis: Linear Regression – Logistic Regression – Time series models – Machine Learning: Decision Trees – Naïve Bayes – SVM – Nearest Neighbor learning – Clustering - Confusion Matrix |
| **Unit*–* V** | **Data Science Tools and Applications** | **Hours: 9** |
| Introduction to Data Science Tools – SAS- APACHE FLINK – BigML – Excel – Tableau-Matplotlib- Tensor Flow- Weka- Applications: Hands-on with Solving Data Problems-Introduction-Collecting and Analyzing Twitter Data- Collecting and Analyzing YouTube Data |
| **Unit*–* VI** | **Contemporary Issues** | **Hours:2** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops |
| **Total Lecture Hours** |  **48** |
| **Text Book(s)** |
| 1 | Sinan Ozdemir, Principles of Data Science, Packt Publishing, December 2016 |
| 2 | Vijay Kotu, Bala Deshpande, Data Science: Concepts and Practices, Morgan Kaufmann Publishers, Second edition, 2019 |
| 3 | Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, Fundamentals of Data Science, 1st Edition, 2022 |
| **Reference Book(s)** |
| 1 | Jure Leskovek, Anand Rajaraman and Jeffrey Ullman, Mining of Massive Datasets. v2.1, Cambridge University Press, 2014 |
| 2 | Cielen, Davy, Arno DB Meysman, Mohamed Ali, Introducing Data Science: Big Data, Machine Learning, and more, using Python Tools, Manning Publications Co., 2016 |
| 4 | Daimi, Kevin, Ed. Hamid R. Arabnia, Principles of Data Science, Springer, 2020. |
| 5 | D J Patil, Hilary Mason, Mike Loukides, Ethics and Data Science, O’ Reilly, 1st edition, 2018 |
| **Related Online contents(MOOC,SWAYAM,NPTEL,WEBSITES ETC...)** |
| 1 | <https://onlinecourses.nptel.ac.in/noc19_cs60/preview> |
| 2 | https://onlinecourses.swayam2.ac.in/ini25\_cs04/preview |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **M** | **M** | **S** | **S** | **S** | **M** |
| **CO2** | **S** | **M** | **M** | **S** | **S** | **S** | **S** | **M** | **M** | **S** |
| **CO3** | **S** | **M** | **M** | **M** | **S** | **S** | **M** | **M** | **S** | **S** |
| **CO4** | **S** | **S** | **M** | **M** | **S** | **S** | **S** | **M** | **S** | **S** |
| **CO5** | **S** | **S** | **M** | **M** | **S** | **S** | **S** | **M** | **M** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CORE IV:** **PYTHON PROGRAMMING** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic Programming Knowledge | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| **1** | To apply the basic concepts of Python programming. |
| **2** | To develop data manipulation and visualization skills using Python. |
| **3** | To apply basic programming skills for solving data analysis problems. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Apply basic Python programming constructs and control structures | **K3** |
| **CO2** | Analyze and utilize built-in data structures, functions, and file handling mechanisms | **K4** |
| **CO3** | Analyze numerical computing techniques using NumPy for data operations. | **K4** |
| **CO4** | Analyze and manipulate structured data using Python data analysis libraries. | **K4** |
| **CO5** | Create data analysis applications using Python libraries | **K6** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Python** | **Hours:9**  |
| Basics of Python: Installation and Simple Syntax- Variables, Data Types, and Operators- Input/Output Operations and Simple Arithmetic Calculations- Control Structures: Conditional Statements and Loops |
| **Unit – II** | **Built in Data Structures, Functions and Files** | **Hours: 9** |
| Data Structures and Sequences – Tuple, List, dict, set – Functions: Namespaces - scope and local function - Returning multiple values - Anonymous Functions -Errors and Exception handling - File Handling. |
| **Unit – III** | **Introduction to NumPy** | **Hours: 9** |
| NumPy Basics: Arrays and Vectorized Computation- The NumPy ndarray -Creating ndarrays - Data Types for ndarrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions – Array-oriented Programming with Arrays – Expressing conditional logic as Array operations - Mathematical and Statistical Methods – Methods for Boolean arrays – Sorting- Unique and Other Set Logic. |
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| **Unit – IV** | **Data Manipulation with Pandas** | **Hours:9**  |
| Introduction to pandas Data Structures: Series - DataFrame - Essential Functionality: Reindexing -Dropping Entries- Indexing, Selection, and Filtering – Integer Indexes - Arithmetic and data alignment - Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership.  |
| **Unit – V** | **Basic Applications of Python**  | **Hours: 10** |
| Data Cleaning and Preparation: Handling Missing Data - Data Transformation - String Manipulation - Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.Case Studies: Small Data Analysis Projects |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| **1.** | Ashok Namdev Kamthane and Amit Ashok Kamthane, **Programming and Problem Solving with Python, Tata McGraw Hill, 2nd Edition,2020** |
| **2.** | Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O’Reilly, 2nd Edition,2018. |
| **Reference Book(s)** |
| **1** | T. R. Padmanabhan**, Python Programming,Springer Verlag,2018** |
| **2** | V. K. Jain, **Data Science and Analytics with Python**, **Khanna Book ,2018** |
| **3** | Jake VanderPlas,“Python Data Science Handbook: Essential Tools for Working with Data”, O’Reilly, 2017. |
| **4** | Y. Daniel Liang, “Introduction to Programming using Python”, Pearson,2012. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | <https://onlinecourses.nptel.ac.in/noc23_cs99/preview> |
| **2** | <https://onlinecourses.swayam2.ac.in/aic20_sp33/preview> |
| **3** | <https://www.classcentral.com/course/swayam-python-for-data-science-14266> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **M** | **M** | **S** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | S | **M** | **M** | **M** | **M** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **L** | **M** | **L** | **M** | **S** |
| **CO4** | **S** | **S** | **S** | **M** | **S** | **L** | **M** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **PRACTICAL I: DATABASE MANAGEMENT SYSTEM LAB** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **0** | **0** | **5** | **4** |
| **Pre-Requisite** | Knowledge of fundamentals of database management system | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To understand the fundamental principles of database systems. |
| **2** | To developtheabilitytodesigndatabasesthatefficientlystoreandretrieve data. |
| **3** | To equip students with foundational knowledge for further study in advanced database topics. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Understand and apply fundamental database models and normalization. | **K2 / K3** |
| **CO2** | Apply and analyze SQL operations for database management. | **K3 / K4** |
| **CO3** | Analyse and evaluate transactions, concurrency and security mechanisms. | **K4 / K5** |
| **CO4** | Apply and analyse NoSQL databases and compare with relational models. | **K3 / K4** |
| **CO5** |

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| Analyze and evaluate MongoDB design and indexing strategies. |

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 | **K4 / K5** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **List of Programs** |
| **1** | Implementing DDL Commands in Oracle: Write SQL queries to create, modify, and droptables with constraints  |
| **2** | Manipulating Table Data Using DML: Write SQL queries to insert, update, delete, and query datausing SELECT with filtering and sorting. |
| **3** | Using Built-in Functions and Grouping Data: Apply string, numeric, datefunctions and GROUP BY clause in SQL queries. |
| **4** | Performing Joins and Set Operations: Retrieve related data from multipletables using INNER, OUTER, and CROSS joins; use UNION, INTERSECT |
| **5** | Creating Views, Sequences, and Indexes: Write SQL queries to create and use views, generate sequences, and apply indexing for performance optimization. |
| **6** | Handling Transactions and Locks: Implement transaction control using COMMIT,ROLLBACK, and demonstrate row-level locking. |
| **7** | Implement Cloud Database Setup and BasicsI) Create a Cloud Database InstanceII) Connect to a Cloud DatabaseIII) Database Creation in the CloudIV) Insert Data into a Cloud Database |
| **8** | Write a program to implement Basics of MongoDBI) Create a Collection/TableII) Insert a DocumentIII) Batch InsertIV) Update a DocumentV) Delete a Document |
| **9** | Run MongoDB Queries for Indexing and Aggregation:I) Create an IndexII) List IndexedIII) Aggregation PipelineIV) Filtering Data |
| **10** | Perform CRUD operations on JSON documents in MongoDB. |
| **11** | Work with time-series data models in MongoDB: Create and manage collections for time-series datasets, insert records, and query time-based data. |
| **12** | Implement Data Backup and Restore in MongoDBI) Export a MongoDB collection to a JSON/CSV fileII) Drop the collectionIII) Restore the collection from the backup file |
| **Text Book(s)** |
| **1** | Database Systems using Oracle, Nilesh Shah, 2nd edition, PHI. |
| **2** | Guy Harrison, Next Generation database: NoSQL New SQL and Big Data, 2015, 1 st Edition, Apress. |
| **Reference Book(s)** |
| **1** | Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Seventh Edition, McGraw Hill, 2020. |
| **2** | Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, Fourth Edition, McGraw-Hill Education, 2015. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | https://onlinecourses.swayam2.ac.in/ntr25\_ed136/ |
| **2** | https://onlinecourses.swayam2.ac.in/aic20\_sp36/ |
| **3** | https://www.scaler.com/topics/course/dbms/ |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **S** | **L** | **S** |
| **CO2** | **S** | **M** | **M** | **M** | **M** | **M** | **S** | **S** | **L** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **L** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **S** | **L** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **PRACTICAL II: PYTHON PROGRAMMING LAB** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **0** | **0** | **5** | **4** |
| **Pre-Requisite** | Basic Programming Knowledge | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| **1** | To apply the basic concepts of Python programming. |
| **2** | To develop data manipulation and visualization skills using Python. |
| **3** | To apply basic programming skills for solving data analysis problems. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Apply Python programming constructs to solve basic computational problems. | **K3** |
| **CO2** | Apply and analyze data structures and file handling techniques in Python. | **K3 / K4** |
| **CO3** | Analyze and implement numerical computations and data manipulation using NumPy. | **K4** |
| **CO4** | Analyze structured datasets to extract summaries and insights using Python libraries. | **K4** |
| **CO5** | Create simple data analysis applications with visualizations and reports. | **K5 / K6** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **List of Programs** |
| **1** | Write a Python program to calculate the Body Mass Index (BMI) of a person and classify them as Underweight, Normal, Overweight, or Obese based. |
| **2** | Write a Python program that accepts marks of five subjects, calculates the total, percentage, and assigns a grade based on the percentage obtained. |
| **3** | Write a Python program to add, update, delete, and search employee records using dictionaries. |
| **4** | Write a Python program that reads a text file, counts the number of lines, words, and characters, and prints the results. Handle exceptions if the file is not found. |
| **5** | Write a Python program to store student details in a dictionary and save them to a file, then read back the file and display the details in sorted order. |
| **6** | Write a Python program using NumPy to create a 2D array of random numbers and perform basic operations like finding the sum, mean, and standard deviation of the array elements. |
| **7** | Write a Python program using NumPy to simulate a dataset of exam marks and:1. Categorize marks as "Fail", "Pass", "Merit", "Distinction" based on ranges using boolean indexing.
2. Count how many students fall into each category.
 |
| **8** | Write a Python program to analyze employee details and compute average salary by department and rank by experience. |
| **9** | Write a Python program to summarize bank transactions, compute net balances, and identify top customers. |
| **10** | Write a Python program to process a sales dataset (CSV file), compute total sales per region, and find the best-performing region. |
| **11** | Write a Python program to calculate monthly revenue and plot a suitable chart of sales trend. |
| **12** | Write a Python program to analyze student marks and generate grade-wise performance statistics. Export the final results to a CSV file. |

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| **Text Book(s)** |
| **1.** | Ashok Namdev Kamthane and Amit Ashok Kamthane, **Programming and Problem Solving with Python, Tata McGraw Hill, 2nd Edition,2020** |
| **2.** | Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O’Reilly, 2nd Edition,2018. |
| **Reference Book(s)** |
| **1** | T. R. Padmanabhan**, Python Programming,Springer Verlag,2018** |
| **2** | V. K. Jain, **Data Science and Analytics with Python**, **Khanna Book ,2018** |
| **3** |  Jake VanderPlas, “Python Data Science Handbook: Essential Tools for Working with Data”, O’Reilly, 2017. |
| **4** | Y. Daniel Liang, “Introduction to Programming using Python”, Pearson,2012. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | https://onlinecourses.nptel.ac.in/noc23\_cs99/preview |
| **2** | <https://onlinecourses.swayam2.ac.in/aic20_sp33/preview> |
| **3** | <https://www.classcentral.com/course/swayam-python-for-data-science-14266> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **M** | **S** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **M** | **L** | **M** | **L** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **L** | **M** | **L** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **L** | **L** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **M** | **S** |

**S- Strong; M-Medium; L-Low**

**SEMESTER – II**

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| **Course Name** | **CORE V: ARTIFICIAL INTELLIGENCE** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | **Basic Concepts of Computer Science** | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To enablethestudentstounderstand the fundamental concepts and problem-solving approaches in AI |
| **2** | To develop understanding of intelligent systems, agent architectures, and search strategies. |
| **3** | To provide knowledge of knowledge representation techniques and expert systems. |
| **4** | To explore and analyze real-world AI applications |
| **Expected Course Outcomes** |
| Onthesuccessfulcompletion ofthecourse,student willbeable to: |
| **CO1** | Describe the foundations, history, and principles of AI | **K2** |
| **CO2** | Apply uninformed, informed, and heuristic search strategies to problem-solving | **K2/K3** |
| **CO3** | Demonstrate knowledge representation techniques and reasoning approaches. | **K3** |
| **CO4** | Analyze and design expert systems for specific problem domains | **K4** |
| **CO5** | Evaluate and apply AI techniques in real-world applications such as NLP, robotics, and text mining | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Artificial Intelligence** | **Hours: 8** |
| Introduction–Definition – The Foundations of Artificial Intelligence – History of Artificial Intelligence. Intelligent Systems: Agents and Environments – Concept of Rationality – The Nature of environment – The Structure of Agents. |
| **Unit – II** | **Search Strategies in AI** | **Hours: 10** |
| Problem solving agents – Example problems - Searching for solutions - Uninformed search strategies - Breadth first search, Uniform-cost search, Depth first Search. Informed (Heuristic Search) techniques: Greedy best-first search – Memory bounded heuristic search. Local Search Algorithms: Hill Climbing search, Simulated annealing, local beam search, Genetic algorithms |
| **Unit – III** | **Knowledge Representation** | **Hours: 10** |
| Introduction – Ontologies, objects and events - Representations and mappings - Approaches to Knowledge representation - Forward Chaining-Backward Chaining – Matching and control knowledge – Slot and filler structures - Issues in Knowledge representations - Developments. |
| **Unit – IV** | **Expert systems and Applications** | **Hours: 9** |
| Expert System – Knowledge Representation – Expert System shells – Knowledge Acquisition of an Expert System – Applications of Expert Systems – Examples of Expert systems – Problem Solving Examples. |
| **Unit – V** | **AI Applications** | **Hours: 9** |
| Text Analysis and Mining: Introduction – Language Models – Text classification - Information Retrieval- Information Extraction. Natural Language Processing –Machine Translation – Speech Recognition – Robot – Hardware –Perception – Planning – Moving |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expertlectures,onlineseminars– webinars |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| **1** | Artificial Intelligence: A Modern Approach, 4th Edition, Stuart Russell, peter Norvig University of California at Berkeley, Pearson education, 2020 |
| 2 | Lavika Goel, “Artificial Intelligence Concepts and Applications”, First Edition, Wiley India Pvt Ltd., 2021. |
| **Reference Book(s)** |
| 1 | GeorgeFLuger,"ArtificialIntelligence",4thEdition,PearsonEducationPubl,2002 |
| 2 | David L. Poole and Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2010. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | <https://onlinecourses.swayam2.ac.in/nou25_cs21/preview> |
| 2 | <https://nptel.ac.in/courses/106102220> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **M** | **L** | **L** | **M** | **L** | **L** | **L** | **M** | **L** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **L** | **L** | **L** | **L** | **M** |
| **CO3** | **S** | **S** | **M** | **M** | **S** | **L** | **L** | **L** | **L** | **M** |
| **CO4** | **S** | **S** | **S** | **M** | **S** | **L** | **L** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CORE VI: MACHINE LEARNING** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic knowledge on mathematics, statistics and good analytical skills | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are to:** |
| 1 | Understand the concepts, types of problems, and mathematical foundations of machine learning. |
| 2 | Explore and apply supervised, unsupervised, and clustering techniques along with preprocessing and feature engineering methods. |
| 3 | Evaluate and improve models using appropriate validation and performance metrics. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Explain the fundamental issues, challenges, and mathematical foundations of machine learning. | **K2 / K3** |
| **CO2** | Apply supervised learning algorithms for classification and regression. | **K3** |
| **CO3** | Apply preprocessing, scaling, dimensionality reduction, and feature extraction techniques for unsupervised learning tasks. | **K3** |
| **CO4** | Implement clustering algorithms and apply feature engineering techniques | **K3 / K4** |
| **CO5** | Evaluate models using appropriate performance metrics for classification and regression tasks. | **K5** |
| **K1- Remember** | **K2- Understand** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Machine Learning** | **Hours:8** |
| Understanding Machine Learning- Need –History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Decision Theory - Information theory |
| **Unit – II** | **Supervised LearningAlgorithms** | **Hours: 10** |
| Classification and Regression – Generalization, Overfitting, and Underfitting – Supervised Machine learning algorithms:Linear models – k-nearest neighbour - Naïve Bayes classifiers – Decision trees – Random Forest - SVM – Neural networks. – Uncertainty Estimates from classifiers.  |
| **Unit – III** | **Unsupervised Learning and Preprocessing** | **Hours: 10** |
| Types of Unsupervised learning – Challenges in Unsupervised learning – Preprocessing and scaling – Dimensionality Reduction, Feature Extraction and Manifold learning: Principal component analysis – Non-negative Matrix Factorization – Manifold learning with t-SNE |
| **Unit – IV** | **Clustering, Representing data and Engineering features** | **Hours: 10** |
| Introduction - Clustering Algorithms: K–Means clustering – Agglomerative clustering –Hierarchical Clustering and Dendrograms - DBSCAN -Comparing and evaluating clustering algorithms.Categorical Variables:One-Hot encoding – Binning, Discretization, Linear models and Trees – Univariate non-linear transformations – Automatic feature selection. |
| **Unit – V** | **Model Evaluation and Improvement** | **Hours: 08** |
| Cross–Validation –Benefits – Stratified k-fold cross-validation – Grid search: simple grid – grid search with cross-validation. Evaluation metrics and scoring –Binary classification – Multiclass classification – Regression metrics – Using Evaluation Metrics in Model selection. |
| **Unit – VI** | **Contemporary Issues** | **Hours:02** |
| Expert lectures, online seminars – webinars |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| 1 | Ethem Alpaydm, “Introduction to Machine Learning”, Third Edition, The MIT Press, Cambridge, 2014 |
| 2 | Andreas C.Muller & Sarah Guido, “Introduction to Machine Learning with Python”, O’Reilly, 2017 |
| **Reference Book(s)** |
| 1 | Stephen Marsland, “Machine Learning –An Algorithmic Perspective”, CRC Press, 2009 |
| 2 | K.P. Soman, Machine Learning with SVM and Other Kernel Methods,2011, PHI Publishing |
| 3 | Giuseppe Bonaccorso, “Machine Learning Algorithms”, Second Edition, 2018 [Packt] |
| 4 | Hastie, Tibshirani, Friedman, “The Elements of Statistical Learning”, Second Edition, Springer |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | https://www.coursera.org/specializations/machine-learning-introduction |
| 2 | <https://onlinecourses.nptel.ac.in/noc23_cs18/preview> |
| 3 | <https://www.mygreatlearning.com/machine-learning/free-courses> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **M** | **S** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **M** | **L** | **M** | **L** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **L** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **M** | **S** | **L** | **L** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **M** | **S** | **L** | **M** | **L** | **M** | **S** |

**L-Low, M- Medium, S- Strong**

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| **Course Name** | **CORE VII: EXPLORATORY DATA ANALYSIS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic statistics and programming knowledge (Python/R) | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| **1** | To introduce the fundamental concepts and techniques of Exploratory Data Analysis (EDA). |
| **2** | To develop skills in summarizing and visualizing data to uncover patterns and insights. |
| **3** | To apply EDA methods using statistical software and programming languages. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Understand and explain the principles and importance of EDA.  | **K2 / K3** |
| **CO2** | Apply various EDA techniques to summarize and visualize data.  | **K3** |
| **CO3** | Apply univariate &bivariate data exploration and analysis. | **K4** |
| **CO4** | Use data exploration and visualization techniques for multivariate and time series data. | **K3** |
| **CO5** | Build EDA applications and case study analysis | **K6** |
| **K1- Remember** | **K2- Understanding** | **K3-Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Exploratory Data Analysis** | **Hours:10** |
| EDA fundamentals – Understanding data science – Significance of EDA – Making sense of data –Comparing EDA with classical and Bayesian analysis – Software tools for EDA- Visual Aids forEDA- Descriptive Statistics: Measures of Central Tendency - Measures of Dispersion - Data Distribution - Data transformation techniques- Merging database, reshaping and pivoting, Transformation techniques - Grouping Datasets - Data aggregation – Pivot tables and cross-tabulations |
| **Unit – II** | **Data Visualization Techniques** | **Hours: 8** |
| Principles of Data Visualization – Simple line plots – Simple scatter plots – visualizing errors – Densityandcontour plots – Histograms – legends – colors – subplots – text and annotation – customization –three-dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn. |
| **Unit – III** | **Univariate andBivariate Analysis** | **Hours: 10** |
| Introduction to Single variable: Distributions and Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality - Smoothing Time Series.Relationships between Two Variables - Percentage Tables - Analyzing Contingency Tables-Handling Several Batches - Scatterplots and Resistant Lines – Transformations. |
| **Unit – IV** | **Multivariate and Time Series Analysis** | **Hours: 10** |
| Introducing a Third Variable - Causal Explanations - Three-Variable Contingency Tables and Beyond - Longitudinal Data – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling. |
| **Unit – V** | **Case Studies and Applications** | **Hours: 8** |
| Case Studies: Small Data Analysis Projects. Ethical Challenges in Data Interpretation and Visualization- Bias Detection and Mitigation in EDA-Handling and Visualizing Big Data- Automation of EDA: Tools and Techniques- Role of AI in Enhancing EDA |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expert lectures, online seminars – webinars |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| **1.** | Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with Python”,Packt Publishing, 2020.  |
| **2.** | Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", Oreilly, 1st Edition, 2016.  |
| **3.** | Catherine Marsh, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for SocialScientists”, Wiley Publications, 2nd Edition, 2008. |
| **Reference Book(s)** |
| **1** | Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017. |
| **2** | Hector Cuesta**, Practical Data Analysis,Packt Publishing,2016** |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | <https://www.coursera.org/learn/exploratory-data-analysis> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **M** | **S** | **M** | **M** | **M** | **M** |
| **CO3** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **S** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **L** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CORE VIII: MULTIVARIATE DATA ANALYSIS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basics of Mathematics and Statistics | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The main objectives of this course are:**  |
| 1 | To inculcate the knowledge on various multivariate statistical techniques and its applications |
| 2 | To know the usage of dependence and interdependence multivariate methods |
| 3 | To know the statistics associated with principal component and factor analysis |
| 4 | To impart the regression, classification and various clustering techniques |
| **Expected Course Outcomes** |
| **On the successful completion of the course, student will be able to:** |
| **CO1** | Distinguish between dependence and interdependence techniques  | **K2** |
| **CO2** | Fit the various regression models and predict the results  | **K3** |
| **CO3** | Perform the dimension reduction techniques and interpret the results  | **K4** |
| **CO4** | Discriminate and classify the given objects by using target variable  | **K5** |
| **CO5** | Form the groups by using suitable clustering techniques  | **K6** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Multivariate Analysis** | **Hours: 10** |
| Meaning of Multivariate Analysis – Multivariate Analysis in Statistical Terms – Basic concepts: Variate, Measurement Scales, Measurement Error, Multivariate Measurement, Statistical Significance and Statistical Power. Classification of Multivariate Techniques: Dependence and Independence Techniques – Applications of Multivariate Techniques. |
| **Unit – II** | **Multiple Regression Analysis** | **Hours: 9** |
| Concept of Simple and Multiple Regressions – Illustrations. Prediction using Single and Several Independent Variables – Decision Process in Multiple Regression Analysis: Objectives, Research Design, Assumptions, Estimation of Regression Model – Assessing Model Fit – Interpretation of Regression Variate using Regression Coefficients and Assessing Multicollinearity. |
| **Unit – III** | **Factor Analysis** | **Hours: 9** |
| Notion of Principal Components and Factors – Concept of Data Summarization and Data Reduction - Introduction to Principal Component Analysis and Factor Analysis – Illustrations. Decision Process in Factor Analysis: Objectives, Design, Assumptions, Deriving Factors, Interpretation of Factors, Validation of Factors – Illustrations. |
| **Unit – IV** | **Discriminant Analysis** | **Hours: 9** |
| Concept of Discriminant Function – Meaning of Discriminant Analysis – Decision Process in Discriminant Analysis: Objectives, Research Design, Assumptions, Estimation of Discriminant Model, Assessing Model Fit, Interpretation. |
| **Unit – V** | **Cluster Analysis** | **Hours: 9** |
| Meaning and Conceptual Development of Cluster Analysis – Decision Process in Cluster Analysis: Objectives, Research Design, Assumptions, Deriving Clusters, Interpretation of Clusters, 23 Validation and Profiling of Clusters – Illustrations – Basic Notion of Hierarchical and Non-hierarchical Clusters |
| **Unit – VI** | **Contemporary Issues** | **Hours :2** |
| Expert lectures, online seminars – webinars |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| 1 | Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2018). Multivariate Data Analysis, Eighth Edition, Pearson. |
| 2 | Johnson, R. A., and Wichern, D. W. (2019). Applied Multivariate Statistical Analysis, Seventh Edition, Pearson. |
| 3 | Johnson, D. E. (1998). Applied Multivariate Methods for Data Analysts, First Edition, Duxbury Press |
| **Reference Book(s)** |
| 1 | Tabachnick, B. G., & Fidell, L. S. (2019). Using Multivariate Statistics (7th Edition). Pearson. |
| 2 | Anderson, T. W. (2003). An Introduction to Multivariate Statistical Analysis (3rd Edition). Wiley. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | https://nptel.ac.in/courses/111105091 |
| 2 | <https://builtin.com/data-science/step-step-explanation-principal-component-analysis> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **M** | **S** | **M** | **M** | **M** | **M** |
| **CO3** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **S** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **L** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **PRACTICAL III**  **MACHINE LEARNING LAB** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE LAB** | **0** | **0** | **5** | **4** |
| **Pre-Requisite** | Basic knowledge on mathematics, statistics and good analytical skills | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| 1 | To understand the concepts, types of problems, and mathematical foundations of machine learning. |
| 2 | To explore and apply supervised, unsupervised, and clustering techniques along with preprocessing and feature engineering methods. |
| 3 | To evaluate and improve models using appropriate validation and performance metrics. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Apply basic statistical and probability techniques to explore and summarize datasets. | **K3** |
| **CO2** | Apply supervised learning algorithms for classification and regression. | **K3** |
| **CO3** | Apply preprocessing and dimensionality reduction techniques to improve model performance. | **K3 /K4** |
| **CO4** | Implement and analyze clustering algorithms for unsupervised learning tasks. | **K3 / K4** |
| **CO5** | Evaluate and compare machine learning models using cross-validation and multiple performance metrics. | **K4 / K5** |
| **K1- Remember** | **K2- Understand** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **List of Programs** |
| **1** | Write a program to implement Linear Regression |
| **2** | Write a program to implement Logistic Regression for binary classification. |
| **3** | Write a program to implement Support Vector Machine (SVM) for classification on a real-world dataset. |
| **4** | Write a program to implement the Decision Tree Classification |
| **5** | Write a program to implement the Random Forest classifier |
| **6** | Write a program to implement K-Means Clustering.  |
| **7** | Write a program to implement Hierarchical Clustering |
| **8** | Write a program to normalize and standardize dataset features, then compare the effect of each method on a simple classifier’s accuracy. |
| **9** | Write a program to implement Principal Component Analysis for dimensionality reduction. |
| **10** | Write a program to perform K-Fold Cross Validation for a given model. |
| **11** | Write a program to compare model performance using multiple evaluation metrics (accuracy, precision, recall, F1-score) for binary and multiclass classification. |
| **12** | Write a program to implement Naïve Bayes classification on a real-world dataset and evaluate its performance using confusion matrix and accuracy score. |
| **Text Book(s)** |
| 1 | Ethem Alpaydm, “Introduction to Machine Learning”, Third Edition, The MIT Press, Cambridge, 2014 |
| 2 | Andreas C.Muller & Sarah Guido, “Introduction to Machine Learning with Python”, O’Reilly, 2017 |
| **Reference Book(s)** |
| 1 | Stephen Marsland, “Machine Learning –An Algorithmic Perspective”, CRC Press, 2009 |
| 2 | K.P. Soman, Machine Learning with SVM and Other Kernel Methods,2011, PHI Publishing |
| 3 | Giuseppe Bonaccorso, “Machine Learning Algorithms”, Second Edition, 2018 [Packt] |
| 4 | Hastie, Tibshirani, Friedman, “The Elements of Statistical Learning”, Second Edition, Springer |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | https://www.coursera.org/specializations/machine-learning-introduction |
| 2 | <https://onlinecourses.nptel.ac.in/noc23_cs18/preview> |
| 3 | <https://www.mygreatlearning.com/machine-learning/free-courses> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **M** | **S** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **M** | **L** | **M** | **L** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **L** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **M** | **S** | **L** | **L** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **M** | **S** | **L** | **M** | **L** | **M** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **PRACTICAL IV: EXPLORATORY DATA ANALYSIS LAB** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE LAB** | **0** | **0** | **5** | **4** |
| **Pre-Requisite** | Fundamentals of Data Science, Programming  | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| **1** | To understand and apply fundamental Exploratory Data Analysis (EDA) techniques using R for data cleaning, transformation, and summarization. |
| **2** | To develop skills in creating and customizing visualizations for univariate, bivariate, multivariate, and time-series data. |
| **3** | To integrate statistical and graphical methods to analyze real-world datasets and extract meaningful insights. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Inspect, summarize, and transform datasets using R functions and packages. | **K2/K3** |
| **CO2** | Apply descriptive statistics, grouping, and aggregation techniques to explore data patterns. | **K3** |
| **CO3** | Analyse univariate & bivariate data exploration. | **K4** |
| **CO4** | Perform correlation analysis, multivariate visualizations, and clustering-based EDA. | **K4** |
| **CO5** | Conduct comprehensive EDA for real-world datasets, integrating statistical and visualization methods to derive insights. | **K4 /K5** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **List of Programs** |
| **1** | Write a program to load a CSV dataset, inspect its structure, data types, dimensions, and display summary statistics (mean, median, variance, min, max, IQR). |
| **2** | Write a program to merge two datasets, reshape and pivot data, group datasets using dplyr, and create pivot tables. |
| **3** | Write a program to create histograms, bar plots, and boxplots using both base R and ggplot2 with proper legends, titles, and colors. |
| **4** | Write a program to create scatter plots with regression lines, density plots, and contour plots for visualizing relationships between variables. |
| **5** | Write a program to create multi-panel plots in ggplot2, and 3D plots using plotly. |
| **6** | Write a program to perform univariate analysis for numeric and categorical variables, including scaling, standardizing, and inequality measures. |
| **7** | Write a program to create contingency tables, percentage tables, and visualize relationships between two variables using grouped boxplots and scatter plots. |
| **8** | Write a program to compute and visualize correlation matrices and create pair plots. |
| **9** | Write a program to load a time series dataset, perform time-based indexing, resampling, and cleaning, and plot trends over time. |
| **10** | Write a program to group and aggregate time series data by month and year, and visualize seasonal trends. |
| **11** | Write a program to perform complete EDA on a retail sales dataset, including cleaning, transformations, and univariate, bivariate, and multivariate analysis, and summarize key insights. |
| **12** | Write aprogram to perform EDA on an e-commerce customer dataset, analyzing purchase frequency, order value distributions, and visualizing customer segments using clustering-based plots. |
| **Text Book(s)** |
| **1** | Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017. |
| **2** | Hector Cuesta**, Practical Data Analysis,Packt Publishing,2016** |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | https://www.coursera.org/learn/exploratory-data-analysis |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **M** | **S** | **M** | **M** | **M** | **M** |
| **CO3** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **S** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **M** | **M** | **M** | **L** | **S** |

**S- Strong; M-Medium; L-Low**

**SEMESTER – III**

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| **Course Name** | **CORE IX: BIG DATA ANALYTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic knowledge of databases, programming, and data structures | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| **1** | To gain in-depth knowledge of Big Data fundamentals, characteristics, applications, and emerging industry trends. |
| **2** | To understand and work with the Hadoop ecosystem and Spark for data processing and analysis. |
| **3** | To apply Big Data tools and frameworks for analytics, reporting, visualization, and real-time applications. |
| **Expected Course Outcomes** |
| **On the successful completion of the course, student will be able to:** |
| **CO1** | Explain the fundamentals, characteristics, and industry applications of Big Data.  | **K2** |
| **CO2** | Apply suitable Big Data tools and frameworks to process and analyze large datasets. | **K3** |
| **CO3** | Analyze MapReduce workflows and job execution in Hadoop. | **K4** |
| **CO4** | Implement queries and data operations using HiveQL, Pig Latin, and HBase. | **K5** |
| **CO5** | Apply Spark for data analysis, ETL, visualization, and machine learning tasks. | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Big Data** | **Hours: 9** |
| Introduction: What is big data – why big data – convergence of key trends - unstructured data – industry examples of big data – Web analytics - big data and marketing – fraud and big data - risk and big data – credit risk management – big data and algorithmic trading - big data and healthcare – big data in medicine – advertising and big data – big data technologies - cloud and big data– mobile business intelligence – crowd sourcing analytics.  |
| **Unit – II** | **Hadoop** | **Hours:9** |
| History of Hadoop – Why Hadoop – Why not RDBMS – Distributed computing challenges - Components of Hadoop - The Hadoop Distributed File System - Design of HDFS – HDFS concepts –Processing Data with Hadoop – Managing Resources and Applications with Hadoop YARN - Interacting with Hadoop Ecosystem  |
| **Unit – III** | **MapReduce** | **Hours: 9** |
| MapReduce: MapReduce workflows – Anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution –MapReduce types – input formats – output formats.  |
| **Unit – IV** | **Hadoop Eco System** | **Hours: 11** |
| Introduction to Hive: What is Hive? – Hive Architecture – Hive data types – Hive file format – Hive Query language (HQL) – User-Defined function. Introduction to Pig – What is Pig? – Anatomy of Pig – Pig on Hadoop – Use Case for Pig: ETL Processing – Pig Latin overview – Data types in pig – Running Pig – Execution Modes of Pig – HDFS Commands – Relational operators – Eval function – complex data types. HBase – data model and implementations – Hbase clients – Hbase examples. |
| **Unit – V** | **Spark** | **Hours: 8** |
| Spark – Introduction to Data Analysis with Spark – Spark SQL – Data Analysis operations – Programming using RDDs and MLIB: Programming with RDDs – Machine learning with MLib – Data ETL Process – Introduction to Analytics, Reporting and Visualising – Data/Information reporting – Data Visualization - Real Time Applications |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| **1** | Michael Minelli, Michelle Chambers, Ambiga Dhiraj, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley, 2013. |
| **2** | Seema Acharya, Subhashini Chellappan, “Big Data Analytics”, Wiley, 2015 |
| **3** | Raj Kamal, Preeti Saxena, “Big Data Analytics – Introduction to Hadoop, Spark and Machine learning”, McGraw Hill, 2019 |
| **Reference Book(s)** |
| **1** | Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Wiley Publishers, 2015 |
| **2** | Kim H. Pries and Robert Dunnigan, Big Data Analytics: A Practical Guide for Managers, CRC Press, 2015. |
| **3** | Tom White, “Hadoop: The Definitive Guide”, Fourth Edition, O′Reilly Publishers, 2012. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | [nptel.ac.in/courses/106104189](https://nptel.ac.in/courses/106104189) |
| **2** | https://www.edureka.co/blog/big-data-tutorial |
| **3** | https://www.coursera.org/learn/big-data-introduction |
| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **M** | **S** | **S** | **M** | **L** | **M** | **L** | **M** | **L** |
| **CO2** | **S** | **M** | **M** | **S** | **S** | **M** | **S** | **L** | **M** | **M** |
| **CO3** | **S** | **L** | **S** | **M** | **S** | **L** | **L** | **M** | **S** | **M** |
| **CO4** | **S** | **M** | **S** | **M** | **M** | **M** | **S** | **S** | **M** | **M** |
| **CO5** | **S** | **L** | **S** | **M** | **M** | **S** | **M** | **S** | **S** | **M** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CORE X: DEEP LEARNING** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic knowledge on mathematicsandmachine learningconcepts | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| 1 | To understand the fundamental concepts and mathematical foundations of deep learning. |
| 2 | To explore various neural network architectures and their training mechanisms. |
| 3 | To apply deep learning techniques to solve real-world computer vision, NLP, and sequence prediction. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Understand the fundamental concepts of deep learning | **K2**  |
| **CO2** | Understand the fundamentals of Neural Networks | **K2** |
| **CO3** | Apply deep learning techniques for solving computer vision problems. | **K3** |
| **CO4** | Implement deep learning techniques forprocessing text and sequence data. | **K3** |
| **CO5** | Analyzedeep learning models for real-time applications. | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Deep Learning** | **Hours:09** |
| Fundamentals of Deep Learning: What is deep learning - Artificial intelligence, machine learning and deep learning –Why deep learning? Why now. Mathematical building blocks of neural networks: Data representation for Neural Networks– Tensor operations – Gradient based optimization  |
| **Unit – II** | **Neural Networks** | **Hours: 08** |
| Anatomy of Neural Network – Introduction to Keras - Setting up Deep Learning Workstation. |
| **Unit – III** | **Deep Learning for Computer Vision** | **Hours: 10** |
| Introduction to convnets: The convolution operation – The max-pooling operation - Training a convnet on a dataset – Using a pretrained convnets – Feature extraction – Fine-tuning - Visualizing convnets. |
| **Unit – IV** | **Deep Learning for text and sequences** | **Hours: 11** |
| Working with text data – Understanding recurrent neural networks – Advanced use of recurrent neural networks – Sequence processing with convnets - Keras Functional API – Text generation with LSTM  |
| **Unit – V** | **Applications of Deep Learning** | **Hours: 08** |
| Image classification using CNN – Visual Speech Recognition using 3d-CNN – Stock Market Prediction using RNN – Next-Word Prediction using RNN-LSTM – Handwritten Character Optical Recognition using CRNN. |
| **Unit – VI** | **Contemporary Issues** | **Hours:02** |
| Expert lectures, online seminars – webinars |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| 1 | Francois Chollet, “Deep Learning with Python”, Manning publications, 2018 |
| 2 | S. Lovelyn Rose, L. Ashok Kumar, D. Karthik, “Deep Learning using Python”, Wiley Publications, 2019 |
| **Reference Book(s)** |
| 1 | AurelienGeron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, O’Reilly, 2017. |
| 2 | Josh Patterson and Adam Gibson,Deep Learning a Practitioner’s Approach,O’Reilly Media, Inc.2017 |
| 3 | Nikhil Buduma, “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithm”, O’Reilly, 2017. |
| 4 | Nikhil Ketkar, “Deep Learning with Python: A Hands-on Introduction”, Apress, 2017 |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | <https://onlinecourses.nptel.ac.in/noc20_cs62/preview> |
| 2 | <https://www.coursera.org/specializations/deep-learning> |
| 3 | <https://www.mygreatlearning.com/deep-learning/free-courses> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **M** | **S** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **L** | **L** | **M** | **L** | **M** |
| **CO3** | **S** | **M** | **S** | **S** | **M** | **M** | **M** | **L** | **M** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **L** | **M** | **L** | **S** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CORE XI: DATA PRIVACY AND SECURITY** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic knowledge about databases, data structures and networking concepts | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To understand the importance of data privacy and security. |
| **2** | To learn privacy-preserving methods for protecting different types of data. |
| **3** | Tostudy significant global and sector-specific privacy regulations. |
| **4** | To implement security policies, controls for protecting information andsystems |
| **Expected Course Outcomes** |
| Onthesuccessfulcompletion ofthecourse,student willbeable to: |
| **CO1** | Explain the need for data sharing and analyze various privacy-preserving methods. | **K2/K4** |
| **CO2** | Apply privacy-preserving methods to different data types. | **K3** |
| **CO3** | Describe and interpret major privacy regulations across different countries and sectors. | **K2/K3** |
| **CO4** | Evaluate security policies and identify potential system vulnerabilities. | **K5** |
| **CO5** | Apply security tools, policies, and standards to protect devices and manage data securely. | **K3/K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Data Privacy** | **Hours: 10** |
| Data Privacy and its Importance - Need for Sharing Data - Methods of Protecting Data - Importance of Balancing Data Privacy and Utility – Introduction to Anonymization Design Principles - Nature of Data in the Enterprise Static Data Anonymization on Multidimensional Data: Introduction -Classification of Privacy Preserving Methods - Classification of Data in a Multidimensional Data Set - Group-Based Anonymization |
| **Unit – II** | **Static Data Anonymization for Complex DataStructures** | **Hours: 9** |
| Introduction - Privacy Preserving Graph Data - Privacy Preserving Time Series Data - Privacy Preservation of Longitudinal Data - Privacy Preservation of Transaction Data - Static Data Anonymization: Threats to Anonymized Data - Threats to Data Structures - Threats by Anonymization Techniques |
| **Unit – III** | **Privacy Regulationsand Compliance** | **Hours: 9** |
| Introduction - UK Data Protection Act 1998. - Federal Act of Data Protection of Switzerland 1992 - Payment Card Industry Data Security Standard (PCI DSS) - The Health Insurance Portability and Accountability Act of1996 (HIPAA): Effects of Protection - Anonymization Considerations - AnonymizationDesignforHIPAA-ExplicitIdentifiers-Quasi-Identifiers-SensitiveData.-AnonymizationDesignChecklist |
| **Unit – IV** | **Data Securityand Encryption** | **Hours: 9** |
| Securing Unstructured Data: Structured Data vs. Unstructured Data – At Rest, in Transit and in Use – Approaches to secure Unstructured Data – Newer Approaches to Secure Unstructured Data. Information Rights Management: Overview – IRM Technology Details – Getting Started with IRM. Encryption: History of Encryption – Symmetric Key Cryptography - Public Key Cryptography |
| **Unit – V** | **Storage and Database Security** | **Hours: 9** |
| Storage Security: Evolution – Modern Storage Security – Risk Remediation – Best Practices. Database Security: General Concepts – Database Security Layers – Database-Level Security – Database Backup and Recovery – Database Auditing and Monitoring |
| **Unit – VI** | **Contemporary Issues** | **Hours: 2** |
| Expertlectures,onlineseminars– webinars |
| **Total Lecture Hours** |  **48** |
| **Text Book(s)** |
| 1 | Venkataramanan,Nataraj,and AshwinShriram.DataPrivacy:PrinciplesandPractice.CRCPress,2017. |
| 2 | Rhodes-Ousley,Mark.InformationSecurity:TheCompleteReference,SecondEdition,And InformationSecurityManagement:ConceptsandPractice. NewYork, McGraw-Hill,2013. |
| **Reference Book(s)** |
| 1 | DavidSalomon,DataPrivacyandSecurity,Springer,2003 |
| 2 | Andrew Vladimirov Michajlowski, Konstantin, Andrew A. Vladimirov, and Konstantin V. Gavrilenko. Assessing Information Security: Strategies, Tactics, Logic and Framework. IT Governance Ltd, 2010 |
| 3 | William Stallings, Lawrie Brown, Computer Security: Principles and Practice, 5th edition, Pearson, 2024. |
| 4 | SergeGutwirth,RonaldLeenes,PaulDeHert,DataProtectionontheMove–Current Developments in ICT and Privacy/Data Protection, Springer, 2016 |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | <https://onlinecourses.nptel.ac.in/noc22_cs37/preview> |
| 2 | <https://onlinecourses.nptel.ac.in/noc21_cs28/preview> |
| 3 | https:/[/www.coursera.org/learn/privacy-law-data-protection](http://www.coursera.org/learn/privacy-law-data-protection) |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **M** | **M** | **M** | **S** | **S** | **L** | **M** | **L** |
| **CO2** | **S** | **M** | **S** | **S** | **M** | **S** | **L** | **M** | **S** | **S** |
| **CO3** | **S** | **S** | **M** | **S** | **S** | **M** | **M** | **S** | **L** | **M** |
| **CO4** | **S** | **M** | **S** | **M** | **L** | **S** | **L** | **M** | **S** | **S** |
| **CO5** | **S** | **M** | **L** | **S** | **S** | **M** | **S** | **S** | **M** | **M** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **PRACTICAL V:** **DATA VISUALIZATION LAB** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE LAB** | **0** | **0** | **5** | **4** |
| **Pre-Requisite** | Basic statistics and data analysis skills | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| 1 | To develop the ability to import, clean, and prepare datasets for visualization |
| 2 | To design and implement a variety of visualizations and dashboards for effective data analysis. |
| 3 | To apply advanced visualization techniques, including interactive filtering, forecasting, and drill-throughs, for decision-making. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Import, clean, and prepare datasets for visualization | **K3** |
| **CO2** | Create and customize basic and advanced visualizations for different domains. | **K3** |
| **CO3** | Develop interactive dashboards with filters, slicers, and drill-through features. | **K4** |
| **CO4** | Apply forecasting, KPI indicators, and advanced analytics in visual reports. | **K4** |
| **CO5** | Integrate visualizations for storytelling and effective communication of insights. | **K5** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **List of Programs** |
| **1** | Write a program to import a retail sales dataset in Power BI, create KPIs for Total Sales, Profit, and Quantity, and display them using bar, line, and map charts. |
| **2** | Write a program to load a student performance dataset in Power BI, create slicers for class, subject, and gender, and visualize average scores using bar charts. |
| **3** | Write a program to import a customer purchase dataset in Power BI, segment customers by region and product category, and display age group distribution using a pie chart. |
| **4** | Write a program to import monthly sales data in Power BI, create a line chart showing sales trends over time, and add forecasting analytics. |
| **5** | Write a program to load employee attendance data in Power BI, create a matrix table showing employee vs. month attendance, and apply conditional formatting. |
| **6** | Write a program to import e-commerce order data in Power BI, display order status distribution using a donut chart, and create a drill-through table for detailed order data. |
| **7** | Write a program to import the Superstore dataset in Tableau, create KPIs for sales, profit, and orders, and combine bar charts and line charts in a dashboard. |
| **8** | Write a program to load a student marks dataset in Tableau, create a heatmap of subjects vs. average marks, and add filters for gender and grade level. |
| **9** | Write a program to import customer demographic data in Tableau, create a pie chart of customers by gender, and a bar chart for age group distribution. |
| **10** | Write a program to visualize product category performance in Tableau, display sales by category using bar charts, and highlight top 5 products by profit. |
| **11** | Write a program to load patient data in Tableau, create a histogram for age distribution, and display a map of patient counts by region. |
| **12** | Write a program to import survey feedback data in Tableau, create stacked bar charts for multiple-choice responses, and display a word cloud for text responses. |
| **Reference Book(s)** |
| **1** | Brett Powell, Mastering Microsoft Power BI: Expert techniques for effective data analytics and business intelligence, Packt Publishing, 2nd Edition, 2022. |
| **2** | Devin Knight, Brian Knight, Mitchell Pearson, Manuel Quintana, Microsoft Power BI Quick Start Guide: Build dashboards and visualizations to turn your data into valuable business insights, Packt Publishing, 2nd Edition, 2020. |
| **3** | Joshua N. Milligan, Learning Tableau 2022: Create effective data visualizations, build interactive visual analytics, and transform your organization, Packt Publishing, 8th Edition, 2022. |
| **4** | Daniel G. Murray, Tableau Your Data: Fast and Easy Visual Analysis with Tableau Software, Wiley, 2nd Edition, 2016. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | https://onlinecourses.nptel.ac.in/noc24\_cs65/preview |
| 2 | https://onlinecourses.swayam2.ac.in/imb25\_mg221/preview |
| 3 | https://www.tableau.com/learn |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **M** | **S** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **M** | **L** | **M** | **L** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **L** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **M** | **S** | **L** | **L** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **M** | **S** | **L** | **M** | **L** | **M** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **PRACTICAL VI** **DEEP LEARNING LAB** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **CORE LAB** | **0** | **0** | **5** | **4** |
| **Pre-Requisite** | Basics Deep Learning Techniques | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| 1 | To understand the fundamental concepts of Deep Learning. |
| 2 | To understand the concepts of Deep Learning Categories. |
| 3 | To understand and apply Deep Learning concepts in real-time. |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Apply tensor operations and gradient-based optimization techniques in deep learning frameworks. | **K2 /K3** |
| **CO2** | Build and train simple feedforward neural networks for classification tasks. | **K2 /K4** |
| **CO3** | Demonstrate understanding of model generalization by identifying and mitigating overfitting/underfitting. | **K4** |
| **CO4** | Design and implement Convolutional Neural Networks (CNN) for image classification. | **K4** |
| **CO5** | Apply Recurrent Neural Networks (RNN) and Long Short-Term Memory (LSTM) models for text-based tasks. | **K3** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **List of Programs** |
| **1** | Create and manipulate tensors using TensorFlow, performing addition, multiplication, reshaping, and transposition. |
| **2** | Implement gradient descent on a simple linear function and visualize the cost reduction over iterations. |
| **3** | Demonstrate basic tensor operationsincluding slicing, reshaping, and broadcasting. |
| **4** | Build a simple feedforward neural network for classifying handwritten digits using the MNIST dataset. |
| **5** | Create and train a simple feedforward neural network for MNIST classification and evaluate model performance. |
| **6** | Create a program to classify movie reviews as positive or negativebased on the text content of the reviews. |
| **7** | Demonstrate overfitting and underfitting by training a neural network with different dataset sizes and plotting training vs. validation accuracy. |
| **8** | Implement a basic CNN for image classification |
| **9** | Implement a simple RNN for predicting the next character in a given text sequence |
| **10** | Implement sentiment analysis on text data using LSTM networks. |

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| **Text Book(s)** |
| 1 | Francois Chollet, “Deep Learning with Python”, Manning publications, 2018 |
| 2 | S. Lovelyn Rose, L. Ashok Kumar, D. Karthiks, “Deep Learning using Python”, Wiley Publications, 2019 |
| **Reference Book(s)** |
| 1 | AurelienGeron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, O’Reilly, 2017. |
| 2 | Nikhil Ketkar, “Deep Learning with Python: A Hands-on Introduction”, Apress, 2017 |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | <https://onlinecourses.nptel.ac.in/noc20_cs62/preview> |
| 2 | <https://www.coursera.org/specializations/deep-learning> |
| 3 | <https://www.mygreatlearning.com/deep-learning/free-courses> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **M** | **S** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **M** | **M** | **S** | **L** | **L** | **M** | **L** | **M** |
| **CO3** | **S** | **M** | **S** | **S** | **M** | **M** | **M** | **L** | **M** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **L** | **S** | **S** |

**S- Strong; M-Medium; L-Low**

**GUIDELINES TO PREPARE -MINI-PROJECT**

This document provides guidelines for writing and evaluating the technical specifications for a M.Sc. Data Science Mini project.

Writing the specification

The purpose of the technical specification is to provide specific information about the how the project will be carried out with details about the products that will be delivered.

The technical specification should include the following sections

**Front Page**

Page 1 Title page

Page 2 Certificate

Page 3 Acknowledgement

Page 4 Contents

Page 5 Abstract

Page 6 List of Figures/ tables/screens

**CONTENTS**

Contents

 **Synopsis / Project Overview**

* Introduction & Motivation
* Organization Profile *(if applicable)*
* Problem Statement
* Project Objectives
* Scope of the Study

 **System / Project Specification**

* Hardware Configuration
* Software Tools & Libraries (Python, R, TensorFlow, Scikit-learn, etc.)

 **Data Understanding**

* Data Source(s) (dataset description, source, size)
* Data Dictionary (description of variables)
* Initial Exploration (sample records, statistics, missing values)

 **Data Preparation**

* Data Cleaning (handling missing values, outliers)
* Feature Engineering & Transformation
* Data Splitting (train/test/validation)

 **System Design and Development**

* Modelling Approach
* Algorithms Chosen & Justification
* Model Training Process
* Hyperparameter Tuning

 **Evaluation**

* Evaluation Metrics
* Results & Comparisons

 **Visualization & Insights**

* EDA outputs, correlation heatmaps, plots
* Key trends, patterns, anomalies observed

 **Conclusion & Future Work**

* Summary of Findings
* Challenges Faced
* Recommendations for future improvement

 **Bibliography**

* References

 **Appendices**

* Data Flow Diagram *(optional)*
* Table Structure *(if using a DB)*
* Sample Coding
* Sample Input & Output

**SEMESTER IV**

PROJECT WORK

TITLE OF THE DISSERTATION

Bonafide Work Done by

STUDENT NAME

REG. NO.

Dissertation submitted in partial fulfillment of the requirements for the award of

<Name of the Degree>

of Bharathiar University, Coimbatore-46.

College Logo

Signature of the Guide Signature of the HOD

Submitted for the Viva-Voce Examination held on -----------------------

Internal Examiner External Examiner

Month – Year

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**Front Page**

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 **Data Understanding**

* Data Source(s) (dataset description, source, size)
* Data Dictionary (description of variables)
* Initial Exploration (sample records, statistics, missing values)

 **Data Preparation**

* Data Cleaning (handling missing values, outliers)
* Feature Engineering & Transformation
* Data Splitting (train/test/validation)

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* Modelling Approach
* Algorithms Chosen & Justification
* Model Training Process
* Hyperparameter Tuning

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* Evaluation Metrics
* Results & Comparisons

 **Visualization & Insights**

* EDA outputs, correlation heatmaps, plots
* Key trends, patterns, anomalies observed

 **Conclusion & Future Work**

* Summary of Findings
* Challenges Faced
* Recommendations for future improvement

 **Bibliography**

* References

 **Appendices**

* Data Flow Diagram *(optional)*
* Table Structure *(if using a DB)*
* Sample Coding

Sample Input & Output

**ELECTIVE – I**

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| --- | --- | --- | --- | --- | --- |
| **Course Name** | **DESIGN AND ANALYSIS OF ALGORITHM** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE I** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic Data Structures & Algorithms  | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To understand fundamental concepts of Algorithm  |
| **2** | To impart knowledge about Basic Traversal and Search Techniques |
| **3** | To identify thevariousdesignandanalysisofthe algorithms |
| **Expected Course Outcomes** |
| Onthesuccessfulcompletion ofthecourse,student willbeable to: |
| **CO1** | Getknowledgeabout algorithmsanddetermines theirtime complexity. | **K2 / K3** |
| **CO2** | Demonstratespecificsearchandsortalgorithmsusingdivideandconquer technique. | **K3** |
| **CO3** | GaingoodunderstandingofGreedy method andits algorithm | **K3** |
| **CO4** | Abletodescribe aboutgraphsusingdynamicprogramming technique. | **K4** |
| **CO5** | Demonstratetheconceptofbacktracking&branchandboundtechnique. | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction**  | **Hours: 10** |
| Introduction: Algorithm-Specification - Performance Analysis. Elementary Data Structure: Stacks And Queues – Trees –Priority Queues– Graphs |
| **Unit – II** | **TraversalandSearch Techniques** | **Hours: 9** |
| Basic Traversal and Search Techniques: Techniques for Binary Trees-Techniques for Graphs -Divide and Conquer: General Method – Binary Search – Merge Sort – Quick Sort. |
| **Unit – III** | **Greedy Method** | **Hours: 8** |
| GreedyMethod:Knapsackproblem,Minimum Costspanningtrees,Singlesourceshortestpaths. |
| **Unit – IV** | **Dynamic Programming** | **Hours: 10** |
| DynamicProgramming-GeneralMethod–MultistageGraphs–AllPairShortestPath–Optimal Binary Search Trees – 0/1 Knapsacks – Traveling Salesman Problem – Flow Shop Scheduling. |
| **Unit – V** | **Backtracking** | **Hours: 9** |
| Backtracking:GeneralMethod–8-QueensProblem–SumofSubsets–GraphColoring– Hamiltonian Cycles – Branch and Bound: - The Method – Traveling Salesperson. |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expertlectures,onlineseminars– webinars |
| **Total Lecture Hours** |  **48** |
| **Text Book(s)** |
| 1 | EllisHorowitz,SartajSahni,SanguthevarRajasekaran,“Fundamentalsof ComputerAlgorithms”,GalgotiaPublications,2011. |
| 2 | KleinbergandTardos:“AlgorithmDesign”,Pearson,ISBN:01321310802018. |
| 3 | Aho, Hoporoft and Ullman, ―The Design and Analysis of Computer Algorithm, Pearson Education, Delhi, 2001. |
| **Reference Book(s)** |
| 1 | ThomasH.Cormen,CharlesE.Leiserson,RonaldL.Rivest,CliffordStein,“Introductionto Algorithms”, Massachusetts Institute of Technology, MIT Press, III Edition, 2009. |
| 2 | Skiena,”TheAlgorithm DesignManual”,SecondEdition,Springer,2008 |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | <https://nptel.ac.in/courses/106/106/106106131/> |
| 2 | <https://www.tutorialspoint.com/design_and_analysis_of_algorithms/index.htm> |
| 3 | <https://www.javatpoint.com/daa-tutorial> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | S | M | M | S | - | M | - | L | - | L |
| **CO2** | M | S | S | S | L | M | - | M | - | L |
| **CO3** | S | S | S | S | - | M | L | L | - | M |
| **CO4** | S | S | S | S | - | M | L | L | - | M |
| **CO5** | S | S | S | S | - | M | S | S | M | S |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **BUSINESS INTELLIGENCE** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE I** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Basic knowledge of databases, data warehousing, and fundamental statistics | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The main objectives of this course are:**  |
| 1 | To gain knowledge on business intelligence system, life cycle and techniques used in it. |
| 2 | To become familiar with the knowledge delivery and modeling aspects. |
| 3 | To learn how to use and apply machine learning models to solve the business problems. |
| **Excepted Course Outcomes** |
| **On the successful completion of the course, student will be able to:** |
| **CO1** | Understand the concepts of Business Intelligence cycle to take the correct decision at right time. | **K2** |
| **CO2** | Demonstrate various Business knowledge representations and reporting features. | **K3** |
| **CO3** | Identification of good operating practices in business environments.  | **K4** |
| **CO4** | Demonstrates the Business Intelligence models in logistics and production domain. | **K4** |
| **CO5** | Communicate technologies going to rule the future of Business Intelligence. | **K5** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Overview and language modelling** | **Hours: 10** |
| Business Intelligence: Effective and timely decisions – Data, information and knowledge – Role of mathematical models – Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence. |
| **Unit – II** | **Word level and syntactic analysis** | **Hours: 9** |
| Knowledge Delivery: The business intelligence user types, Standard reports, Interactive Analysis and Adhoc Querying, Parameterized Reports and Self-Service Reporting, dimensionalanalysis, Alerts/Notifications, Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization, Integrated Analytics, Considerations: Optimizing the Presentation for the Right Message.  |
| **Unit – III** | **Extracting Relations from Text: From Word Sequences to Dependency Paths** | **Hours: 9** |
| Efficiency: Efficiency measures – The CCR model: Definition of target objectives- Peer groups – Identification of good operating practices; cross efficiency analysis – virtual inputs and outputs – Other models. Pattern matching – cluster analysis, outlier analysis. |
| **Unit – IV** | **Evaluating Self-Explanations in iSTART** | **Hours: 9** |
| Business Intelligence Applications: Marketing models – Logistic and Production models – Case studies  |
| **Unit – V** | **Future Trends** | **Hours: 9** |
| Future of Business Intelligence: Future of business intelligence – Emerging Technologies, Machine Learning, Predicting the Future, BI Search & Text Analytics – Advanced Visualization – Rich Report, Future beyond Technology. |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Discussion on case study - Expert lectures - Online seminars – Webinars – Workshops |
| **Total Lecture Hours** | **48** |
| **Text Book(s)** |
| 1 | Efraim Turban, Ramesh Sharda, Dursun Delen, “Decision Support and Business Intelligence Systems”, 9th Edition, Pearson 2013 |
| **Reference Book(s)** |
| 1 | Larissa T. Moss, S. Atre, “Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making”, Addison Wesley,  |
| 2 | David Loshin Morgan, Kaufman, “Business Intelligence: The Savvy Manager‟s Guide”, Second Edition, 2012. |
| 3 | Cindi Howson, “Successful Business Intelligence: Secrets to Making BI a Killer App”, McGraw-Hill, 2007. |
|  | Carlo Vercellis, “Business Intelligence: Data Mining and Optimization for Decision Making”, Wiley Publications, 2009 |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | <https://www.classcentral.com/course/swayam-business-analytics-for-managementdecision-10050> |
| 2 | <https://www.coursera.org/specializations/business-analytics> |
| 3 | https://www.udacity.com/course/business-analytics-nanodegree--nd098 |
| 4 | <https://www.tutorialspoint.com/business_analysis/business_analysis_quick_guide.htm> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **S** | **M** | **L** | **L** | **L** | **M** | **M** |
| **CO2** | **S** | **S** | **M** | **L** | **M** | **M** | **L** | **M** | **S** | **S** |
| **CO3** | **S** | **S** | **M** | **S** | **M** | **M** | **L** | **L** | **M** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **L** | **S** | **S** |
| **CO5** | **S** | **L** | **S** | **S** | **M** | **L** | **L** | **M** | **S** | **S** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **IOT ANALYTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE I** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Knowledge on basic terminologies and concepts in Data Science and IoT | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To understand IoT analytics, challenges, and connectivity protocols. |
| **2** | To introduce IoT cloud and big data integration techniques and services. |
| **3** | To inculcate knowledge on creating cloud analytics environment. |
| **4** | To explore and visualize of IoT data. |
| **5** | To familiarize with IoT analytics applications. |
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| **Expected Course Outcomes** |
| Onthesuccessfulcompletion ofthecourse,student willbeable to: |
| **CO1** | Understand the concepts and techniques of IoT Data Analytics Lifecycle and Machine Learning Application in IoT. | **K2** |
| **CO2** | Develop cognitive IoT solutions, leveraging artificial intelligence and data science. | **K3/K4/K6** |
| **CO3** | Examine concepts of cloud based IoT, big data and IoT in various domains | **K2/K4/K5/K6** |
| **CO4** | Propose new strategies for organizations to optimize cost benefits using IoT data. | **K6** |
| **CO5** | Explore end-to-end data science industry use cases using the data analytics lifecycle. | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction to Internet of Things and Analytics** | **Hours: 10** |
| Introduction to Internet of Things (IoT): Concepts and Definition of IoT – IoT Devices - IoT Networking Connectivity Protocols – IoT Data Messaging Protocols – MQTT, CoAP. IoT Analytics: Data vs big data- Challenges of IoT Analytics Applications - IoT Analytics Lifecycle and Techniques. |
| **Unit – II** | **IoT Cloud and Big Data Integration** | **Hours: 9** |
| IoT Cloud and Big Data Integration: Cloud based IoT platform – Data Analytics for IoT – Data Collection – WAZIUP software Platform – Ikaas Software Platform - Elastic analytics concepts – designing for scale – Cloud security and analytics – AWS overview - AWS key services for IoT analytics. |
| **Unit – III** | **Strategies and Techniques in Data Collection** | **Hours: 8** |
| Strategies and Techniques in Data collection: Designing Data Processing for Analytics – Applying Big Data to Storage – Apache Spark for IoT Data Processing - Solving Industry Specific Problems. |
| **Unit – IV** | **Geospatial Analytics to IoT Data** | **Hours: 10** |
| Geospatial Analytics to IoT Data: Basics – Vector and Raster Based Methods – Processing Geospatial Data. Data Science for IoT Analytics – Machine Learning Basic – Forecasting IoT data using ARIMA – Deep learning with IoT data. |
| **Unit – V** | **Applications & Case Studies** | **Hours: 9** |
| Applications & Case Studies: Data Analysis in Smart Building – Internet of Things Analytics for Smart Cities – IoT Analytics: From Data Collection to Deployment and Operationalization. |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expertlectures,onlineseminars– webinars |
| **Total Lecture Hours** |  **48** |
| **Text Book(s)** |
| 1 | Andrew Minteer, Analytics for the Internet of things, Packt publishing, 2017. |
| 2 | John Soldatos, Building Blocks for IoT Analytics, River Publishers, 2016. |
| **Reference Book(s)** |
| 1 | Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things: Principles and Paradigms, Elsevier, 2016. |
| 2 | R. Chandrasekaran, Essentials of Cloud computing, 2nd Edition, Chapman and Hall/CRC, 2015. |
| 3 | Amita Kapoor, Hands on Artificial intelligence for IoT, 1st Edition, Packt Publishing, 2019. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | https://www.udemy.com/course/data-analytics-in-internet-of-things-iot/ |
| 2 | https://www.coursera.org/lecture/aws-iot-developing-and-deploying-an-internet-of-things/iot analytics-part-1-p5qoe |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **S** | **M** | **S** |
| **CO2** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **M** | **S** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **M** | **S** | **S** | **S** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |

**S- Strong; M-Medium; L-Low**

**ELECTIVE II**

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| **Course Name** | **WEB ANALYTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE II** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | Web Technology and Data Analytics | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The main objectives of this course are:**  |
| 1 | To equip with knowledge of web analytics evolution, data collection methods, and challenges in modern analytics. |
| 2 | To develop skills in qualitative analysis techniques and crafting customer-centric web analytics strategies. |
| 3 | To implement and optimize web analytics tools while ensuring data quality and adherence to best practices. |
| 4 | To enable to create, interpret, and utilize insightful reports for assessing website performance and content quality. |
| 5 | To empower to perform search analytics, optimize SEO and PPC campaigns, and design effective experimentation programs. |
| **Expected Course Outcomes** |
| **On the successful completion of the course, student will be able to:** |
| **CO1** | Comprehend the fundamentals of web analytics | **K2** |
| **CO2** | Apply qualitative analysis techniques and develop effective web analytics strategies | **K3** |
| **CO3** | Select, implement, and optimize web analytics tools | **K3** |
| **CO4** | Generate and interpret insightful reports | **K4** |
| **CO5** | Perform search analytics and implement website experimentation programs | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Web Analytics—Present and Future** | **Hours: 9** |
| Web Analytics—Present and Future: A Brief History of Web Analytics, Current Landscape and Challenges, Traditional Web Analytics Is Dead, What Web Analytics Should Be Data Collection—Importance and Options: Understanding the Data Landscape, Click stream Data, Outcomes Data, Research Data, and Competitive Data. |
| **Unit – II** | **Qualitative Analysis and Web Analytics Strategy** | **Hours: 8** |
| Overview of Qualitative Analysis: Overview of Qualitative Analysis, Lab Usability Testing, Heuristic Evaluations Critical Components of a Successful Web Analytics Strategy?: Focus on Customer Centricity, Solve for Business Questions, Follow the 10/90 Rule, Hire Great Web Analysts, Identify Optimal Organizational Structure and Responsibilities. |
| **Unit – III** | **Web Analytics Fundamentals** | **Hours: 10** |
| Web Analytics Fundamentals: Capturing Data: Web Logs or JavaScript tags? Selecting Your Optimal Web Analytics Tool, Understanding Clickstream Data Quality, Implementing Best Practices, Apply the “Three Layers of So What” Test. |
| **Unit – IV** | **Core Web Analytics Concepts and Reporting** | **Hours: 10** |
| Diving Deep into Core Web Analytics Concepts: Preparing to Understand the Basics, Revisiting Foundational Metrics, Understanding Standard Reports, Using Website Content Quality and Navigation Reports. Jump-Start Your Web Data Analysis: Creating Foundational Reports, E-commerce Website, Support Website, Blog Measurement |
| **Unit – V** | **Search Analytics and Website Experimentation** | **Hours: 9** |
| Search Analytics—Internal Search, SEO, and PPC Performing Internal Site Search Analytics, Beginning Search Engine Optimization, Measuring SEO Efforts, Analyzing Pay per Click Effectiveness. Website Experimentation and Testing—Shifting the Power: Why Test and What Are Your Options? What to Test, Build a Great Experimentation and Testing Program. |
| **Unit – VI** | **Contemporary Issues** | **Hours :2** |
| Expert lectures, online seminars – webinars |
| **Total Lecture Hours** | **48 Hours** |
| **Text Book(s)** |
| 1 | Web Analytics: An Hour a Day by Avinash Kaushik ,2007, Publisher(s): Sybex, ISBN: 9780470130650 |
| **Reference Book(s)** |
| 1 | Actionable Web Analytics: Using Data to Make Smart Business Decisions by Jason Burby and Shane Atchison,2007, Publisher(s): Sybex |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | https://www.oreilly.com/library/view/web-analytics-an/9780470130650/ |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **M** | **M** | **M** | **S** | **S** | **L** | **M** | **L** |
| **CO2** | **S** | **M** | **S** | **S** | **M** | **S** | **L** | **M** | **S** | **S** |
| **CO3** | **S** | **S** | **M** | **S** | **S** | **M** | **M** | **S** | **L** | **M** |
| **CO4** | **S** | **M** | **S** | **M** | **L** | **S** | **L** | **M** | **S** | **S** |
| **CO5** | **S** | **M** | **L** | **S** | **S** | **M** | **S** | **S** | **M** | **M** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **NATURAL LANGUAGE PROCESSING** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE II** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** |  Basics of Machine Learning and Deep Learning | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The main objectives of this course are:**  |
| 1 | To understand the origins, challenges, and applications of Natural Language Processing (NLP). |
| 2 | To explore word-level and syntactic analysis techniques, including regular expressions, morphological parsing, part-of-speech tagging, and probabilistic parsing. |
| 3 | To analyze and extract relationships from text using techniques and investigate advanced NLP applications. |
| 4 | To utilize lexical resources like wordnet, framenet, and research corpora for linguistic analysis and information retrieval. |
| **Expected Course Outcomes** |
| **On the successful completion of the course, student will be able to:** |
| **CO1** | Understand the origins, challenges, and applications of NLP | **K2** |
| **CO2** | Apply techniques like regular expressions, finite-state automata, morphological parsing, spelling error correction, and part-of-speech tagging for word-level analysis and syntactic parsing. | **K3** |
| **CO3** | Extract relationships from textual data using subsequence kernels, dependency path kernels, and evaluate their effectiveness through experimental methods. | **K4** |
| **CO4** | Investigate advanced text mining techniques, including semantic role labeling, document separation, and explanatory pattern evolution for effective text analysis. | **K4** |
| **CO5** | Design and evaluate information retrieval systems, understand various retrieval models, and effectively use lexical resources like WordNet, FrameNet, and POS taggers. | **K5** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Overview and language modelling** | **Hours: 8** |
| **Overview:** Origins and challenges of NLP-Language and Grammar-Processing Indian Languages- NLP Applications-Information Retrieval. **Language Modeling:** Various Grammar- based Language Models-Statistical Language Model. |
| **Unit – II** | **Word level and syntactic analysis** | **Hours: 9** |
| **Word Level Analysis:** Regular Expressions-Finite State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. **Syntactic Analysis:** Context-free Grammar Constituency- Parsing-Probabilistic Parsing. |
| **Unit – III** | **Extracting Relations from Text: From Word Sequences to Dependency Paths** | **Hours: 10** |
| **Extracting Relations from Text: From Word Sequences to Dependency Paths:** Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation.**Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles:** Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labeling, Learning to Annotate Cases with Knowledge Roles and Evaluations.**A Case Study in Natural Language Based Web Search:** InFact System Overview, The GlobalSecurity.org Experience. |
| **Unit – IV** | **Evaluating Self-Explanations in iSTART** | **Hours: 10** |
| **Evaluating Self-Explanations in iSTART:**Word Matching, Latent Semantic Analysis, and Topic Models: Introduction, iSTART: Feedback Systems, iSTART: Evaluation of Feedback Systems,**Textual Signatures: Identifying Text-Types Using Latent Semantic Analysis to Measure the Cohesion of Text Structures:** Introduction, Cohesion, Coh-Metrix, Approaches to Analysing Texts, Latent Semantic Analysis, Predictions, Results of Experiments.**Automatic Document Separation: A Combination of Probabilistic Classification and Finite-State Sequence Modeling:** Introduction, Related Work, Data Preparation, Document Separation as a Sequence Mapping Problem, Results. |
| **Unit – V** | **Information Retrieval and Lexical Resources** | **Hours: 9** |
| **Information Retrieval:** Design features of Information Retrieval Systems-Classical, Non classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame Net Stemmers-POS Tagger- Research Corpora. |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expert lectures, online seminars – webinars |
| **Total Lecture Hours** | **48 Hours** |
| **Text Book(s)** |
| 1 | Tanveer Siddiqui, U.S. Tiwary, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008. |
| 2 | Anne Kao and Stephen R. Poteet (Eds), “Natural Language Processing and Text Mining”, Springer-Verlag London Limited 2007. |
| **Reference Book(s)** |
| 1 | Daniel Jurafsky and James H Martin, “Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition”, 2nd Edition, Prentice Hall, 2008. |
| 2 | James Allen, “Natural Language Understanding”, 2nd edition, Benjamin/Cummings publishing company, 1995.  |
| 3 | Gerald J. Kowalski and Mark.T. Maybury, “Information Storage and Retrieval systems”, Kluwer academic Publishers, 2000. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | <https://www.deeplearning.ai/resources/natural-language-processing/> |
| 2 | <https://www.coursera.org/specializations/natural-language-processing#courses> |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **M** | **M** | **M** | **S** | **S** | **L** | **M** | **L** |
| **CO2** | **S** | **M** | **S** | **S** | **M** | **S** | **L** | **M** | **S** | **S** |
| **CO3** | **S** | **S** | **M** | **S** | **S** | **M** | **M** | **S** | **L** | **M** |
| **CO4** | **S** | **M** | **S** | **M** | **L** | **S** | **L** | **M** | **S** | **S** |
| **CO5** | **S** | **M** | **L** | **S** | **S** | **M** | **S** | **S** | **M** | **M** |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **SENTIMENT ANALYSIS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE II** | **4** | **0** | **0** | **4** |
| **Pre-Requisite** | **Basic knowledge of Natural Language Processing and Machine Learning** | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| **1** | To understand the problems of sentiment analysis |
| **2** | To understand the sentiment classification of documents |
| **3** | To understand the extraction of entities |
| **4** | To detect the fake or deceptive opinions |
| **Expected Course Outcomes** |
| Onthesuccessfulcompletion ofthecourse,student willbeable to: |
| **CO1** | Understand the concepts on sentiment analysis and apply for different problems | **K2/K3** |
| **CO2** | Design and apply supervised sentiment classification | **K3** |
| **CO3** | Understand and evaluate different approaches for aspect and entity extraction | **K2/K5** |
| **CO4** | Design and create sentiment analysis applications | **K6** |
| **CO5** | Analyze the fake or deceptive opinions and discovering abnormal patterns | **K4** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Introduction** | **Hours: 10** |
| Introduction to Sentiment Analysis – Applications – Sentiment Analysis Research – The Problem of Sentiment Analysis – Opinion – Opinion Summary – Affect, Emotion and Mood – Different types of opinions |
| **Unit – II** | **Document-Level Sentiment Classification** | **Hours: 9** |
| Document Sentiment Classification – Supervised Sentiment Classification – Unsupervised Sentiment Classification – Sentiment Rating Prediction – Cross-Domain Sentiment Classification – Cross language Sentiment Classification – Emotion Classification of Documents – Sentence Subjectivity and Sentiment Classification. |
| **Unit – III** | **Aspect-Level Sentiment Classification** | **Hours: 8** |
| Aspect Sentiment Classification -Supervised Learning – Lexicon Based Approach - Rules of Sentiment Composition – Negation and Sentiment. |
| **Unit – IV** | **Aspect Extraction and Sentiment Lexicons** | **Hours: 10** |
| Frequency Based Aspect Extraction – Exploiting Syntactic Relations – Using Supervised Learning – Mapping Implicit Aspects – Grouping Aspects into categories – Exploiting Topic Models – Entity Extraction and Resolution – Opinion Holder and Time Extraction - Sentiment Lexicon Generation – Dictionary-Based Approach – Corpus Based Approach |
| **Unit – V** | **Opinion Detection** | **Hours: 9** |
| Detecting Fake or Deceptive Opinions – Spam types – Supervised Fake Review Detection – Supervised Yelp Data Experiment – Automated Discovery of Abnormal Patterns – Model Based Behavioral Analysis – Group Spam Detection – Identifying Reviewers with Multiple User IDs -Quality of Reviews. |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expertlectures,onlineseminars– webinars |
| **Total Lecture Hours** |  **48** |
| **Text Book(s)** |
| 1 | Bing Liu, Sentiment Analysis: Mining Opinions, Sentiments, and Emotions, 2nd Edition, Cambridge University Press, December 2020. |
| **Reference Book(s)** |
| 1 | Bing Liu, “Sentiment Analysis and Opinion Mining”, Morgan and Claypool publishers, 2012. |
| 2 | Bo Pang and Lillian Lee, “Opinion Mining and Sentiment Analysis”, Now Publishers Inc,2008. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| 1 | https://www.coursera.org/lecture/text-mining/5-6-opinion-mining-and-sentiment-analysis sentiment-classification-9zE5i |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **L** | **M** | **M** | **L** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **S** | **M** | **S** | **M** | **M** | **L** | **L** | **S** |
| **CO3** | **S** | **S** | **M** | **S** | **M** | **L** | **L** | **M** | **L** | **S** |
| **CO4** | **S** | **S** | **S** | **M** | **S** | **L** | **M** | **M** | **L** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **S** | **M** | **L** | **L** | **M** | **S** |

**S- Strong; M-Medium; L-Low**

**ELECTIVE III**

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| **Course Name** | **SOCIAL MEDIA ANALYTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE III** | **3** | **0** | **0** | **3** |
| **Pre-Requisite** | Foundations of Data Science and Big Data Framework  | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| **1** | To provide an overview of common text mining and social media data analytic activities |
| **2** | To understand the complexities of processing text and network data from different data sources.  |
| **3** | To enable students to solve complex real-world problems for recommendation systems |
| **4** | To enable the learners to develop skills required for analyzing the effectiveness of social media for business purposes.  |
| **5** | To familiarize the learners with the concept of social media analytics and understand its significance.  |
| **6** | To familiarize the learners with the tools of social media analytics.  |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Understand the terminologies, metaphors and perspectives of social media analytics | **K2** |
| **CO2** | Apply a wide range of classification, clustering, estimation and prediction algorithms on Textual data | **K4** |
| **CO3** | Perform social network analysis to identify important social actors, subgroups and network properties in social media sites. | **K4** |
| **CO4** | Apply state of the art web mining tools and libraries on realistic data sets as a basis for business decisions and applications. | **K4** |
| **CO5** | Provide solutions to the emerging problems with social media such as behavior analytics and Recommendation systems | **K4** |
| **C06** | Design new ontology-based solutions for opinion extraction, sentiment classification, and data summarization problems. | **K6** |
| **K1- Remember** | **K2- Understand** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |

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| **Unit – I** | **Foundation for Social Media Analytics**  | **Hours: 7** |
| Foundation for Analytics: – Digital Gap – Social Media Data Sources – Defining Social Media Data –Data Sources – Estimated vs. Factual Data Sources – Data Gathering in Social Media Analytics. From Data to Insights: Actionable Analytics – Focus on objective – Plan to shape data to insights –Choosing a good analytics tool – Data Aggregation calculations and display – Data display – Social-Media and Big data – Potential Challenges. Data Identification: Professional networking sites - social sites – information sharing sites – micro blogging sites – blogs /wikis.  |
| **Unit – II** | **Social Media Analytics Types, Tools and Social Network Landscape**  | **Hours:7** |
| Analytics in social media: Types of analytics. Dedicated Vs. Hybrid Tools – Dedicated tools – Hybrid tools – Data Integration Tools – Best Setup. Social Network Landscape: Concept and UX on social networks – Interactivity of social network –Content flow on social network – Interaction Pattern between users – Social-Media as a two-way channel. |
| **Unit – III** | **Analytic Process and Metrics**  | **Hours: 7** |
| Analytics Process: Analysis – Insight – Investigation beyond social analytics – Shaping a method –analysis cycle – Community Activity – Resources – Attention span – Dynamic cycles – Short Periods –Long Periods – Analyst Mindset – Instinctive Analyst. Metrics: Introduction – Default and custom metrics – Metrics Categories – Graph Types – Metric Capabilities – Metrics and Strategy – Estimated Metrics – Metrics and Tactics.  |
| **Unit – IV** | **Semantic Web and Social Network Analysis**  | **Hours: 7** |
| Introduction to Semantic Web: Limitations of current Web, Development of Semantic Web, Emergence of the Social Web. Social Network Analysis: Development of Social Network Analysis -Key concepts and measures in network analysis. Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks. |
| **Unit – V** | **Semantic Web and Ontology**  | **Hours: 6** |
| Knowledge representation on the Semantic Web: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language. |
| **Unit – VI** | **Contemporary Issues** | **Hours :2** |
| Online Courses, Webinars and Case studies  |
| **Total Lecture Hours** | **36** |
| **Text Book(s)** |
| **1** | Alex Goncalves, “Social Media Analytics Strategy - Using Data to Optimize Business Performance”, Alex Goncalves, APress 2017.  |
| **2** | Peter Mika, “Social Networks and the Semantic Web”, First Edition, Springer 2007. |
| **Reference Book(s)** |
| **1** | Ganis, Kohirkar (2016). Social media Analytics, IBM Press PTG, 1st Edition.  |
| **2** | Nancy Flynn (2012). The Social Media Hand book Policies, and Best Practices, Wiley. |
| **3** | Guandong Xu,Yanchun Zhang and Lin Li, “Web Mining and Social Networking Techniques and applications”, First Edition Springer, 2011 |
| **4** | Dion Goh and Schubert Foo, “Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively”, IGI Global Snippet, 2008.  |
| **Related Online Contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | https://www.coursera.org/learn/social-media-data-analytics  |
| **2** | https://www.classcentral.com/course/social-media-analytics-introduction-6916  |
| **3** | https://und.edu/academics/online/enroll-anytime/comm499.html  |
| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **M** | **L** | **L** | **M** | **M** | **M**  |
| **CO2** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **M** | **S**  | **S**  |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S**  | **S**  |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S**  | **S**  |
| **CO5** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S** | **S**  | **S**  |
| **CO6** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **S** | **S**  | **S**  |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **CLOUD ANALYTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE III** | **3** | **0** | **0** | **3** |
| **Pre-Requisite** | Basic Knowledge of Data Storage and Client-Server Systems | **Syllabus: 2025-2026** |
| **Course Objectives** |
| The main objectives of this course are: |
| 1 | To understand fundamental concepts of cloud analytics and evaluate major cloud service providers' analytics solutions  |
| 2 | To develop proficiency in analyzing and visualizing large-scale datasets using cloud-based tools and technologies  |
| 3 | To gain practical experience in implementing data analytics solutions on cloud platforms through hands-on projects  |
| 4 | To demonstrate the ability to select and utilize appropriate cloud services for different analytical requirements  |
| 5 | To master the implementation of cloud-based machine learning and artificial intelligence services for advanced analytics |
| **Expected Course Outcomes** |
| On the successful completion of the course, student will be able to: |
| **CO1** | Interpret the deployment and service models of cloud applications | **K2** |
| **CO2** | Understand big data analytical concepts and their implementation in cloud | **K2** |
| **CO3** | Ingest, store, and secure data using cloud services | **K3** |
| **CO4** | Process and visualize structured and unstructured data using cloud tools | **K4** |
| **CO5** | Process cloud-based machine learning and AI solutions | **K6** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6-Create** |

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| **Unit – I** | **Introduction** | **7 Hours** |
| Introduction to cloud computing –Cloud Computing Fundamentals - Cloud computing deployment models - Private cloud - Public cloud - Hybrid cloud - Types of cloud computing services -Infrastructure as a Service – PaaS – SaaS- Benefits and Challenges of Cloud Analytics - Parameters before adopting cloud strategy - Technologies utilized by cloud computing- Security practices in cloud environments: Threat Detection and Mitigation - Major Cloud Service Providers Overview (AWS, Azure, Google Cloud) |
| **Unit – II** | **Cloud Enabling Technologies** | **6 Hours** |
| Virtualization and its significance - Load Balancing Strategies - Scalability & Elasticity: Concepts and Implementation – Monitoring and logging tools in cloud environments- Service Level Agreements(SLAs)- Identity and Access Management (IAM)  |
| **Unit – III** | **Core Cloud Services & Platforms** | **8 Hours** |
| Compute Services: Amazon Elastic Compute Cloud - Google Compute Engine - Windows Azure Virtual Machines - Storage Solutions: Amazon Simple Storage Service - Google Cloud Storage - Windows Azure Storage - Managed Database Services: Amazon Relational Data Store - Amazon DynamoDB - Google Cloud SQL - Google Cloud Datastore - Windows Azure SQL Database - Windows Azure Table Service |
| **Unit – IV** | **Data Ingestion& Processing**  | **7 Hours** |
| Data Ingestion Tools and pipelines– Cloud Dataflow,Cloud Pub/Sub - Cloud storage - Cloud SQL - Cloud BigTable - Cloud Spanner - Cloud Datastore - Persistent disks solutions for scalable data storage - Data Processing frameworks: Apache Spark on Cloud Dataproc, Google BigQuery  |
| **Unit – V** | **Machine Learning, Deep Learning And AI** | **6 Hours** |
| Machine Learning Platforms: Tensor Flowand PyTorch integration with cloud – AI service APIs: Google Vision API - Natural Language API –Cloud Speech API - Cloud Translation API - Cloud Vision API - Cloud Video Intelligence – Dialogflow – Automated Machine Learning tools  |
| **Unit – VI** | **Contemporary Issues** | **2 Hours** |
| Expert lectures, online seminars – webinars |
| **Total Lecture Hours** | **36 Hours** |
| **Text Book(s)** |
| **1** | SanketThodge, Cloud Analytics with Google Cloud Platform, Packt Publishing, 2018.  |
| **2** | ArshdeepBahga and Vijay Madisetti, Cloud computing - A Hands-On Approach, Create Space Independent Publishing Platform, 2014. |
| **3** | **RajkumarBuyya, Christian Vecchiola, and ThamaraiSelvi**Mastering Cloud Computing: Foundations and Applications ProgrammingMorgan Kaufmann, 2013. |
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| **Reference Book(s)** |
| **1** | Deven Shah, Kailash Jayaswal, Donald J. Houde, JagannathKallakurchi, Cloud Computing - Black Book, Wiley, 2014. |
| **2** | Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2014. |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | https://nptel.ac.in/courses/106/104/106104182/ |

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| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **M** | **L** | **L** | **M** | **M** | **M**  |
| **CO2** | **S** | **S** | **S** | **S** | **M** | **L** | **M** | **M** | **S**  | **S**  |
| **CO3** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S**  | **S**  |
| **CO4** | **S** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S**  | **S**  |
| **CO5** | **S** | **S** | **S** | **S** | **M** | **M** | **M** | **S** | **S**  | **S**  |

**S- Strong; M-Medium; L-Low**

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| **Course Name** | **DIGITAL MARKETING ANALYTICS** | **L** | **T** | **P** | **C** |
| **Core/Elective** | **ELECTIVE III** | **3** | **0** | **0** | **3** |
| **Pre-Requisite** | **Basic knowledge of Marketing Concepts and Internet Technologies** | **Syllabus: 2025-2026** |
| **Course Objectives** |
| **The major objectives of this course are:** |
| **1** | To cover some of the most important aspects of digital marketing analytics since it is the essential tool for optimizing and connecting results of all digital marketing tactics  |
| **2** | To focus on how digital data is handled in media including search, social media, and email in a business perspective |
| **3** | Will focus on enriching student knowledge in analytics techniques for managerial decisions, which have emerged as critical assets to business professionals and firms nowadays |
| **Expected Course Outcomes** |
| On the successful completion of the course, students will be able to: |
| **CO1** | Understand how digital marketing transformed into digital marketing and the technology behind digital marketing  | **K3** |
| **CO2** | Know the key elements of a digital marketing strategy. | **K3** |
| **CO3** | Understand the requirements to implement digital business such as domain registration, website development, website upgradation etc. | **K4** |
| **CO4** | Understand how social media can be used for business and its impacts.  | **K4** |
| **CO5** | Know analytics tools for business summarization  | **K3** |
| **K1- Remember** | **K2- Understanding** | **K3- Apply** | **K4-Analyze** | **K5-Evaluate** | **K6- Create** |
| **Unit – I** | **Digital Marketing** | **Hours: 6** |
| Introduction about digital marketing- How have digital technologies transformed marketing- Digital marketing in practice - Definitions – what are digital marketing and multichannel marketing? Paid, owned and earned media -The growing range of digital marketing platforms - The technology behind digital marketing |
| **Unit – II** | **Digital Marketing Strategy Development** | **Hours:6** |
| Introduction to digital marketing strategy - Key features of digital marketing strategy -Applications of digital marketing -Benefits of digital marketing - Alternative digital business models - The difference between e-commerce and e-business - Different forms of online presence - Challenges in developing and managing digital marketing strategy - A strategic framework for developing a digital marketing strategy  |
| **Unit – III** | **Digital Marketing Implementation**  | **Hours: 8** |
| Introduction: Creating effective digital experiences -Digital marketing in practice- Planning website design and redesign projects - Who should be involved in a website project? - Prototyping and agile software development - Initiation of the website project - Domain name selection and registration - Website performance optimization - Defining site or app requirements - Business requirements - Usability requirements - Designing the information architecture -Mobile design considerations and techniques - Multichannel communications preferences - The relationship between service quality, customer. |
| **Unit – IV** | **Social Media Analytics**  | **Hours: 7** |
| Social Business Fundamentals - social media and Customer Engagement - The Social Feedback Cycle - Open Access to Information -Social Analytics - Quantitative Measurement - The Need to Measure More - Source and Sentiment Analysis - The Role of Trust - Web Analytics-Website Performance - Business Analytics - Offline and Non business Processes - Sources of Business Analytics. |
| **Unit – V** | **Digital Marketing tools**  | **Hours: 7** |
| Different types of social media marketing tools - The medium changes the nature of standard marketing communications tools such as advertising - Selecting the right mix of digital media communications tools -Tools and techniques for collecting metrics and summarizing results - The Tools that Power a Social Graph  |
| **Unit – VI** | **Contemporary Issues** | **Hours:2** |
| Expert lectures - Online seminars – Webinars  |
| **Total Lecture Hours** | **36** |
| **Text Book(s)** |
| **1** | Dave Chaffey, Fiona Ellis-Chadwick, “Digital Marketing – Strategy, Implementation and Practice”, Pearson Education, Sixth edition, ISBN-13: 978-1292077611, 2016.  |
| **2** | Social Media Marketing- the next generation of Business Engagement, Dave Evans and Jake McKee, Wiley Publishing, Inc. ,2010  |
| **3** | Social Media Analytics Strategy- Using Data to Optimize Business Performance, Alex Goncalves, Apress, 2017 |
| **Reference Book(s)** |
| **1** | Damian Ryan, Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation Paperback – Import, Kogan Page, Fourth Edition, |
| **2** | Marketing 4.0- Moving from Traditional to Digital, Philip Kotler, Hermawan Kartajaya, Iwan Setiawan, Wiley Publishing, 2017  |
| **3** | Advanced Social Media Marketing- how to lead, launch and manage a successful social media program, Tom Funk, Aprss,2013  |
| **Related Online contents (MOOC, SWAYAM, NPTEL, WEBSITES ETC...)** |
| **1** | https://www.coursera.org/learn/digital-analytics  |
| **2** | <https://www.tutorialspoint.com/digital_marketing/digital_marketing_web_analytics.html> |
| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** |
| **CO1** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **L** | **M** | **S** |
| **CO2** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **L** | **M** | **S** |
| **CO3** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **L** | **M** | **S** |
| **CO4** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **L** | **M** | **S** |
| **CO5** | **S** | **S** | **S** | **S** | **M** | **M** | **L** | **L** | **M** | **S** |

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