**Annexure: III**

**BHARATHIAR UNIVERSITY, COIMBATORE–641 046**
**DEPARTMENT OF COMPUTER APPLICATIONS**

**M.Sc. DATA ANALYTICS 2020-2021 – (CBCS) University Dept.**
**(Effective from the academic Year 2020-2021)**

**1. Eligibility for Admission**

A pass in any Bachelors degree of minimum 3 years duration with Mathematics or Statistics as any one of the subjects at Graduate level.

**2. Duration**

The programme shall be offered on a full-time basis for two years. The programme will consist of three semesters of course work and laboratory work and the fourth semester consist of major project.

**3. Regulations**

The general Regulations of the Bharathiar University Choice Based Credit System Programme are applicable to these programmes.

**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 Note Books prescribed for the Examinations. Otherwise the candidates will not be permitted to take the Practical Examinations. Candidates taking the Project Viva Examination should submit Project Report prescribed for the Examinations. Otherwise the candidates will not be permitted to take the Project Viva-voce Examination.

Students carry out Mini-project and major project and the schedule for project review meetings are as given below:

Table: Schedule for Project Review Meetings

| | First Review | Second Review |
|---|---|---|
| Mini Project | Thursday of first week in June | Thursday of first week in August |
| Major Project | Friday of first week of February | Friday of first week of April |

**6. Ranking**

A candidate who qualifies for the PG Degree Course passing all the Examinations in the first attempt, within the minimum period prescribed for the Course of Study from the date of admission to the Course and secures 1st or 2nd Class shall be eligible for ranking and such ranking will be confined to 10% of the total number of candidates qualified in that particular subject to a maximum of 10 ranks.

**7. Revision of Regulations and Curriculum**

The above Regulation and Scheme of Examinations will be in vogue without any change for a minimum period of three years from the date of approval of the Regulations. The University may revise/amend/ change the Regulations and Scheme of Examinations, if found necessary.

# M.Sc. Data Analytics

# Syllabus

# (With effect from 2020- 2021)

## Program Code :

## DEPARTMENT OF COMPUTER APPLICATIONS

## Bharathiar University

**(A State University, Accredited with "A" Grade by NAAC and**
**13th Rank among Indian Universities by MHRD-NIRF)**

## Coimbatore 641 046, INDIA

# BHARATHIAR UNIVERSITY: COIMBATORE 641046

# DEPARTMENT OF COMPUTER APPLICATIONS

## MISSION

- To impart practical knowledge and professional skills in the area of computer applications to students to make them industry ready.
- To contribute to the advancement of knowledge in the field of Computer Applications through research.
- To involve the students in societal contributions to make them aware of the society and its needs.

**BHARATHIAR UNIVERSITY, COIMBATORE–641 046**
**DEPARTMENT OF COMPUTER APPLICATIONS**

**M.Sc. DATA ANALYTICS**

| **Program Educational Objectives (PEOs)** | |
|---|---|
| The PEOs of **M.Sc Data Analytics** programme describe accomplishments that graduates are expected to attain within five to seven years after graduation | |
| PEO1 | Apply terminologies and principles in problem solving adapting to applications of Mathematics, Statistics, Business and emerging computing technologies in the field of Data Analytics to conceptualize real world problems. |
| PEO2 | Exhibit proficiency as data analytics professionals through latest technologies to business and organizations in demonstrating the ability for work efficacy |
| PEO3 | Work and collaborate with interdisciplinary backgrounds as a part of team to address the contemporary issues with innovation |
| PEO4 | Pursue entrepreneurship, research and higher studies associated with the program to function efficiently and effectively addressing challenging problems innovatively in the society |
| PEO5 | Communicate effectively, recognize and incorporate societal needs and constraints in their professional endeavor |
| PEO6 | Practice their profession as Data Analyst with high regard to ethical responsibilities. |

**BHARATHIAR UNIVERSITY:: COIMBATORE-641046**
**DEPARTMENT OF COMPUTER APPLICATIONS**

## M.Sc. DATA ANALYTICS

| **Program Specific Outcomes (PSOs)** | |
|---|---|
| After the successful completion of M.Sc Data Analytics Programme, the students are expected to demonstrate | |
| PSO1 | Knowledge on Data Analytics Principles and Components Data Acquisition, Data Transformations, Big Data Platforms for analysis and Interpretation |
| PSO2 | Sound Knowledge of constructing data into meaningful structures by data curation and reporting to predict and gather valuable Data Insights |
| PSO3 | Knowledge on using Statistics, Mathematics in designing Models and Algorithms for achieving Business Objectives |
| PSO4 | Sound Knowledge on Data Analytics, Big Data Technology Tools, Visualization, Database Management, Machine Learning and Programming for Analytics of Large scale Data to support business processes and functions |
| PSO5 | Apply data science methods in assessing data requirements and integrating data analytic problem framework for domain specific applications |
| PSO6 | Communicate data assumptions, analysis and insights in written and visual dashboards and articulate as data story |
| PSO7 | Knowledge on Professional and ethical responsibility on data ownership and data privacy |

| **Program Outcomes (POs)** | |
|---|---|
| On successful completion of the M. Sc. Data Analytics program | |
| PO1 | Apply knowledge of mathematics, statistics, science and computing appropriately to model the software applications, configure software platform and analyze real time data in heterogeneous domains. |
| PO2 | Design a system, component or process, tools to meet desired needs within realistic constraints such as economic, environmental, social, and ethical and safety contexts |
| PO3 | Have an ability to design, implement, evaluate, analyze, interpret complex problems and data, provide sustainable computational solutions and synthesis of information to provide valid conclusion for domains of business, healthcare, environment,. |
| PO4 | Create, Select and apply appropriate technologies, tools, techniques for data modeling, processing of complex problems and prediction for data analysis. |
| PO5 | Communicate effectively with the computing community, and with society, about complex computing activities by being able to comprehend and write effective reports, design documentation, demographics and make effective presentations. |
| PO6 | Manage projects and function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO7 | Understand the impact of professional analytical solutions in societal and environmental contexts and apply the knowledge for benefit of individual for sustainable development. |
| PO8 | Recognize the need for, and prepare them to engage in independent and life-long learning in the context of technological advancements for the betterment of individuals, organizations, research community and society. |
| PO9 | Apply ethical principles, commit to professional ethics and responsibilities and human values. |
| PO10 | Utilize the knowledge of education in understanding of data, management principles, computing solutions to apply on one’s own work, as a member and leader in a team to manage project in multidisciplinary environments and societal contexts. |
| | |

# BHARATHIAR UNIVERSITY : : COIMBATORE 641 046

## M.Sc. Data Analytics Curriculum (University Department)

*(For the students admitted during the academic year 2020 – 21 onwards)*

## SCHEME OF EXAMINATIONS

| Course Code | Title of the Course | Credits | Hours | | Maximum Marks | | |
|---|---|---|---|---|---|---|---|
| | | | Theory | Practical | CIA | ESE | Total |
| **FIRST SEMESTER** | | | | | | | |
| 21CSEGC01 | Principles of Data Science | 4 | 4 | 0 | 25 | 75 | 100 |
| 21CSEGC02 | Probability and Statistics for Data Analytics | 4 | 4 | 0 | 25 | 75 | 100 |
| 21CSEGC03 | Data Structure, Design and Analysis of Algorithms | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGC04 | Soft Skill I | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGE01 | Elective I : Python Programming | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGE02 | Elective II: Data Mining | 4 | 4 | 0 | 25 | 75 | 100 |
| General | General Supportive | 2 | 2 | 0 | 15 | 35 | 50 |
| **Total** | | 26 | 16 | 12 | 165 | 485 | 650 |
| **SECOND SEMESTER** | | | | | | | |
| 21CSEGC05 | Advanced Database Management | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGC06 | Mathematical Foundations for Machine Learning | 4 | 4 | 0 | 25 | 75 | 100 |
| 21CSEGC07 | Data Analytics with R | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGC08 | Data Visualization | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGE03 | Elective-III: Evolutionary Computing | 4 | 4 | 0 | 25 | 75 | 100 |
| 21CSEGE04 | Elective-IV: Text Analytics | 4 | 3 | 2 | 25 | 75 | 100 |
| **Total** | | 24 | 17 | 14 | 150 | 450 | 600 |
| **Job Oriented Course I** | | | | | | | |
| **Value Added Course I** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **THIRD SEMESTER** | | | | | | | |
| 21CSEGC09 | Virtualization and Cloud | 4 | 4 | 0 | 25 | 75 | 100 |
| 21CSEGC10 | Big Data Analytics Frameworks and Tools | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGC11 | Machine Learning | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGC12 | Soft Skills – II | 4 | 2 | 4 | 25 | 75 | 100 |
| 21CSEGE05 | Elective – V:Internet of Things | 4 | 3 | 2 | 25 | 75 | 100 |
| 21CSEGE06 | Elective – VI: Sentiment Analytics | 4 | 4 | 0 | 25 | 75 | 100 |
| 21CSEGC13 | Mini Project and Viva Voce | 4 | | | 25 | 75 | 100 |
| | **Total** | 28 | 17 | 14 | 150 | 450 | 700 |
| **FOURTH SEMESTER** | | | | | | | |
| 21CSEGC14 | Project and Viva Voce | 12 | | | 75 | 225 | 300 |
| | **Total** | 12 | | | 75 | 225 | 300 |
| | **Grand Total** | 90 | 50 | 40 | 465 | 1385 | 2250 |
| **Job Oriented Course – II** | | | | | | | |
| **Value Added Course – II** | | | | | | | |
| **ONLINE COURSES** | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| | M.Sc. (Data Analytics)<br><br>Electives | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **Title of the Course** | **Credits** | **Hours** | **Maximum Marks** | | |
| | | | **Theory** | **Practical** | **CIA** | **ESE** |
| 21CSEGE01 | Python Programming | 4 | 2 | 2 | 25 | 100 |
| 21CSEGE02 | Data Mining | 4 | 4 | 0 | 25 | 100 |
| 21CSEGE03 | Evolutionary Computing | 4 | 2 | 2 | 25 | 100 |
| 21CSEGE04 | Text Analytics | 4 | 3 | 1 | 25 | 100 |
| 21CSEGE05 | Internet of Things | 4 | 3 | 1 | 25 | 100 |
| 21CSEGE06 | Sentiment Analysis | 4 | 4 | 0 | 25 | 100 |
| 21CSEGE07 | Social Media Mining | 4 | 3 | 1 | 25 | 100 |
| 21CSEGE08 | Progressive Web Application Development | 4 | 2 | 2 | 25 | 100 |
| 21CSEGE09 | Semantic Web | 4 | 4 | 0 | 25 | 100 |
| 21CSEGE10 | NoSQL: Graph Database | 4 | 2 | 2 | 25 | 100 |
| 21CSRGE11 | Health Care Analytics | 4 | 2 | 2 | 25 | 100 |

| Course code | 21CSEGC01 | PRINCIPLES OF DATA SCIENCE | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 4 | 0 | 4 |
| Pre-requisite | | Basica of Data and Data types | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand Data source evolution, data Characteristics and data processing models.
2. To understand and apply data processing architecture ,Eco System Components of Big Data Frameworks HADOOP, SPARK MapReduce
3. To analyze and Build Data Science use cases for specific domain and applications.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand Data sources, generations, data formats, Data Evolution, Data from various domains | K1, K2 |
| 2 | Understand Big Data Characteristics What, Why, When, Limitation of traditional approaches and models. Map Big Vs to Data Domains | K3 |
| 3 | Understand Big Data Processing platform , frameworks , Hadoop, Spark , storage models – Hbase- Programming Model of Big Data MapReduce, Why MapReduce, Limitations of Traditional Models | K2 |
| 4 | Understand the Role of Big Data and Artificial Intelligence – Ethics – AI Applications | K2-K5 |
| 5 | Analyze various domains of Big Data Characteristics, Platform, Programming Model and Design Big Data framework ecosystem, and data processing framework of domains of Marketing, Health Care and Supply Chain | K4-K5 K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to Data Evolution & Sources | 12-- hours |
|---|---|---|

Big Data in Industry 4.0 - Data Evolution: Data Development Time Line – ICT Advancement-a Perspective – Data Growth-a Perspective – IT Components-Business Process – Landscape-Data to Data Science – Understanding data: Introduction – Type of Data: Numeric – Categorical – Graphical – High Dimensional Data — Data Classification –-Data Formats: Structured, Semi-Structured and Un-Structured – Data Sources : Time Series – Transactional Data – Biological Data – Spatial Data – Social Network - Data Science: Data Science-A Discipline – Data Science vs. Statistics – Mathematics - Programming Language - Database, - Machine Learning. Data Analytics Relation: Data Science, Analytics, Big Data Analytics. .

| Unit:2 | Big Data Towards Data Science | 12-- hours |
|---|---|---|

| | | |
|---|---|---|
| Big Data: Introduction To Big Data: - Evolution – Data as Economy - What is Big Data – Sources of Big Data. – Big Data Myths - Characteristics of Big Data 6Vs – Big Data Use cases - Big data- Challenges of Conventional Systems- -– Data Processing Models – Limitation of Conventional Data Processing Approaches - Data Discovery-Traditional Approach, Big Data Technology: Big Data Exploration - Data Augmentation – Operational Analysis – 360 View of Customers – Security and Intelligence – Data Analytics – Classification - Descriptive – Diagnostic - Predictive – Prescriptive – Augmented – Pervasive Analytics- Data Science Components: Data Engineering, Data Analytics-Methods and Algorithm, Data Visualization – P's of Data Science – Process – People – Platform | | |
| | | |
| **Unit:3** | **Big Data Framework and Components** | **12-- hours** |
| Big Data Technologies - Hadoop: Basic Concepts-An Overview of Hadoop-The Hadoop Distributed File System-Anatomy of a Hadoop Cluster-Hadoop Ecosystem Components. SPARK – in Architecture – SPARK Advantages - HBASE: HBase Architecture-HBase API-Managing large data sets with HBase - Map Reduce Framework Phases - Map Reduce Input and Output Formats - Advanced Concepts - Sample Applications – Combiner – Joining datasets in Map reduce jobs – Map - side join – Reduce - Side join - Map reduce – customization | | |
| | | |
| **Unit:4** | **Big Data and AI : Roles and Skills** | **12-- hours** |
| AI: Cognitive Computing : Learning Perceptions – Terminologies - Machine Learning – Neural Networks – Deep Learning - NLP – Speech Processing – Big Data and AI – Ethics in AI Research - Advanced Applications – AI Myths – Data Science Roles Data Scientist , Data Architect, Data Analyst – Machine Learning Engineer - Skills | | |
| | | |
| **Unit:5** | **Data Science Use cases** | **12-- hours** |
| Data Science & Big Data Use cases Specifications and Discussion – Data Sources Identification – Data Types –Data Classification – Data Characteristics of Big V's – Data Science P's – Big Data Frameworks – Data Analytics Classification – Applications of AI:<br>Domains : Customer Insights – Behavioral Analysis –- Marketing – Retails – Insurance – Risk and Security –Health care – Supply Chain Logistics | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Addressing **C**ontroversy Views of social media – Big Data Source – Data Science Technology - Animal Testing : Technological Solution – Human Rights and Data<br><br>Expert lectures, online seminars – webinars | | |
| | | |
| | **Total Lecture hours** | **62-- hours** |

| Text Book(s) | |
|---|---|
| 1 | V. Bhuvaneswari, T. Devi, "**Big Data Analytics: A Practitioner's Approach**", Sci-Tech Publications, 2016. |
| 2 | Han Hu, Yonggang Wen, Tat-Seng, Chua, XuelongLi,"**Toward Scalable Systems for Big**", |
| 3 | Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publication, first edition. Reprint in 2016 |
| 4 | Joel Grus, **"Data Science from Scratch"**, 2nd Edition, O′Reilly Publisher, ISBN: 9781492041139, May 2019 |
| **Reference Books : EBooks** | |
| 1 | SinanOzdemir, Sunil Kakade, "**Principles of Data Science**", Second Edition, [Packt] |
| 2 | David Natingga, **"Data Science for Algorithms in a Week",** Second Edition, [Packt] |
| 3 | PrabhanjanTattar, Tony Ojeda, Et al, **"Practical Data Science Cookbook"**, Second Edition, [Packt], ISBN: 9781787129627 |
| 4 | Lillian Pierson, Jake Porway, **"Data Science for Dummies"**, Second Edition, John Wiley & Sons, Publishers, ISBN**:** 9781119327639, 2017 |
| 5 | Field Cady, **"The Data Science Handbook"**, John Wiley & Sons, Publishers, ISBN**:** 9781119092940, 2017 |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |

| | Course Title | Duration | Provider |
|---|---|---|---|
| 1. | Python for Data Science | 4 Weeks | Swayam |
| 2. | Introduction to Data Science in Python (Free) | 4 Weeks | Coursera |
| 3. | Intro to Data Science (Free) | 8 Weeks | Udacity |
| 4. | Data Science Certification Training – R Programming | 14 hours | Simlilearn |
| 5. | Data Science with Python | 15 hours | Simplilearn |
| **Web link** | | | |

1. hthttps://builtin.com/data-science
2. https://www.udacity.com/course/intro-to-data-science--ud359
3. https://www.tutorialspoint.com/python_data_science/index.htm

Course Designed by: Dr.V.Bhuvaneswari

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | L | S | M | M | S | L | L | M | M | S |
| **CO2** | L | L | S | S | S | L | M | M | M | M |
| **CO3** | S | S | S | S | S | M | S | M | S | S |
| **CO4** | M | M | M | S | S | M | L | M | S | S |
| **CO5** | S | S | S | S | S | M | M | S | S | S |
| | | | | | | | | | | |

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

| Course code | 21CSEAC02 | PROBABILITY AND STATISTICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 4 | 0 | 4 |
| Pre-requisite | | Basics of Mathematics and Statistics | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the Probability Theory
2. To understand theoretical distributions and automata theory

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | To understand the principles of probability, frequency distribution measures | K2 |
| 2 | To understand the correlation and regression, hypothesis test, sampling techniques for specific applications | K3 |
| 3 | To apply probabilistic models and distribution models | K3 |
| 4 | To apply hypothesis testing and regression models for specific domain | K4 |
| 5 | To design statistical models for specific domains and illustrate statistical methods | K5, K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to Set Theory | 12-- hours |
|---|---|---|

Set Theory: Basic set operations, relations and functions, transitive closure relation, principle of mathematical induction. Matrices: Properties of determinants, inverse of a matrix, Eigen values and Cayley Hamilton theorem.

| Unit:2 | Probability Theory | 12-- hours |
|---|---|---|

Introduction to Probability Theory: Sample space and events, axioms of Probability, conditional probability, Bayer's theorem, independence of events.

| Unit:3 | Descriptive Statistics | 12-- hours |
|---|---|---|

Basic probability theory - distributions and their properties - Frequency Distribution - Continuous or Grouped Frequency Distribution - Magnitude of Class intervals - Cumulative Frequency Distribution - Two Way Frequency Distribution - Measures of Central Tendency: Arithmetic Mean, Geometric Mean - Harmonic Mean - Median, Mode - Dispersion: Overview - Mean Deviation - Standard Deviation - Combined Standard Deviation.

| Unit:4 | Theoretical Distribution | 12-- hours |
|---|---|---|

Theoretical Distribution: Binominal Distribution - Obtaining Coefficient - Poison Distribution - Normal Distribution - Poisson - Cumulative Poisson Process and its generalization - applications in different business domain - ARMA and ARIMA - Monte Carlo Simulations

| Unit:5 | Automata Theory: NDFSA and NDFSA | 12-- hours |
|---|---|---|

Introduction to Automata Theory: Introduction - Finite State Automata – Deterministic Finite State Automata - Non-Deterministic Finite State Automata, NDFSA with E - Transitions, Moore and Mealy Machines, Regular Expressions.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Application of data analytics in different domains – Exploring Case Studies for the topics given in Unit 1 to Unit 5.

| | **Total Lecture hours** | **62-- hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | William A. R. Weiss **"An Introduction to Set Theory"** Publisher: University of Toronto 2008 |
| 2 | RafVandebril, Marc Van Barel, Nicola Mastronardi, **"Matrix Computations and Semiseparab Matrices: Eigenvalue and Singular Value Methods"**, JHU Press, 2009. |
| 3 | By Vijay K. Rohatgi, A.K. Md. EhsanesSaleh. **"An Introduction To Probability And Statistics"**, ISBN: 978-1-118-79964-2, 3rd Ed , 2015. |
| 4 | Jacques Sakarovitch, **"Elements of Automata Theory"**, Cambridge University Press, 2009. |
| 5 | R.S.N. Pillai, Bagavathi, "Statistics Theory and Practice, S.Chand & Company, 2013 |

**Reference Books**

| | |
|---|---|
| 1 | Charles E. Roberts, Jr, **"Introduction to Mathematical Proofs A Transition to Advanced Mathematics"** Denny Gulick, 4th Edition, Published by Pearson, ISBN: 9780134746753, 2018. |
| 2 | John R. Hauser, **"Numerical Methods for Nonlinear Engineering Models"**, Springer Netherlands, ISBN: 9401777071, 9789401777070, 1013 pages, 2017. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | **Course Title** | **Duration** | **Provider** |
|---|---|---|---|
| 1 | Advanced Probability Theory | 12 Weeks | Swayam |
| 2 | Discrete Mathematics | 12 Weeks | Swayam |
| 3 | Numerical Methods And Simulation Techniques For Scientists and Engineers | 8 weeks | Swayam |
| 4 | Theory of Automation | 8 Weeks | Swayam |

Course Designed By: K.Moorthy and Dr.T.Devi

**Mapping with Programme Outcomes**

| **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

| Course code | 21CSEGC03 | DATA STRUCTURES, DESIGN AND ANALYSIS OF ALGORITHMS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Knowledge on data, data types | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the object oriented concepts: Class, Inheritance and Polymorphism.
2. To understand and analysis concepts of Algorithmic analysis and algorithm approaches.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Develop and understand on data structures, the information arranged in memory of computer, information manipulation with the use of algorithms in a data structure. | K1, K2 |
| 2 | Formulate general principles with notations, to increase the computation time and size, search nodes to find the depth root of a tree. | K3 |
| 3 | Identify classes and objects from the given problem description and create classes and objects using C++, Code reusability and extensibility by means of Inheritance and Polymorphism | K2,K5 |
| 4 | Design algorithms for problem solving by using the suitable algorithmic technique | K2,K3 |
| 5 | Analyze a given algorithm for its efficiency based on time and space it occupies and optimization techniques for improving the performance of algorithms. | K4,K5, K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| Unit:1 | Introduction to Data Structures | 18-- hours |
|---|---|---|

Stacks – Push and Pop – Stack frames for Sub Programmes – Queues – Tree – Graphs – Directed Graphs – Graph Traversal – List representation – Linked list – File organization – Sorting Algorithms and efficiency considerations - Searching

| Unit:2 | Algorithmic Case Analysis | 18-- hours |
|---|---|---|

Asymptotic Notations: Big Oh notation – O – Omega notation – Theta notation – Average case analysis – Binary tree – Recursion – Towers of Hanoi – Non Recursive Quicksort – Non Deterministic Algorithms.

| | | |
|---|---|---|
| **Unit:3** | **Object Oriented Language** | **18-- hours** |
| Object oriented language fundamentals – programming basics – Conditional statements – Structures – Functions - Objects and Classes **–** Constructors – Overloading. Inheritance – Hierarchy - Derived class – Access specification - Polymorphism – virtual functions – virtual class – Files - Exception Handling. | | |
| | | |
| **Unit:4** | **Design of Algorithms** | **18-- hours** |
| Introduction to algorithms, Analyzing algorithms. Divide and Conquer: General Method, Binary Search, Merge sort, Quick sort. Greedy Method: Knapsack problem, Job sequencing with deadlines, Minimum spanning trees, Single source shortest paths. | | |
| | | |
| **Unit:5** | **Dynamic Programming** | **18-- hours** |
| Dynamic Programming: Multistage graphs, All pair's shortest paths, Travelling salesperson problem. Back Tracking: 8-queens problem, Sum of subsets, Graph coloring, Hamiltonian cycles. Branch and Bound: General method, Travelling salesperson problem. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| 1. Document classification – Key word identification – Higher level heuristics<br>2. Big Data – Contemporary applications – parallel algorithms –Architectures<br>3. Processor – Communication – Predicted complexity – CPU/GPU cycles – Sequential algorithms – optimization tools. | | |
| | | |
| | **Total Lecture hours** | **92-- hours** |

| **Text Book(s)** | |
|---|---|
| 1 | Kleinberg and Tardos: "Algorithm Design",Pearson, ISBN: 0132131080 2018. |
| 2 | BjarneStroustrup, "The C++ Programming Language", Addison Wesley, 7th Edition, ISBN: 0321563840, 2017. |
| 3 | Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, "Fundamentals of Computer Algorithms", Galgotia Publications, 2011. |
| **Reference Books : EBooks** | |
| 1 | M.A.Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education Asia,2013. |
| 2 | Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Massachusetts Institute of Technology, MIT Press, III Edition, 2009. |

| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | | |
|---|---|---|---|
| | **Course Title** | **Duration** | **Provider** |
| 1. | Mastering Data Structures & Algorithms using C and C++ | 56 hours 20m | Udemy |
| 2. | Data Structures | 5 hours | Coursera |
| 3. | Data Structures Fundamentals (Free) | 6 Weeks | edX |
| 4. | Design and Analysis of Algorithm (Free) | 11 Weeks | NPTEL |

| | | | |
|---|---|---|---|
| 5. | Design and Analysis of Algorithms (Free) | 8 Weeks | SWAYAM |
| **Web link** | | | |
| 1. https://www.tutorialspoint.com/design_and_analysis_of_algorithms/<br>2. https://www.javatpoint.com/daa-tutorial<br>3. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms | | | |
| Course Designed by: Dr. J. Satheeshkumar | | | |

**Mapping with Programme Outcomes**

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

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

| Course code | 21CSEGC04 | SOFT SKILL - I | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Fundamentals on English speaking and writing | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the basics of communication skills
2. To Understand the logical skills
3. To develop interpersonal skills
4. To improve the writing skills
5. To acquired knowledge in technical programming
6. To acquired knowledge in technical programming and quantitative aptitude

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Develop the basics of communication skills and Develop confidence, clarity, fluency through active involvement | K2 |
| 2 | Increase logical skills, analytical skills and apply in software applications | K2 |
| 3 | Develop interpersonal skills, listening through (seminar, self intro, stage speaking) | K3 |
| 4 | Improve writing skills through various modes (letter writing, resume writing) | K3 |
| 5 | Practice technical programming, cracking code, simple logic and concepts | K1/K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

| Unit:1 | Introduction to Communication | 18 hours |
|---|---|---|

Importance – Basics of Communication – Purpose and Audience - Language as a Tool of Communication – Communicative Skills - Modes of Communication – Active Listening- Introduction - Traits of a Good Listener – Listening Modes – Effective Speaking: Achieving Confidence, Clarity and Fluency – Paralinguistic Features – Types of Speaking

| Unit:2 | Personality Development | 18 hours |
|---|---|---|

A Must for Leadership and Career Growth – Swami Vivekananda Concept of Personality Development – Interpersonal Skills -Soft Skills: Introduction to Soft Skills – Classification of Soft Skills-Case study: Resume Writing-Email-letter Writing-Self Introduction.

| Unit:3 | Technical programming skill | 18 hours |
|---|---|---|

Variables and keywords - Operators in C – Decision Making– Looping - Branching Statements – Array – Functions.

| Unit:4 | Quantitative Aptitude1 | 18 hours |
|---|---|---|

Number series -Ratio, Proportion and Partnership – Problems on Ages - Average - Profit and Loss.

| Unit:5 | Quantitative Aptitude 2 | 18 hours |
|---|---|---|
| Simple Interest – Compound Interest – Time and Work – Time and Distance. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Write an assignment on any one of the following:<br>1. Traits needed for a software Engineer.<br>2. Traits needed for a software project Manager.<br>3. Traits needed for a Teacher (Software Tester). | | |
| | | |
| | **Total Lecture hours** | **92 hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | Raman Sharma, "Technical Communication", 3rd Edition, Oxford University Press, and ISBN: 9780199457496, 2017. |
| 2 | Barun K. Mitra, "Personality Development and Soft Skills", 2nd Edition Oxford University Press, ISBN: 9780199459742, 2016. |

**Reference Books**

| | |
|---|---|
| 1 | E. Balagurusamy, "Programming in ANSI C", Tata McGraw – Hill Edition", 7th Edition, 2017. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | www.coursera.com [E-mail letter writing- Write Professional Emails in English] |
| 2 | www.coursera.com[Improve your English Communication Skills specialization course] |
| 3 | www.udemy.com [Personality and Soft Skills Development] |
| 4 | www.coursera.com[ The Science of Well Being] |

**Web Links**

| | |
|---|---|
| 1 | https://owl.purdue.edu/ [Online Writing Lab] |
| 2 | www.grammarbook.com |

Course Designed By:**Dr. M. Punithavalli**

**Mapping with Programme Outcomes**

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

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

| Course code | 21CSEGC05 | ADVANCED DATABASE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Knowledge on data, tables, files and databases | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the concepts of DBMS, Data Model and Normal forms.
2. To understand the concepts of concurrency control and Recovery.
3. To understand basics of SQL and NoSQL databases.
4. To understand and apply MongoDB (NoSQL) for Data Analysis using CURD and User Management.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the structure and model of the relational database management systems. | K2 |
| 2 | Understand the concepts of transaction management and SQL, NoSQL database models | K3 |
| 3 | Understand and create database models using MongoDB | K4 |
| 4 | Apply MongoDB operators to retrieve data from document data stores | K3 |
| 5 | Understand and apply concepts of data management indexing techniques for specific applications | K5, K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| Unit:1 | Database Overview | 18 hours |
|---|---|---|

Introduction - Database concepts, Basic components of DBMS, sources of data - data models – hierarchical – network – XML and Stores - Relational Database Design: Anomalies ina Database– Functional Dependency – Lossless Join and Dependency – Preserving Decomposition – Third Normal Form– Boyce Codd Normal Form – Multivalued Dependency – Fourth Normal Form – Join Dependency – Project Join Normal Form –Domain Key Normal Form - SQL: Data Definition – Data Manipulation – Integrity Constraints–Views–PL/SQL.

| Unit:2 | NoSQL | 18 hours |
|---|---|---|

Indexing and Hashing – Query Processing – Transaction Processing – Concurrency Control and Recovery - Advanced Database Concepts and Emerging Applications: Distributed Databases – Object Oriented Databases - Object Relational Databases- Data mining and Data Warehousing – Big Data - Big Databases- SQL–NoSQL Tradeoffs–CAP Theorem–Eventual Consistency - NoSQL–database types – Document Oriented – Columnar – Graph – KeyValue Pair - NoSQL database, design for performance / quality parameters, documents and information retrieval.

| | | |
|---|---|---|
| **Unit:3** | **MongoDB Introduction** | **18 hours** |
| MongoDB- Introduction - MongoDb – Need – MongoDBVs RDBMS – MongoDB- Driver Installation – Configuration – Import and Export – MongoDB Server Configuration - Data Extraction Fundamentals - Intro to Tabular Formats - Parsing CSV -Parsing XLS with XLRD- Parsing XML - Intro to JSON - Getting Data into MongoDB - MongoDB- CURD – Database Creation – Update – Read – Delete. | | |
| | | |
| **Unit:4** | **MongoDB Operators** | **18 hours** |
| Using mongoimport -Operators like $gt, $lt, $exists, $regex -Querying Arrays and using $in and $all Operators -Changing entries: $update, $set, $unset - Data Analysis - Field Queries -Projection Queries- Limiting – Sorting - Aggregation - Examples of Aggregation Framework -The Aggregation Pipeline - Aggregation Operators: $match, $project, $unwind, $group. | | |
| | | |
| **Unit:5** | **Advanced MongoDB** | **18 hours** |
| User Management – MongoDb Data Replication in Servers – Data Sharding – MongoDB Indexes – Create – Find – Drop – Backup – MongoDB – Relationships – Analyzing Queries – MongoDBObjectid – Advanced MongoDB:MapReduce – MongoDB - Text Processing - Regular Expression – Case Studies – Text processing of large datasets, Map Reduce using MongoDB | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Data Security – Performance – Data Safety – Resource Utility – High Availability.<br><br>Expert lectures, online seminars – webinars | | |
| | | |
| | **Total Lecture hours** | **92-- hours** |

| **Text Book(s)** | |
|---|---|
| 1 | Abraham Silberchatz, Henry K.Forth, Sudharshan, **"Database system Concepts"**, 7th edition, McGraw Hill, 2020. |
| 2 | Prabu C.S.R, **"Object-Oriented Database Systems: Approaches and Architectures"** 3rd Edition, PHI, 2011. |
| 3 | Kristina Chodorow , **"MongoDB: The Definitive Guide"**, 3rd Edition , O'Reilly Media, ISBN: 9781491954461, 2019. |
| 4 | Guy Harrison, **"Next Generation Databases: NoSQL, NewSQL, and Big Data"**, Apress, 2016. |
| **Reference Books : EBooks** | |
| 1 | ShamkantB.Navathe, RamezElamsri**"Fundamentals of Database Systems"**, 7th Edition, Pearson Education Limited, 2017. |
| 2 | David Hows , Peter Membrey , EelcoPlugge , Timm Hawkins , **"The Definitive Guide to MongoDB"**, 3rd Edition, Apress, 2015. |

| | |
|---|---|
| 3 | GauravVaish ,**"Getting Started with NoSQL"**Packt Publishing, 2013. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | Course Title | Duration | Provider |
|---|---|---|---|
| 1. | Database Management System | 12 Weeks | Swayam |
| 2. | Database Management System | 8 Weeks | NPTEL |
| 3. | NoSQL Systems | 4 Weeks | Coursera |
| 4. | Introduction to MongoDB | 3 Weeks | Coursera |
| **Web link** | | | |
| 1. | https://www.w3schools.in/dbms/ | | |
| 2. | https://www.guru99.com/nosql-tutorial.html | | |
| 3. | https://www.tutorialspoint.com/mongodb/index.htm | | |

Course Designed by: **Dr.S.Gavaskar**

**Mapping with Programme Outcomes**

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

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

| Course code | 21CSEGC06 | MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 4 | 0 | 4 |
| Pre-requisite | | Basic Mathematics | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand linear programming methods.
2. To understand Dynamic programming approach.
3. To understand concepts basics concepts of Linear Algebra
4. To understand concepts of vector spaces and matrices
5. To understand the applications of Linear Algebra in Machine Learning

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Solve linear programming techniques to optimization problems arising in all Computer fields | K3 |
| 2 | Use Dynamic programming approach to real time problems. | K3 |
| 3 | Understand the basics of Linear Programming constructs | K2 |
| 4 | Apply vector spaces and their applications in Machine Learning | K3 |
| 5 | Understand the concepts of matrix, Gaussian Elimination and differential equations and Apply the concepts of Linear Algebra in Machine Learning Algorithms | K2, K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Linear Programming Problem | 12 hours |
|---|---|---|

Introduction to Operations Research: Basics definition - scope – objectives - phases - models - limitations of Operations Research - Linear Programming Problem - Formulation of LPP - Graphical solution of LPP - Simplex Method - Artificial variables - Big-M method - Two-phase method - Degeneracy - Unbound solutions – Duality in Linear Programming Problems – Dual Simplex - Introduction to optimization - gradient descent method - convex optimization.

| Unit:2 | Dynamic Programming | 12 hours |
|---|---|---|

Introduction - Characteristics of dynamic programming – Dynamic programming approach for Priority Management employment smoothening – capital budgeting – Stage Coach/Shortest Path – cargo loading and Reliability problems.

| Unit:3 | Geometry Linear Equations and Vector Spaces | 12 hours |
|---|---|---|

The Geometry of Linear Equations - An Example of Gaussian Elimination- Matrix Notation and Matrix Multiplication - Triangular Factors and Row Exchanges- Inverses and Transposes.
Vector Spaces and Subspaces – Solving Ax=0 and Ax=b - Linear Independence, Basis and Dimension- The Four Fundamental Subspaces- Graphs and Networks- Linear Transformations.

| **Unit:4** | **Determinants, Eigenvalues and Eigenvectors** | **12 hours** |
|---|---|---|

Determinants: Introduction- Properties of the Determinant- Formulas for the Determinant – Applications of Determinants. Eigenvalues and Eigenvectors: Introduction- Diagonalization of a Matrix .- Difference Equations and Powers A k- Differential Equations and e At - Complex Matrices- Similarity Transformations – A - Applications of Machine Learning – Use cases.

| **Unit:5** | **Positive Definite Matrices** | **12 hours** |
|---|---|---|

Minima, Maxima, and Saddle Points - Tests for Positive Definiteness - Singular Value Decomposition – Machine Learning Applications – Use cases.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Use Linear and Dynamic programming approach to real time problems. Apply the concepts of Linear Algebra in Machine Learning Algorithms

Expert lectures, online seminars – webinars

| | **Total Lecture hours** | **62 hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | J K Sharma, **"Operations Research Theory &Applications"** 6th Edition, Laxmi Publications, 2017. |
| 2 | Gilbert Strang, Linear Algebra and Its Application, 5th Edition, Wellesley Cambridge Press, ISBN: 9780980232776, 2017. |

**Reference Books : EBooks**

| | |
|---|---|
| 1 | P. K. Gupta and D. S. Hira, **"Operations Research"**, S. Chand & co., 2017 |
| 2 | David C. Lay, Steven R. Lay, Judi J. McDonald, **"Linear Algebra and Its Applications"** 5th Edition, Pearson Education, 2016. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | **Course Title** | **Duration** | **Provider** |
|---|---|---|---|
| 1. | Operations Research | 15 Weeks | Swayam |
| 2. | Linear Algebra | 12 Weeks | Swayam |
| **Web link** | | | |
| 1. https://stemez.com/subjects/science/1HOperationsReseach/1HOperationsReseach.php | | | |
| 2. https://www.khanacademy.org/math/linear-algebra | | | |
| Course Designed by: Mr. Moorthy , Dr. T. Devi | | | |

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | M | S | M | M | M | S | S | M | S |
| **CO2** | S | S | S | S | M | M | S | S | M | S |
| **CO3** | M | M | M | S | S | M | M | S | L | S |
| **CO4** | S | M | S | S | S | M | S | S | L | S |
| **CO5** | M | M | M | S | S | M | M | S | L | S |

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

| Course code | 21CSEGC07 | DATA ANALYTICS With R | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Knowledge on Data, Statistical Methods for Analysis | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

1. To understand the basics constructs of R Programming Constructs and Visualization.
2. To understand and apply Exploring variables using Visualization.
3. To understand and apply Exploratory Data Analytics using Data Visualization
4. To understand and apply Inferential Statistics and Regression Models.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the basic programming structure of R– Data frame, Matrix, List, Packages and Functions | K1, K2 |
| 2 | Understand various visualization models and gather insights and inference of the datasets | K2<br>K3 |
| 3 | Apply statistical functions, Central tendency measure, Range, Variance, Standard Deviation to perform Diagnostic Analytics | K2, K3 |
| 4 | Understand data distribution of data and perform Regression and Annova to predict the insights | K3,K4 |
| 5 | Evaluate data set and perform EDA and Inferential Analytics to gather insights and design Models | K5 ,K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | R Basics | 18-- hours |
|---|---|---|

Introduction:What is R–Downloading and Installing R–. **Getting Data into R:** First Step in R:Typing in Small Datasets – Concatenating Data with c Function – Combining Variables with the c, cbind, rbind Functions - Vector Function –Matrix - Ddata frame – List - Importing Excel Data – Accessing Data from other Statistical Packages – Accessing the Database. Functions - The Attach Function – Exporting Data - The Tapply Function – The Supply and Lapply Function – The Summary and Table Function. Importing Data – Csv, Excel, Table, Xml, Json , Databases Conditional – Control flow – Loops– A Function with Multiple Arguments -

| Unit:2 | Exploratory Data Analytics : Visualization Packages | 18-- hours |
|---|---|---|

Cleaning Data : – Exploring raw data –Missing values - Zeros and NAs – Separating – Uniting Columns - String Manipulation – Filling Missing values – Packages – R Visualization Packages – Lattice – ggplot2 –Plotly , seaborn- understanding plots – aesthetics - - statistical function - Histogram – Box Plot – Density Plot – Scatter Plots The Plot Function –Adding a Smoothing Line The Pie Chart – The Bar and Strip Chart – Box Plot – Cleveland Dotplots- Reporting– Data Preparation – Embedding R chunks – Labelling and reusing code chunks – Report Compiling – Configuring – R Packages – shiny –Flex - ggvis -

| | | |
|---|---|---|
| **Unit:3** | **Visualization: Univariate and Multivariate Analysis** | **18-- hours** |
| Variable Analysis – One variable – Understanding outliers through – histogram , boxplot, density plot – dataset – pseudo dataset of facebook Exploring two variables – Understanding Variables and relationships – scatter plots – correlations – condition means – Explore multivariate variables – Visualization of variables using aesthetics in R – Case study – Explore Diamond dataset for prize prediction | | |
| | | |
| **Unit:4** | **Categorical and Numerical Data Insights & Inferences** | **18-- hours** |
| Data types – Categorical – Binary – ordinal – Nominal – Continuous – Discrete – Data Dimensions – Univariate – bivariate – multivariate – Numerical Measures – Central Tendency – Mean – Median – Mode - Understanding data using central tendency – plotting histogram – density plots and inference of plot - Variability Measure – Variance - Range - IQC - and Standard Deviation – Sum of squares – Squared Deviations – Absolute Deviations - Identify outlier using Inter Quartile Range – Visualization using boxplot | | |
| | | |
| **Unit:5** | **Data Distribution and Error** | **18-- hours** |
| Data standardizing – Z Score – Negative Z Score – Continuous Distributions - Compute proportions – Relative Frequency histogram - Normalized Distribution using - Ztable – Probability Distributions - Probability of mean – location of mean distribution - Sampling Distributions — Klout Sampling Distribution – Understanding Shape of Distribution – Standard Error - Standard Deviation of sampling distribution – Ratio of Sampling Distribution - Central Limit Theorem R – Mean of sample means Advanced Analytics Regression Analysis – Simple Regression Analysis - – Logistic Regression – Multiple Regression ANNOVA Model – Parametric test - Non Parametric Test | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Analyze Global Datasets to understand Issues on Climate Change, Epidemic and Pandemic Outburst | | |
| | | |
| | **Total Lecture hours** | **92-- hours** |

| Text Book(s) | |
|---|---|
| 1 | V. Bhuvaneswari, "**Data Analytics with R – Step by Step**", SciTech Publications, 2016. |
| 2 | Roger D. Peng, "**R Programming for Data Science**" Lean Publishing, 2014 |
| 3 | Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters,"**A Beginner's Guide to R**" Springer, 2009 |
| 4 | Hadley Wickham, *"***R for Data Science: Import, Tidy, Transform, Visualize, and Model Data",** First Edition, O'Reilly Media Publisher, ISBN: 9781491910399, 2017 |
| **Reference Books:** | |
| 1 | Brett Lantz, **"Machine Learning with R", Third Edition,** ISBN: 9781788295864, 2019, [Packt] |
| 2 | Kaelen Medeiros, "**R Programming Fundamentals**", ISBN: 9781789612998, 2018, [Packt] |
| 3 | VitorBinanchiLanzetta, "**Hands-On Data Science with R**", ISBN: 9781789139402, 2018, [Packt] |
| 4 | Omar Trejo Navarro, "**R Programming by Example**", ISBN: 9781788292542, 2017, [Packt] |
| 5 | Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Second Edition, Pearson Education Publisher, ISBN: 9789386873521, 2018 |
| 6 | VigneshPrajapati, **"Big Data Analytics with R and Hadoop",** First Edition, PACKT Publishing Limited , ISBN: 9781782163282, 2013 |
| 7 | Nina Zumel, **"Practical Data Science with R",** Dreamtech Press Publisher, ISBN: 9789351194378, 2014 |
| 8 | Hadley Wickham, **"Advanced R"**, Second Edition, CRC Publisher, ISBN: 978-0815384571, 2019 |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |

| S. No | Course Title | Duration | Provider -Free |
|---|---|---|---|
| 1. | R Programming | 4 Weeks | Coursera |
| 2. | Data Analysis with R | 8 Weeks | Udacity |
| 3. | Introduction to Data Analytics | 9 Weeks | Swayam |
| 4. | Introduction to R Software | 9 Weeks | Swayam |
| 5. | Data Science Certification Training – R Programming | 14 hours | Simlilearn |

**Web Link:**

1. https://www.datacamp.com/tracks/r-programming
2. https://www.tutorialspoint.com/r/index.htm
3. https://www.datamentor.io/r-programming/

Course Designed by: **Dr.V.Bhuvaneswari**

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | S | S | L | L | L | L | L | L | L |
| **CO2** | S | S | S | S | S | S | S | M | M | S |
| **CO3** | S | M | M | S | S | S | L | L | L | L |
| **CO4** | S | S | S | S | M | M | L | L | L | L |
| **CO5** | S | S | S | S | S | S | S | S | S | S |

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

| Course Code | 21CSEGC08 | DATA VISUALIZATION | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Knowledge on Data, Graphs and plots | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand how accurately represent voluminous complex data set in web and from other data sources.
2. To understand the methodologies used to visualize large data sets
3. To know how to work with visualization tools.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the concepts of visualization | K2 |
| 2 | Understand the methods for visualizing data in D3j, c3j, and Tableau | K1, K2 |
| 3 | Apply Visualization methods for different data domains | K4 |
| 4 | Design Interactive Charts based on Data | K3 |
| 5 | Distinguish and Suggest the appropriate data visualization tools for domain specific applications and Design an Interactive data visualization story board for data | K4, K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to Data Visualization | 18 hours |
|---|---|---|

Definition – Methodology – Seven Stages of Data Visualization - Data Visualization Tools. Visualizing Data: Mapping Data onto Aesthetics – Visualizing Amounts - Visualizing Distributions: Histograms and Density Plots – Visualizing Propositions: – Visualizing Associations: Among Two or More Quantitative Variables – Visualizing Time Series and Other Functions of an Independent Variable – Trends – Visualizing Geospatial Data.

| Unit:2 | Interactive Data Visualization | 18 hours |
|---|---|---|

Introduction to D3 - Fundamental Technology: The Web – HTML – DOM – CSS – JavaScript – SVG. D3 Setup – Generating Page Elements – Binding Data - Drawing with data – Scales: Domains and Ranges – Normalization – Creating a Scale – Scaling the Scatter Plot – Other Methods and Other Scales. Axes – Modernizing the Chart – Update the Data – Transition – Updates – Interactivity.

| Unit:3 | D3 Based Reusable Chart Library | 18 hours |
|---|---|---|

Setup and Deployment – Generate Chart – Customize Chart: Additional Axis – Show Axis Label –

| | | |
|---|---|---|
| Change Chart Type – Format Values – Size – Color – Padding –Tooltip. Use APIs: Load and Unload – Show and Hide – Focus – Transform – Groups – Grid – Regions – Flow – Revert – Toggle –Legend – Sub chart – Zoom – Resize. Customize Style. Building Real time and Live Updating animated graphs with C3. | | |
| | | |
| **Unit:4** | **Tableau Introduction** | **18 hours** |
| Environment Setup – Navigation – File & Data Types. TA SOURCE: Custom Data View – Extracting Data – Fields Operations – Editing Meta Data – Data Joining – Data Blending. Worksheets. | | |
| | | |
| **Unit:5** | **Basic and Advanced Charts in Tableau** | **18 hours** |
| Bar Chart – Line Chart – Pie Chart – Scatter Plot – Bubble Chart –Gantt Chart – Histograms - Waterfall Charts. Dashboard – Formatting – Forecasting – Trend Lines. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Apply Visualization methods for different domains. Design an Interactive data visualization story board for real time data<br><br>Expert lectures, online seminars - webinars | | |
| | | |
| | **Total Lecture hours** | **92 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1 | Ben Fry, **"Visualizing Data: Exploring and Explaining Data with the Processing Environment"**, O'Reilly, 1st Edition, 2008. |
| 2 | Scott Murray, **"Interactive data visualization for the web: An Introduction to Designing with D3"**, O'Reilly, 2nd Edition, 2017. |
| 3 | Joshua N. Milligan, "**Learning Tableau 2019: Tools for Business Intelligence, data prep, and visual analytics",** Packt Publishing Limited, 2019. |
| 4 | Claus O. Wilke, **"Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures"**, O.Reilly, 2019. |
| **Reference Books : EBooks** | |
| 1 | Ritchie S. King, **"Visual Storytelling with D3: An Introduction to Data Visualization in JavaScript"**, Addison-wesley Data and Analytics, 2014. |
| 2 | Elijah Meeks, **"D3.js in Action: Data visualization with JavaScript"**, Second Edition, Manning Publications, 2017. |
| 3 | Lindy Ryan, **"Visual Data Storytelling with Tableau"**, 1st Edition, Pearson, 2018. |

| | Course Title | Duration | Provider |
|---|---|---|---|
| 1. | Fundamentals of Visualization with Tableau | 4 Weeks | Coursera |
| **Web link** | | | |

1. https://c3js.org/gettingstarted.html
2. https://www.tutorialspoint.com/tableau/index.htm
3. https://www.dashingd3js.com/table-of-contents
4. https://www.udacity.com-Data Visualization and D3.J

Course Designed by: Dr. S. Gavaskar

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

**Mapping with Programme Outcomes**

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

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

| Course code | 20CSEGC09 | VIRTUALIZATION AND CLOUD | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 4 | 0 | 4 |
| Pre-requisite | | Basic knowledge of data storage, Client – Server systems | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are:

1. To impart knowledge on the concepts of distributed systems, cloud computing and AWS
2. To gain knowledge over various virtualization and virtual machines
3. To gain understanding about the data centers

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | To learn the fundamentals of distributed systems | K2 |
| CO2 | To understand and use the cloud services and AWS | K3 |
| CO3 | To understand and perform virtualization | K3, K6 |
| CO4 | To create, configure and manage virtual machines | K4 |
| CO5 | To learn about data center | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Distributed Systems | 12 hours |
|---|---|---|

Introduction to distributed systems - Distributed algorithm - Distributed Data Stores - Distributed Computing - File Systems - Distributed Messaging - Distributed Applications – Distributed Transaction - Parallel and distributed computing - Applications.

| Unit:2 | Cloud Computing | 12 hours |
|---|---|---|

Cloud Concepts: Introduction Cloud Computing - Advantages of Cloud - Public Cloud - five essential characteristics - three service models - Four deployment models - Benefits of Cloud Computing - Cloud Vendors - Traditional Infrastructure setup and Challenges – AWS.

| Unit:3 | Virtualization | 12 hours |
|---|---|---|

Virtualization: Introduction to vSphere and the Software - Defined Data Center - Creating Virtual Machines - VCenter Server - Configuring and Managing - Virtual Networks - Configuring and Managing Virtual Storage - Virtual Machine Management - Resource Management and Monitoring.

| Unit:4 | Virtual Machines | 12 hours |
|---|---|---|

Virtual Machines: vSphere HA - vSphere Fault Tolerance - Protecting Data vSphere DRS - Network Scalability - vSphere Update Manager and Host Maintenance - Storage Scalability - Securing Virtual Machines.

| | | |
|---|---|---|
| **Unit:5** | **Data centre** | **12 hours** |
| Data centre: Data centre overview -Components - Provisions - Need of Data Centre - Data Centre Architecture - Different Racks - Data center architecture for cloud computing - role of data centre in cloud computing. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars – webinars | | |
| | | |
| | **Total Lecture hours** | **62 hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | George Coulouris, Jean Dollimore, Tim Kindberg, Gordan Blair, "Distributed Systems Concepts and Design", 5th Edition, Pearson Education, 2012. |
| 2 | VenkataJosyula , Malcolm Orr , Greg Page, "Cloud Computing: Automating the Virtualized Data Center", 1st Edition, Cisco Press, 2011. |
| 3 | Brian J.S. Chee, Curtis Franklin Jr., "Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center", 1st Edition, CRC Press, 2010. |

**Reference Books**

| | |
|---|---|
| 1 | Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems: Principles and Paradigms", 2nd edition, Createspace Independent Publishers, 2016. |
| 2 | Matthew Portnoy, "Virtualization Essentials", 2nd edition, Wiley Publication, 2016. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | Cloud Computing and Distributed Systems, https://nptel.ac.in/courses/106/104/106104182/ |

Course Designed By: **Dr. T. Amudha**

Mapping with Programme Outcomes

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

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

| Course code | 21CSEGC10 | BIG DATA FRAMEWORKS AND TOOLS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Basics of Programming | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

1. To understand MapReduce programming architecture, processing models.
2. To understand and design MapReduce Programming using PIG and Hive
3. To understand and compare the architectural and processing of MapReduce Programming languages Pig, Hive and SPARK

**Expected Course Outcomes:**

| | | |
|---|---|---|
| 1 | Understand distributed, MapReduce Processing architectures | K2 |
| 2 | Configure and setup MapReduce Processing architectures Ecosystem – Hadoop, Spark , Pig and Hive | K1, K2 |
| 3 | Understand and write MapReduce program using Pig and Hive, SPARK | K3 |
| 4 | Critically Analyze dataset using Pig , Hive and SPARK and suggest MapReduce Programming models based on domains specific applications | K3 |
| 5 | Design and setup a Big Data Analytics Ecosystem for specific Business scenarios. | K4 , K5, K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Big Data Framework | 18-- hours |
|---|---|---|

Introduction to Big Data – Distributed file system –,Hadoop Storage [HDFS], Common Hadoop Shell commands - Anatomy of File Write and Read, NameNode, Secondary NameNode, and DataNode - Map Reduce Architecture -Hadoop Configuration: Environment : Steps – Hadoop 1.0 Version VsHadoop 2.0 YARN – Setting up Hadoop Eco System – Oozie – FLUME- STORM – FLUME - Pig Configuration – Hive Configuration - SPARK Configuration – Integration – Hadoop with R – Hadoop with Python

| Unit:2 | PIG : MapReduce | 18-- hours |
|---|---|---|

Pig Introduction: Overview of Pig - Pig Architecture - Pig Execution modes, Pig Grunt shell and Shell - commands. Pig Latin Basis: Data model, Data Types, Operator - Pig Latin Commands - Load & Store, Diagnostic Operators, Grouping, Cogroup, Joining, Filtering, Sorting, Splitting - Built-In Functions, User define functions.- Pig Execution Modes – Batch Mode – Embedded Mode – Pig Execution in Batch Mode – Embedding Pig in Python – Use cases - Map Reduce programs with Pig – Pig Vs SQL

| Unit:3 | Hive: Map Reduce - CURD | 18-- hours |
|---|---|---|

Introduction of Hive - Hive Features - Hive architecture -Hive Meta store - Hive data types – Hive Tables - Table types - Creating database , Altering database, Create table, alter table, Drop table, - Built-In Functions - Built-In Operators, User defined functions –

| Unit:4 | Hive: Aggregation and Indexing | 18-- hours |
|---|---|---|

Hive QL–Introduction to Hive QL, Hive QL Select, Hive QL – MapReduce using Hive QL OrderBy,

| | | |
|---|---|---|
| Group By Joins, LIMIT, Distribute By , Cluster By - Sorting And Aggregation – Partitioning – Static – Dynamic – Index Creation - Bucketing – Analysis of MapReduce execution – Hive Optimization – Setting Hiving Parameters. – Use case :MapReduce using Hive QL – Hive QLVs SQL | | |
| | | |
| **Unit:5** | **SPARK Query** | **18-- hours** |
| SPARK – MapReduce - RDD Transformations – SPARK Operations – Usecase with SPARK and Comparison - MapReduce – Python – R – Pig – Spark – Hadoop - Limitations – Advantage – SPARK vs Hadoop – SPARK Vs Pig and Hive – MapReduce- Spark Transformations | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Data Processing Architectures Issues – Scalability - Case Study on Industrial Reports | | |
| | **Total Lecture hours** | **92-- hours** |

**Text Book(s):**

| | |
|---|---|
| 1 | Boris Lublinsky Kevin T. Smith Alexey Yakubovich, Professional Hadoop® Solutions, Wiley, ISBN: 9788126551071, 2015. |
| 2 | Chris Eaton, Dirk deroos et al., "**Understanding Big data**", McGraw Hill, 2012. |
| 3 | Tom White, "**Hadoop: The Definitive Guide**", O'Reilly Media 3rd Edition,May 6, 2012 |
| 4 | Donald Miner, Adam Shook, "**MapReduce Design Patterns**", O'Reilly Media November 22, 2012 |
| 5 | Edward Capriolo,DeanWampler, Jason Rutherglen, "**Programming Hive**", O'Reilly Media; 1 edition , October, 2012 |
| 6 | Deepak Vohra, "Practical Hadoop Ecosystem: A Definitive Guide to Hadoop-Related Frameworks and Tools" First Edition, Apress Publisher, ISBN: 9781484221983, 2016 |
| 7 | Alan Gates, "**Programming Pig**", O'Reilly Media; 1st Edition,October, 2011 |

**Reference Books:**

| | |
|---|---|
| **1** | Sridhar Alla**, "Big Data Analytics with Hadoop 3",** First Edition, ISBN: 978-1-78862-884-6, 2018, [Packt] |
| 2 | Naresh Kumar, **"Modern Big Data Processing with Hadoop",** ISBN: 9781787122765, 2018, [Packt] |
| 3 | NeerajMalhotra, **"Data Engineering Skills - Hadoop Shell: A Comprehensive Guide to Hadoop FS Commands",** First Edition, CreateSpace Independent Publishing, ISBN: 9781717577511, 2018 |
| 4 | VigneshPrajapati, **"Big Data Analytics with R and Hadoop",** First Edition, ISBN: 978-1-78216-328-2, 2013, [Packt] |
| 5 | Edward Capriolo, "**Programming Hive: Data Warehouse and Query Language for Hadoop",** First Edition, O'Reilly MediaPublisher, ISBN**:** 9781449319335, 2012 |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| S. No | Course Title | Duration | Provider - Free |
|---|---|---|---|
| 1. | Big Data Hadoop and Spark Developer – R Programming | 26 hours | Simplilearn |

| | | | |
|---|---|---|---|
| 2. | Intro to Hadoop and MapReduce | 4 Weeks | Udacity |
| 3. | Hadoop Platform and Application Framework | 5 Weeks | Coursera |
| 4. | Big Data Essentials: HDFS, MapReduce and Spark RDD | 6 Weeks | Coursera |
| 5. | Mining Massive Datasets | 7 Weeks | edX |

**Web Link – Video**

1. http://hadooptutorial.info/mapreduce-programming-model/
2. https://hadoop.apache.org/docs/r1.2.1/mapred_tutorial.html
3. https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html
4. https://www.edureka.co/blog/mapreduce-tutorial/

Course Designed By: Dr.V.Bhuvaneswari

Mapping with Programme Outcomes

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

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

| Course code | 21CSEGC11 | MACHINE LEARNING | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Basics on Statistics and Linear Algebra | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

1. To understand the Concepts of Machine learning algorithms of different probabilistic, rE
2. To apply the machine learning algorithms for various applications.

**Expected Course Outcomes:**

| | | |
|---|---|---|
| CO1 | Understand the concepts of machine learning | K1 |
| CO2 | Understand the theoretical concepts of probabilistic and linear methods | K2 |
| CO3 | Understand and distinguish Supervised, Unsupervised and semi supervised learning | K2 |
| CO4 | Apply Supervised, Unsupervised and semi supervised algorithms for a specific problem | K4 |
| CO5 | Design a Machine Learning models to predict in domain specific applications | K4, K3 ,K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

| Unit:1 | Unsupervised Models | 18-- hours |
|---|---|---|

Introduction : Machine Learning - Machine Learning Foundations –Overview – applications - Types of machine learning - basic concepts in machine learning Examples of Machine Learning - Applications - -Unsupervised Learning Clustering- K-means - EM - Mixtures of Gaussians - The EM Algorithm in General -Model selection for latent variable models - high-dimensional spaces -- The Curse of Dimensionality -Dimensionality Reduction - Factor analysis - Principal Component Analysis - Probabilistic PCA- Independent components analysis

| Unit:2 | Linear Models | 18-- hours |
|---|---|---|

Supervised Learning Linear Models for Regression - Linear Basis Function Models - The Bias-Variance Decomposition - Bayesian Linear Regression - Bayesian Model Comparison Linear Models for Classification - Discriminant Functions -Probabilistic Generative Models - Probabilistic Discriminative Models - Bayesian Logistic Regression. Decision Trees - Classification Trees- Regression Trees - Pruning. Support Vector Machines - Ensemble methods- Bagging- Boosting – Evaluation Methods

| Unit:3 | Graphical Models | 18-- hours |
|---|---|---|

Probabilistic Graphical Models Directed Graphical Models - Bayesian Networks - Exploiting Independence Properties - From Distributions to Graphs -Examples -Markov Random Fields - Inference in Graphical Models - Learning –Naive Bayes classifiers-Markov Models – Hidden Markov Models – decoding states from observations, learning HMM parameters-Inference – Learning Generalization – Undirected graphical models- Markov random fields- Conditional independence properties - Parameterization of MRFs - Examples - Learning - Conditional random fields (CRFs) - Structural SVMs

| Unit:4 | Advanced Models | 18-- hours |
|---|---|---|

Advanced Learning Sampling – Basic sampling methods – Monte Carlo. Reinforcement Learning- K-Armed Bandit Elements - Model-Based Learning- Value Iteration- Policy Iteration. Temporal Difference Learning Exploration Strategies- Deterministic and Non-deterministic Rewards and Actions- Eligibility Traces - Generalization- Partially Observable States- The Setting- Example. Semi - Supervised Learning. Computational Learning Theory - Mistake bound analysis, sample complexity analysis,

| **Unit:5** | **Deep Learning Models** | **18-- hours** |
|---|---|---|

Neural Networks -Feed-forward Network Functions - Error Back propagation - Regularization - Mixture Density and Bayesian Neural Networks - Kernel Methods - Dual Representations - Radial Basis Function Networks – Sequence Models = Recurrent Net – Types – Word Disambiguation – Convolution Net – Basics – Applications

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Ethical Considerations in Machine Learning Applications – Ethics and Challenges of AI and ML as disruptive technology Use cases – Webinars

| | **Total Lecture hours** | **92-- hours** |
|---|---|---|

**Text Books:**

| | |
|---|---|
| 1 | Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2006 |
| 2 | Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012 |
| 3 | EthemAlpaydin, “Introduction to Machine Learning 3(Adaptive Computation and Machine Learning Series)”, Third Edition, MIT Press, 2014 |
| 4 | Tom M Mitchell, “Machine Learning”, First Edition, McGraw Hill Education, 2013. |

**Reference Books**

| | |
|---|---|
| 1 | JannesKlaas, “Machine Learning for Finance”, ISBN: 978178936364, 2019 [Packt] |
| 2 | Giuseppe Bonaccorso, “Machine Learning Algorithms”, Second Edition, ISBN: 9781789347999, 2018 [Packt] |
| 3 | Stephen Marsland, “Machine Learning –An Algorithmic Perspective”, CRC Press, 2009 |
| 4 | Hastie, Tibshirani, Friedman, “The Elements of Statistical Learning”, Second Edition, Springer, 2008 |
| 5 | Yuxi Liu, “Python Machine Learning By Example”, 2017 [Packt] |
| 6 | John Paul Mueller, Luca Massaron, “Machine Learning (in Python and R) For Dummies”, First Edition, Wiley Publisher, ISBN: 9788126563050, 2016 |
| 7 | U Dinesh Kumar ManaranjanPradhan,,“Machine Learning using Python”. ) Publisher: Wiley, ISBN: 9788126579907, 2019 |

**Online Course:**

| **S. No** | **Course Title** | **Duration** | **Provider -Free** |
|---|---|---|---|
| 1. | Machine Learning | 12 hours | Simplilearn |
| 2. | Machine Learning for Data Analysis | 4 Weeks | Coursera |
| 3. | Machine Learning Foundations: A Case Study Approach | 6 Weeks | Coursera |

| | | | |
|---|---|---|---|
| 4. | Machine Learning : Regression | 6 Weeks | Coursera |
| 5. | Introduction to Machine Learning | 12 Weeks | Swayam - NPTEL |
| 6 | Deep Learning Specialization | 4 Courses | Coursera |

**Web Link - Video:**

1. https://www.packtpub.com/data/hands-on-machine-learning-with-scikit-learn-and-tensorflow-2-0-video
2. https://www.packtpub.com/data/machine-learning-projects-with-tensorflow-2-0-video
3.https://www.packtpub.com/application-development/complete-machine-learning-course-python-video

Mapping with Programme Outcomes

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

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

| Course code | 21CSEGC12 | SOFT SKILLS - II | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 2 | 2 | 4 |
| Pre-requisite | | Soft Skills - I | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the basics of verbal and non-verbal reasoning, technical programming skills using C++
2. To acquired knowledge of using soft skills and the interview-based topics in DBMS and Computer Networks.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the basics of Verbal and Non Verbal reasoning. | K2 |
| 2 | Develop logical skills, analytical skills and apply in software applications | K2 |
| 3 | Widen the Technical programming skills | K3 |
| 4 | Improve personal and inter personal skills | K3 |
| 5 | Understand the basics of Database Management, Operating System and Networking. | K1/K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Verbal Reasoning | 18 hours |
|---|---|---|

General Mental Ability-Coding-Decoding-Blood Relation-Logical Venn Diagram- Mathematical Operations - Arithmetical Reasoning - Truth statement.

| Unit:2 | Non-Verbal Reasoning | 18 hours |
|---|---|---|

Series-Choosing the Missing Figure in a Series-Detecting the Incorrect Order-Detecting the Wrong Figure-Analytical Reasoning-Rule Detection Construction of Boxes-Figure Formation and Analysis -Formation of a Figure from Parts Formation of a Figure Fragmentation-Identical Figure-Pattern Rearrangement

| Unit:3 | Technical Skills | 18 hours |
|---|---|---|

Concepts of OOPS-Object and Classes - Inheritance – Polymorphism – Data Hiding– Virtual Function - Operator Overloading – Function Overloading

| Unit:4 | Interpersonal Skills | 18 hours |
|---|---|---|

Interviews, Group Discussions, Presentation Skills, Conversation: Effective Presentation Strategies Planning-Nuances of Delivery- Controlling Nervousness and Stage Fright-Visual Aids in Presentations- Job Interviews-Media Interviews- Communication-Group Discussions-GD as

Part of a Selection Process.

| Unit:5 | Theoretical Concepts – DBMS | 18 hours |
|---|---|---|

Keys-Normalization-RDBMS-Concurrency Control Software Engineering: Models-Design Strategies – Testing-Operating System – Process-Memory Management – Paging-Dead Lock-Virtual Memory- Computer Networks – OSI-TCP/IP-Communication Modes-N/W Devices

| Unit:6 | Contemporary Issues | 2 hours |
|---|---|---|

Write an assignment on any one of the following:

1. Patent Drafting and Intellectual Property Rights (IPR)

2. Plagiarism Checking Tools

3. A project proposal in any one of your interested domain area

| | Total Lecture hours | 92 hours |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | Dr. R. S. Aggarwal and S. Chand ”A Modern Approach to Verbal & Non-Verbal Reasoning” Revised Edition |
| 2 | Dr. Balagurusamy,” Object Oriented Programming with C++” Tata McGraw-Hill Edition, 2017 |
| 3 | Ramez Elmasri, Shamkant B. Navathe, “FUNDAMENTALS OF DATABASE SYSTEMS. Edition enanglais, 2nd edition ”, Benjamin/Cummings, 1994 |

**Reference Books**

| | |
|---|---|
| 1 | Dr. Balagurusamy, “Programming in C”, Tata McGraw – Hill Edition, 2017 |
| 2 | Raman Sharma, “Technical Communication-Principles and Practices”, Second Edition |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | www.coursera.com |
| 2 | www.udemy.com[Inter personal Skills] |

Web Links

1. https://www.oreilly.com/library/view/web-database-applications/0596005431/ch01.html
2. https://openlibrary.org/

Course Designed By: Dr. M. Punithavalli

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | M | S | L | M | S | M | L | S | L |
| **CO2** | S | M | S | L | M | S | M | L | S | L |
| **CO3** | S | S | L | L | L | S | S | - | M | L |
| **CO4** | L | L | M | L | L | S | M | S | S | L |
| CO5 | M | M | L | L | L | S | S | L | M | L |

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

| Course code | 21CSEGE01 | PYTHON PROGRAMMING | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 2 | 2 | 4 |
| Pre-requisite | | Principles of Programming | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

1. To understand the basics of Python Data structures and Programming constructs
2. To understand and Apply Python Libraries for Data Science and Machine Learning
3. To understand and apply Exploratory Data Analytics using Data Visualization

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the basic programming structure-List, Dictionary, Tuple, String | K1,K2 |
| 2 | Understand the Control structures and object oriented concepts | K1,K2 |
| 3 | Design and Analyze dataset applying statistical models, visualization and models using various tools | K3,K4 |
| 4 | Understand the visualization methods , packages, statistical packages and other packages for building data models | K3,K4, K6 |
| 5 | Design data analytic model using the packages in python and provide inferences for multi-disciplinary domains | K3,K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction | 18-- hours |
|---|---|---|

Introduction to Python: Python Introduction, History of Python, Python features , Python interpreter, Overview of programming in Python, Basic data types, Program input and Program output, Variables and assignment. Global and local variables. Python - Basic Operators: Arithmetic Operators, Comparison Operators, Logical (or Relational) Operators, Assignment Operators, Conditional (or ternary) Operators. Modules: Importing module, Math module Random module, Packages, Composition.

| Unit:2 | Advanced Data Types | 18-- hours |
|---|---|---|

Python Strings and string manipulation [Assigning values in strings, String manipulations, String special operators, String formatting operators, Triple Quotes, Raw String, Unicode String, Build-in-String methods], Python List : Introduction, Accessing values in list, List manipulations, List Operations, Indexing, slicing & matrices. Python Dictionary - Introduction, Accessing values, Properties, Functions in Dictionary. Python Tuples: Introduction, Operation, Accessing, Function and methods in tuples and Data Type Conversion. Python sets

| Unit:3 | Control Structures | 18-- hours |
|---|---|---|

Conditional Statement: Branching (if, else-if, nested), Looping: while statement, for statements, Control Statements: break, continue and pass Statements. Python Exception Handling: Try, Catch,

Finally Functions : Defining a function , Calling a function ,Types of functions , Function Arguments Anonymous functions , Regular expressions : Match function, Search function ,Modifiers. Python OOPs: Class, Object, Inheritance and Constructor.

| **Unit:4** | **Python Libraries for Data Science** | **18-- hours** |
|---|---|---|

Reading and Writing CSV Files in Python using CSV Module, NumPy [Arrays and matrices]: N-dimensional data structure, Creating array, Indexing array, Reshaping, Vectorized operations, Pandas [Data Manipulation]: Create Data Frame, Combining Data Frames, Summarizing, Columns selection, Rows selection (basic) , Rows selection (filtering) , Sorting, Descriptive statistics, Rename values, Dealing with outliers. SciPy Introduction, Basic functions, Special functions(scipy. special), Integration(scipy. integrate), Optimization (scipy. optimize).Tensor Flow: Computation with Tensor Flow, Regression with Tesorflow

| **Unit:5** | **Python Libraries for NLP and Visualization** | **18-- hours** |
|---|---|---|

NLTK,: tokenizing, part-of-speech tagging, stemming, Sentence Segmentation, Methods for cleaning and normalizing text. Textblobn-grams, Parsing, Spelling correction. Visualization libraries : matplotlib, Seabon: Simple Line Plots, Simple Scatter Plots, Density and Contour Plots, Histograms, Customizing Colorbars, Subplots, Text and Annotation, Visualization with Seaborn

| **Unit:6** | **Contemporary Issues** | **2-- hours** |
|---|---|---|

Analyze Data to understand Global Issues on health care, pandemic situations etc..

| | **Total Lecture hours** | **92-- hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | Jake VanderPlas, “Python Data Science Handbook” O'Reilly, 1st Edition, 2017. |
| 2 | Andreas C. Muller & Sarah Guido “Introduction to Machine Learning with Python”, O'Reilly, 1 Edition, 2016. |
| 3 | Dr. Charles Russell Severance, Sue Blumenberg, Elliott Hauser, AimeeAndrion“Python for Everybody: Exploring Data in Python 3”,CreateSpace, 2016. |

**Reference Books**

| | |
|---|---|
| 1 | Wesley J. Chun , “Core Python Programming”, 2nd Edition,Pearson Education,2016. |
| 2 | Mark Summerfield ,“Programming in Python 3”, Pearson Education,2018. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | PYTHON - A to Z Full Course for Beginners, https://www.udemy.com/ |
| 2 | Python for Data Science, https://swayam.gov.in/ |
| 3 | Python for Data Science and Machine Learning Bootcamp, https://www.udemy.com/ |
| 4 | Introduction to Python Programming, https://www.udacity.com/ |

Course Designed By: Dr.J.Ramsingh , Dr.V.Bhuvaneswari

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | L | M | S | M | L | L | L | L | L | L |
| **CO2** | S | L | L | S | L | L | M | L | L | L |
| **CO3** | M | S | S | M | L | L | M | L | L | L |
| **CO4** | S | M | S | L | L | L | L | S | M | M |
| **CO5** | S | S | S | L | L | M | L | L | S | S |

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

| Course code | 21CSEGE02 | DATA MINING | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 4 | 0 | 4 |
| Pre-requisite | | Basics of Data, Data Structures and Algorithms | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the concepts of Data Warehouse architecture and apply for various domains.
2. To understand Data Mining techniques Cluster, Classification and Association Rule Mining.
3. To understand the concepts of Web mining, Text mining and Spatial mining.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand data mining tools and techniques for various domains | K2 |
| 2 | Apply various data mining, text mining and web mining algorithms for real time applications | K3 |
| 3 | Analyze unsupervised and supervised algorithms for real world applications | K4 |
| 4 | Illustrate the mining techniques like association, classification and clustering on datasets | K6 |
| 5 | Compare various approaches of data mining algorithms | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Data Warehousing | 12 hours |
|---|---|---|

Introduction - Definition - Multidimensional data model - OLAP operations - Warehouse schema - Data warehousing architecture - Warehouse Schema - Warehouse server - Meta data - OLAP Engine - Data warehouse backend process - Data Warehouse Technology - Warehousing Software - Cloud data warehousing - Other features. Data Warehousing Case Study: Government, Tourism and Industry

| Unit:2 | Data Mining | 12 hours |
|---|---|---|

Introduction – Data as a Subject - Definitions- KDD vs. Data mining- DM techniques-Current Trends in Data Mining. Association Rules: Concepts- Methods to discover Association rules- A priori algorithm – Partition algorithm- Pioneer search algorithm –Dynamic Item set Counting algorithm- FP-tree growth algorithm-Incremental algorithm-Border algorithm-Generalized association rule. Analysis of association rule using orange.

| Unit:3 | Clustering Techniques | 12 hours |
|---|---|---|

Data Attribute Types – Data Similarity and Dissimilarity - Clustering paradigms– Partition algorithm-K- Medeoid algorithms – CLARA- CLARANS –Hierarchical DBSCAN-BIRCH-

CURE-Categorical clustering algorithms-STIRR-ROCK-CACTUS-Other techniques: Implementation of Clustering techniques using orange tool.

| **Unit:4** | **Classification Techniques** | **12 hours** |
|---|---|---|

Introduction – Decision Trees: Tree Construction Principle – Attribute Selection measure – Tree Pruning - Decision Tree construction Algorithm – CART – ID3 - Rainforest - CLOUDS - BOAT, Pruning Technique – Model Evaluation –Cross Validation – Bootstrap – Holdout – Classifier Performance- Boosting – AdaBoost– Bagging

| **Unit:5** | **Web Mining** | **12 hours** |
|---|---|---|

Basic concepts – Web content mining – Web structure mining – Web usage mining – text mining – Text Preprocessing - Text clustering – Spatial mining – Spatial mining tasks – Spatial clustering – Spatial trends – Case Studies: Big Data, Internet of Things.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Write an assignment on any one of the following:

1. Feature Engineering
2. Aspects of data ethics in a changing world.

| | **Total Lecture hours** | **62 hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | Jiawei Han, MichelineKamber, "Data Mining Concepts and Techniques", Morgan Kaufmann Publishers, 2012 |
| 2 | Pieter Adriaans, DolfZantinge, "Data Mining", Addison Wesley, 2008. |
| 3 | Krzyszlof J Cios, WitoldPedrycz, "Data Mining: A Knowledge Discovery Approach", Springer, 2010. |

**Reference Books**

| | |
|---|---|
| 1 | Arun K Pujari, "Data Mining Techniques", Universities Press. 2012 |
| 2 | ArijayChaudhry, Dr. P .S Deshpande, "Multidimensional Data Analysis and Data Mining", Dreamtech press, 2009. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

1 www.coursera.com [Data Mining Specialization (6 courses) -University of Illinois]

| | | |
|---|---|---|
| I | Data Visualization | 4 Weeks |
| II | Text Retrieval and Search Engines | 6 Weeks |
| III | Text Mining and Analysis | 6 Weeks |
| IV | Pattern Discovery in Data Mining | 4 Weeks |
| V | Cluster Analysis in Data Mining | 4 Weeks |
| VI | Data Mining Project | 6 Weeks |

| | |
|---|---|
| 2 | www.edureka.com [Data Mining using R] |
| 3 | www.edureka.com [Data Warehouse Concepts] |
| 4 | www.udemy.com [Learn Data Mining and Machine Learning With Python] |

**Web Link**

1. http://www.celta.paris-sorbonne.fr/anasem/papers/miscelanea/InteractiveDataMining.pdf
2. https://www.javatpoint.com/data-mining-world-wide-web
3. https://www.peterindia.net/DataMiningLinks.html

Course Designed By: Dr. M. Punithavalli

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | L | L | L | L | L | L | M | L | L | M |
| **CO2** | L | L | L | L | L | L | M | L | L | M |
| **CO3** | S | M | M | S | L | L | S | L | M | S |
| **CO4** | S | M | M | S | L | L | S | L | M | S |
| **CO5** | M | M | L | S | L | L | S | L | L | S |

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

| Course code | 21CSEGE03 | EVOLUTIONARY COMPUTING | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 4 | 0 | 4 |
| Pre-requisite | | Knowledge on algorithms and design strategies | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of the course are

1. To understand the evolutionary and heuristic technique and value representation.
2. To understand Optimization Algorithm, Genetic Algorithm and Neural Networks.
3. To understand multi-objective optimization and applications of heuristic technique.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | Develop knowledge of evolutionary computation methodologies in the context of modern heuristic methods | K2 |
| CO2 | Gain experience in matching various evolutionary computation methods and algorithms for particular classes of problems | K3 |
| CO3 | Understand Single objective and Multi-objective optimization problems | K2 |
| CO4 | Solve optimization problems using suitable algorithms | K5 |
| CO5 | Develop evolutionary algorithms for real-world applications | K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to Evolutionary Computing | 12 hours |
|---|---|---|

Introduction to evolutionary and heuristic techniques - Principles and Historical Perspectives; Application potential in optimization, dimensionality reduction, data mining and analytics, Genetic Algorithms, Evolutionary Strategies, Evolutionary Programming

| Unit:2 | Optimization Algorithms | 12 hours |
|---|---|---|

Introduction to Representations, Binary Strings, Real-Valued Vectors, Various Selection Strategies Introduction to Search Operators, Crossover and Mutation, Ant Colony Optimization, Pheromone mediated search and Exploration and Exploitation strategies, Particle swarm optimization basic PSO strategies and variants, different neighborhood topologies

| Unit:3 | Artificial Neural Networks | 12 hours |
|---|---|---|

Fundamentals of Artificial neural networks – Architecture – Learning Paradigms – Activation Functions - Multi-Objective optimization problem- principles of Multi-objective optimization– Dominance and pareto-optimality - Pareto Front and Non-dominated Solutions – Classical methods

| Unit:4 | Fuzzy Logic | 12 hours |
|---|---|---|

Fuzzy logic - Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions - Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making - Adaptive Neuro-Fuzzy Inference Systems.

| | | |
|---|---|---|
| **Unit:5** | **Optimization in Data Analytics** | **12 hours** |
| Applications of evolutionary & Heuristic techniques in large scale Optimization, Combinatorial & Function optimization - NSGA, Applications to large scale clustering classification, rule mining and Data driven Modeling, Variable Selection and Informative Data reduction and parameter optimization in predictive data analytics | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars – webinars | | |
| | | |
| | **Total Lecture hours** | **62 hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | David E Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning ", Pearson Education India, 2013. |
| 2 | S. Rajasekaran, G. A.VijayalakshmiPai, "Neural Networks, Fuzzy Logic and Evolutionary Algorithms: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., II edition, 2017. |
| 3 | S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", 3rd edition, Wiley India Pvt Ltd, 2018. |
| 4 | Andries P. Engelbrecht, "Fundamentals of Computational Swarm Intelligence", Wiley publications, 2005. |

**Reference Books**

| | |
|---|---|
| 1 | Xin She Yang, "Nature-Inspired Computation and Swarm Intelligence - Algorithms, Theory and Applications", 1st Edition, Academic Press, 2020. |
| 2 | Marco Dorigo, Thomas Stutzle, "Ant Colony Optimization", MIT Press, 2010. |
| 3 | OdedMaimon, LiorRokach (Eds), "Data Mining and Knowledge discovery handbook", Springer, 2005. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | Introduction to Soft Computing, https://nptel.ac.in/courses/106/105/106105173/ |

Course Designed By: **Dr. T. Amudha**

**Mapping with Programme Outcomes**

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

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

| Course code | 21CSEGE04 | TEXT ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 3 | 1 | 4 |
| Pre-requisite | | Knowledge on Txt data, NLP | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

1. To understand the text mining and NLP techniques
2. To understand and apply probabilistic models, clustering and classification for text analytics.
3. To understand and apply text analytics approaches in different domains

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the text mining and text pre-processing techniques | K1, K2 |
| 2 | Understand the concepts of text mining in information retrieval and extraction | K1,K2 |
| 3 | Apply the probabilistic models, clustering and classification for text analytics | K3 |
| 4 | To apply the text analytics approaches in different domains | K3-K5 |
| 5 | Design a text analytic framework to analyze text data for domain specific applications | K4-K5 K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

| Unit:1 | Text Mining | 18-- hours |
|---|---|---|

Text Mining - Definition - General Architecture – Core Text mining Operations. Nature of unstructured and semi-structured text, Collecting documents NLP : Text pre-processing- Sentence Segmentation tokenization - lemmatization - stemming - Parsing text - keywords,- POS, Bag of Words Model, n-grams, chunking and Named Entity Recognition (NER) Corpus - sentence boundary determination - Textual information to numerical vectors -vector generation for prediction- document standardization and Representation – Inverted Index-term document matrix (TDM)-TDM Frequency

| Unit:2 | Information retrieval and Extraction | 18-- hours |
|---|---|---|

Information retrieval- keyword search - Vector space scoring, Models - web- based document search-matching-inverted lists. Information extraction-Architecture - Co-reference - Named Entity and Relation Extraction-Template filling and database construction –Applications. Inductive - Unsupervised Algorithms for Information Extraction. Text Summarization Techniques -Topic Representation -Influence of Context -Indicator representations

.

| Unit:3 | Text Categorization | 18-- hours |
|---|---|---|

Text Categorization – Definition – knowledge engineeringText ClassificationFeature Selection for Text Classification, Gini Index, Information Gain .Evaluating model : confusion matrix, class specific measure Classification models : Decision Tree Classifiers -Rule- based Classifiers - Naive

Bayes Classifiers - Linear Classifiers-Classification of Linked and Web Data –Text Clustering – Definition- Feature Selection and Transformation Methods for Text Clustering –Distance and similarities-Hierarchical cluster –K-means -Semi- Supervised Clustering -Transfer LearningPattern Extraction - Apriori Algorithm – FP Tree algorithm - Results summaries

| **Unit:4** | **Probabilistic Models for Text Mining** | **18-- hours** |
|---|---|---|

Probabilistic Models: Introduction, Mixture Models, Stochastic Processes in Bayesian Nonparametric Models, Graphical Models,Probabilistic Models with Constraints, Parallel Learning Algorithms.Probabilistic Models for Information Extraction -Hidden Markov Models - Stochastic Context-Free Grammars - Maximal Entropy Modeling -Maximal Entropy Markov Models - Conditional Random Fields

| **Unit:5** | **Text Analytics Use Cases** | **18-- hours** |
|---|---|---|

Text Analytics in Social Media, Modeling text sentiments, Spam Detection, Mining Text Streams, Opinion Mining and Sentiment Analysis, Text Visualization Approaches -Architectural Considerations –Common Visualization Approaches for text mining. Case study :

| **Unit:6** | **Contemporary Issues** | **2-- hours** |
|---|---|---|

Challenges of text analytics approaches for regional specific languages

| | **Total Lecture hours** | **92-- hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | MuruganAnandarajan "Practical Text Analytics: Maximizing the Value of Text Data", Springer; 2018 |
| 2 | Charu C. AggarwalMachine Learning for Text 2018 |
| 3 | Steven Bird, Ewan Klein and Edward Loper"Natural Language Processing with Python" |

**Reference Books**

| | |
|---|---|
| 1 | Markus Hofmann, Andrew Chisholm "Text Mining and Visualization: Case Studies Using Open-Source Tools,", CRC press, Taylor & Francis,2016 |
| 2 | Charu C. Aggarwal ,ChengXiangZhai,Mining Text Data, Springer; 2012 |
| 3 | DipanjanSarkar Text Analytics with Python, 2016 |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | Business Analytics & Text Mining Modeling Using Python, IIT Roorkeehttps://swayam.gov.in/ |
| 2 | Natural Language Processing, IIT Kharagpurhttps://swayam.gov.in/ |
| 3 | Text Mining and Natural Language Processing in Rhttps://www.udemy.com/ |

Course Designed By:

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | S | L | L | L | L | L | L | L | L |
| **CO2** | L | S | M | S | L | L | L | L | L | L |
| **CO3** | L | M | S | L | L | L | M | M | L | S |
| **CO4** | L | L | S | S | L | L | L | M | L | M |
| **CO5** | L | L | S | S | L | L | M | M | L | S |

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

| Course code | 21CSEGE05 | INTERNET OF THINGS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 3 | 1 | 4 |
| Pre-requisite | | Basic knowledge of hardware, Programming in C | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are:

1. To gain insight about the architecture and enabling technologies of Internet of Things
2. To understand Arduino micro controller and IDE
3. To develop simple IoT Applications for different domains

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| CO1 | To learn the importance of smart objects and smart environment | K1 |
| CO2 | To understand and use the microcontroller and various sensors | K2 |
| CO3 | To create programs using Arduino IDE and extract data | K3 |
| CO4 | To perform WiFi data communications, remote data storage in cloud, and handle the data using web applications | K3, K4 |
| CO5 | To identify potential problems and develop solutions using IOT | K5, K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to IOT | 10 hours |
|---|---|---|

Introduction to IOT - Enabling technologies of IOT - AI and Machine Learning - Physical and logical design of IoT - IOT Reference Architecture - IOT Functional Architecture - IoT levels and deployment templates – Application domains of IoT: Home automation – Cities – Environment – Energy – Industry – Agriculture – Transportation - Health care & Lifestyle.

| Unit:2 | Basic Electronics for IoT & Arduino IDE | 20 hours |
|---|---|---|

Understanding basic electronic components and power elements Electric Charge, Resistance, Current and Voltage – Resistors, Capacitors, Diodes, LED, Potentiometer, circuit boards - Analog and digital circuits – Microcontrollers – Electronic Signals – A/D and D/A Conversion – Pulse Width Modulation Arduino IDE: Installation and Set-up - Programming Fundamentals with C using Arduino IDE Program Structure in C - Basic Syntax - Data Types / Variables / Constants - Operators, Conditional Statements and Loops - Using Arduino C Library functions for Serial, delay and other invoking functions.

| Unit:3 | Arduino Microcontroller and sensors | 20 hours |
|---|---|---|

Working with Arduino: LED and Switch - Data acquisition with IOT Devices - Understanding Sensors and Devices - Understanding the Inputs from Sensors - Working with Temperature Sensors -Working with Ultrasound Sensor -Working with humidity sensor - Working with Motion Sensor - Working with IR Sensor - Working with Proximity Sensor - Working with Accelerometer and vibration sensor.

| Unit:4 | Medical Sensors and Actuators | 20 hours |
|---|---|---|

| | | |
|---|---|---|
| Understanding Medical Sensors: Flow Sensor - Optical Sensor - Body Temperature Sensor - Blood Pressure Sensor -Airflow sensor (breathing) - Patient position sensor (accelerometer) - Pulse and oxygen in blood sensor (SPO2) - Galvanic skin response (GSR - sweating) sensor.<br>Understanding the Outputs through Actuators - Activating LED Lights - Activating Relays - Activating Buzzer - Running DC Motors - Running Stepper Motors and Servo Motors. | | |
| | | |
| **Unit:5** | **Data Communication from IOT devices** | **20 hours** |
| Building and Using Communication Devices to transfer data from IOT Devices - Understanding the Communication Principles to Transfer the data from IOT Devices; Using WIFI to Transfer the data from IOT Sensor; Programming Fundamentals with Web Applications for handling Data Communication from IOT Device; Remote Communication to cloud/external application . | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars - webinars | | |
| | | |
| | **Total Lecture hours** | **92 hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | ArshdeepBahga, Vijay Madisetti, 'Internet of Things: A Hands-On Approach', Universities Press, 2015. |
| 2 | Boris Adryan, DominikObermaier, Paul Fremantle, 'The Technical Foundations of IoT', Artech Houser Publishers, 2017. |
| 3 | Michael Margolis, "Arduino Cookbook" 2nd Edition, O'Reilly Media, 2012. |
| 4 | Marco Schwartz, 'Internet of Things with ESP8266', Packt Publishing, 2016. |

**Reference Books**

| | |
|---|---|
| 1 | Charles Platt, "Make Electronics – Learning by discovery", O'Reilly Media, 2015. |
| 2 | Michael Miller, "The Internet of Things", Pearson India, 2015. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | Introduction to IOT, https://nptel.ac.in/courses/106/105/106105166/ |

Course Designed By: **Dr. T. Amudha**

**Mapping with Programme Outcomes**

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

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

| Course code | 21CSEGE06 | SENTIMENT ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 4 | 0 | 4 |
| Pre-requisite | | Basics of data and data classification methods | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:
To understand representation and handling of opinions by people in different ways.
To analyze different challenges in sentiment analysis
To understand aspect oriented sentiment analysis classification
To analyze fake opinion detection and intention classification
To understand machine learning techniques for sentiment analysis at different levels

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Introduction to sentiment analysis and its applications | K1,K2 |
| 2 | Understand Sentiment analysis using supervised and unsupervised learning | K2 |
| 3 | Discuss the challenges in sentiment analysis classification | K4 |
| 4 | Create different types of opinion summary from the given data sources | K1,K3 |
| 5 | Understand the aspect oriented sentiment analysis | K3,K4 |
| 6 | Identifying opinion quality, author intention and fake opinions | K1,K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to Sentiment Analysis | 10-- hours |
|---|---|---|

Introduction: Sentiment Analysis Applications - Sentiment Analysis Research - Sentiment Analysis as Mini NLP. The Problem of Sentiment Analysis: Definition of Opinion - Definition of Opinion Summary - Affect, Emotion, and Mood - Different Types of Opinions - Author and Reader Standpoint. Document Sentiment Classification: Supervised Sentiment Classification - Unsupervised Sentiment Classification - Sentiment Rating Prediction - Cross-Domain Sentiment Classification - Cross-Language Sentiment Classification - Emotion Classification of Documents.

| Unit:2 | Subjectivity Classification and Challenges | 10-- hours |
|---|---|---|

Sentence Subjectivity and Sentiment Classification: Subjectivity - Sentence Subjectivity Classification - Sentence Sentiment Classification - Dealing with Conditional Sentences - Dealing with Sarcastic Sentences - Cross-Language Subjectivity and Sentiment Classification - Using Discourse Information for Sentiment Classification - Emotion Classification of Sentences.

| Unit:3 | Aspect Oriented Classification | 14-- hours |
|---|---|---|

Aspect Sentiment Classification: - Rules of Sentiment Composition - Negation and Sentiment - Modality and Sentiment - Coordinating Conjunction But - Sentiment Words in Non-opinion Contexts - Rule Representation - Word Sense Disambiguation and Co reference Resolution. Aspect and Entity Extraction: 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.

| Unit:4 | Sentiment Lexicon generation and Summarization | 14-- hours |
|---|---|---|

Sentiment Lexicon Generation: Dictionary-Based Approach - Corpus-Based Approach - Desirable and Undesirable Facts. Analysis of Comparative Opinions: Problem Definition - Identify Comparative Sentences - Identifying the Preferred Entity Set - Special Types of Comparison - Entity and Aspect Extraction. Opinion Summarization and Search: Aspect-Based Opinion Summarization - Enhancements to Aspect-Based Summary - Contrastive View Summarization - Traditional Summarization - Summarization of Comparative Opinions - Opinion Search - Existing Opinion Retrieval Techniques. Mining Intentions: Problem of Intention Mining - Intention Classification - Fine-Grained Mining of Intentions.

| Unit:5 | Identifying intention, fake and quality of opinion | 12-- hours |
|---|---|---|

Detecting Fake or Deceptive Opinions: Different Types of Spam - 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 - Exploiting Business in Reviews - Some Future Research Directions. Quality of Reviews: Quality Prediction as a Regression Problem - Other Methods - Some New Frontiers.

| Unit:6 | Contemporary Issues | 2-- hours |
|---|---|---|

Expert lectures, online seminars - webinars

| | Total Lecture hours | 62-- hours |
|---|---|---|

**Text Books**

| | |
|---|---|
| 1 | Bing Liu "Sentiment Analysis: Mining Opinions, Sentiments and Emotions, Cambridge University Press, 2015. |

**Reference Books**

| | |
|---|---|
| 1 | Bing Liu "Sentiment Analysis and Opinion Mining, Morgan & Claypool Publishers, 2012. |
| 2 | Erik Cambria, Dipankar Das "A Practical Guide to Sentiment Analysis" Springer, 2017. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | Course Title |
|---|---|
| 1. | https://www.coursera.org/projects/twitter-sentiment-analysis |
| 2. | https://www.udemy.com/course/sentiment-analysis-with-lstm-and-keras-in-python/ |

**Web link**

1. https://towardsdatascience.com/sentiment-analysis-concept-analysis-and-applications-6c94d6f58c17
2. https://www.lexalytics.com/technology/sentiment-analysis
3. https://web.stanford.edu/class/cs124/lec/sentiment.pdf
4. https://www.utas.edu.au/research/degrees/available-phd-projects/phd-projects/college-of-sciences-and-engineering/school-of-technology,-environments-and-design/information-and-communication-technology/a-machine-learning-approach-for-sentiment-analysis-or-opinion-mining

Course Designed By: **Mr. S. Palanisamy**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | L | L | L | L | L | S | S | S |
| **CO2** | S | L | L | S | L | S | M | L | L | L |
| **CO3** | M | L | L | S | S | M | | M | M | M |
| **CO4** | L | M | S | S | L | S | S | S | M | S |
| **CO5** | L | L | L | S | L | M | L | L | L | S |
| **CO6** | L | M | M | S | M | M | S | S | S | S |

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

| Course code | 21CSEGC07 | SOCIAL MEDIA MINING | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | - | - | 4 |
| Pre-requisite | | Knowledge on Complex data structures, algorithm and web | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand how accurately analyze voluminous complex data set in social media and other sources
2. To understand the models and algorithms to process large data sets
3. To understand social behavior and recommendation challenges and methodologies

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the concepts of Graph Models, social communities | K1, K2 |
| 2 | Understand the network models and measures to evaluate information | K3 |
| 3 | Understand and apply algorithms to model data using graph and network structures and recommendations | K2,K5 |
| 4 | Brief on algorithms on social data diffusion and apply for various domains | K2,K3, K4 |
| 5 | Distinguish and Suggest the appropriate algorithms for domain specific applications for data modelling and information diffusion, Evaluate the algorithms for metrics | K4,K5, K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| Unit:1 | Social Media Mining | 12-- hours |
|---|---|---|

Social Media Mining - Introduction – Atoms – Molecules – Interactions – Social Media mining Challenges - Graphs - Basics – Nodes – Edges – Degree of Distribution- Types –Directed – Undirected – Weighted - Graph Connectivity - Tress and Forests – Bipartite graphs – Complete Graphs – Sub graphs – Planar Graphs - Graph Representation - Graph Traversal Algorithms – Shortest path algorithms Dijkstra's - Spanning tree algorithms – Prims - Bipartite matching - Ford-Fulkerson algorithm

| Unit:2 | Network Models | 12-- hours |
|---|---|---|

Network Models – Measures – Node : Eigen Centrality – Page Rank – Group Measures – Between ness centrality - group degree centrality, centrality, and group - Closeness centrality - Node Linking Behavior - Transitivity and reciprocity - Linking Analysis - Cluster coefficient – Jaccard - Case Study : -Modeling small networks with real world model

| | | |
|---|---|---|
| **Unit:3** | **Social Media Communities** | **12-- hours** |
| Social media Communities – Social Communities – Member based Detection – Node degree – Node Similarity – Node reachability - Group Based detection methods - balanced – robust - modular – dense - hierarchical - Spectral Clustering : Balanced Community algorithm Community Evolution - Evaluation. | | |
| | | |
| **Unit:4** | **Social Network** | **12-- hours** |
| Social Network – Information Diffusion – Types - herd behavior - information cascades diffusion of innovation – epidemics – Diffusion Models Case Study – Herd Behavior – Information Cascades Methods – Social Similarity – assortativity – Social Forces - Influence homophily – Confounding - Assortativity measures – Influence measures – Predictive Models | | |
| | | |
| **Unit:5** | **Recommender System** | **12-- hours** |
| Recommendation Vs Search – Recommendation Challenges – Recommender algorithms - Content-Based Methods- Collaborative Filtering – Memory Based – Model Based – Social Media Recommendation – User friendship – Recommendation Evaluation – Precision – Recall – Behavioral– User Behavior – User – Community behavior – User Entity behavior – Behavioral Analytics - Methodology | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| 1. Social Media Plagiarism – Legal and Ethical issues – Social Media Marketing<br>2. Lack of focus – Productivity – Relationship – Infidelity – Privacy – Fake Identities<br>3. Negative impact on Academics – Cyber-crime – Bullying | | |
| | | |
| | **Total Lecture hours** | **62-- hours** |

| **Text Book(s)** | |
|---|---|
| 1 | Reza Zafarani , Mohhammad AliAbbasi – Social Media Mining: An Introduction – Published by Cambridge press, 2014 – (Free Ebook available http://dmml.asu.edu/smm/chapter**)** |
| 2 | **Memon**, N., **Xu**, J.J., **Hicks**, D.L., **Chen**, H. (Eds.), Data Mining for Social Network Data-Springer – Annals of Information Systems ,ISBN 978-1-4419-6287-4 |
| 3 | Lam Thuy Vo, 2019, "Mining Social Media: Finding Stories in Internet Data |
| **Reference Books : EBooks** | |
| 1 | Matthew A. Russel and Mikhail Klassen, 2018, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub |
| 2 | GungorPolatkan, AntonoisChalkiopoulos, P. Oscar Boykin et.al., 2018, "Social Media Mining and Analytics. |
| | |

| Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.] | | | |
|---|---|---|---|
| | **Course Title** | **Duration** | **Provider** |
| 1. | Social Media Data Analytics (Free) | 4 Weeks | Coursera |
| 2. | Introduction to Social Media Analytics | 4 Weeks | Coursera |
| 3. | Social Media Analytics: Using Data to Understand Public Conversations | 3 Weeks | Future Learn |
| 4. | Starting with social network analysis | 2 hours | Udemy |
| **Web link** | | | |

1. https://learn.g2.com/social-media-data-mining
2. https://www.javatpoint.com/social-media-data-mining
3. https://www.igi-global.com/dictionary/applying-critical-theories-to-social-media-mining-and-analysis/50376
4. https://www.cambridge.org/core/books/social-media-mining/introduction/75F143896832B7B9339F2CE663C4815B

Course Designed by: Dr. V. Bhuvaneswari

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | L | L | L | L | S | S | L | L |
| **CO3** | L | S | L | M | S | L | M | L | M | L |
| **CO3** | S | M | M | L | M | L | L | L | L | M |
| **CO4** | L | L | M | S | L | L | L | L | L | L |
| **CO5** | S | M | L | L | L | L | L | L | M | S |
| | | | | | | | | | | |

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

| Course code | 21CSEGE08 | PROGRESSIVE WEB APPLICATION DEVELOPMENT | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 2 | 0 | 2 | 4 |
| Pre-requisite | | HTML, CSS and Object Oriented Programming using JavaScript | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the basics of progressive web applications
2. To understand the fundamentals of Angular and develop Angular applications
3. To create, build and deploy progressive web applications using Angular

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | To learn the basics of Angular and Progressive Web Applications | K2 |
| 2 | To understand and use Angular forms, dependency injection and routing | K3 |
| 3 | To create build and deploy an Angular application using Angular CLI | K6 |
| 4 | To explore Service Workers, Data Storage, App Manifest and Notifications in Progressive Web Applications | K3 |
| 5 | To build and deploy responsive, fast and reliable Progressive Web Applications using Angular | K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Building Blocks of Angular | 10-- hours |
|---|---|---|

**TypeScript**: Built-in Types – Classes – Utilities – Working with Angular CLI – **Building Blocks of Angular**: Modules – Components – Templates – Metadata – Data Binding – Directives – Services – Dependency Injection

| Unit:2 | Data Architecture and Testing in Angular | 20-- hours |
|---|---|---|

Forms in Angular – HTTP - Routing – **Data Architecture in Angular**: Overview – Observables and RxJS – Redux in Angular – **Testing**: Testing Tools – End-to-End and Unit Testing – Testing Services and HTTP – Resting Routing to Components – Testing Forms – Testing HTTP requests

| Unit:3 | Service Workers in Progressive Web Apps (PWAs) | 20-- hours |
|---|---|---|

**Introduction to Progressive Web Apps (PWA)** – Current and Future PWA Support – Why Angular – Installing Node and NPM – **Service Workers**: Understanding Service Worker – Service Worker Life Cycle – Service Worker Functional Events – Cache API – Cache Strategies –

| | | |
|---|---|---|
| Runtime Cache in Angular Service Worker | | |
| | | |
| **Unit:4** | **App Manifest, Notifications and App Shell** | **20-- hours** |
| Background Sync API – **Data Storage**: IndexedDB and localForage **– App Manifest:** The Web App Manifest – Adding Web App Manifest to Home Screen **– Notifications:** Web Notifications – Push Notifications – **App Shell:** App Shell Model – Angular App Shell – Further Optimizations – Exploring HTTP/2 and Server Push | | |
| | | |
| **Unit:5** | **Debugging PWAs and Modern Web APIs** | **20-- hours** |
| **Debugging**: NGSW Debug – Web App Manifest – Service Workers – Storage – Cache – **Measurement**: Audit – Analytics –**Safety Service Worker**: Fail-safe – Safety Worker – **Modern Web APIs**: Credential Management – Payment Request – Video and Audio Capturing - Geolocation | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2-- hours** |
| Expert lectures, online seminars - webinars | | |
| | | |
| | **Total Lecture hours** | **92-- hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | Nathan Murray, Felipe Coury, Ari Lerner and Carlos Taborda, 'ng-book: The Complete Guide to Angular', Fullstack.io, 2018 |
| 2 | MajidHajian, 'Progressive Web Apps with Angular', Apress, 2019. |
| 3 | Dennis Sheppard, 'Beginning Progressive Web App Development', Apress, 2017. |

**Reference Books**

| | |
|---|---|
| 1 | Tal Ater, 'Building Progressive Web Apps', O'Reilly Media, 2017. |
| 2 | Chris Love, 'Progressive Web Application Development By Example', Packt Publishing Ltd, 2018. |
| 3 | John M. Wargo, 'Learning Progressive Web Apps', Addison Wesley, 2020. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | Developing Dynamic Web Applications Using Angular (https://www.edx.org/course/developing-dynamic-web-applications-using-angular) |

Course Designed By: **Dr. R. Rajeswari**

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | S | L | L | L | L | L | L | L | L |
| **CO2** | L | L | S | S | L | L | L | L | L | L |
| **CO3** | L | M | L | L | L | L | L | L | M | M |
| **CO4** | L | L | S | S | L | L | L | L | M | M |
| **CO5** | L | L | M | M | L | L | L | L | L | L |
| | | | | | | | | | | |

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

| Course code | 21CSEGE09 | SEMANTIC WEB | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 4 | 0 | 4 |
| Pre-requisite | | Knowledge on Complex data structures, algorithm and web | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand web 2.0 and web 3.0, the basics of semantic web, features, web standards.
2. To understand and apply knowledge representation methods, standard namespaces, Graph based validation.
3. To analyze and Build Data Integration semantic layer use cases for specific domain and applications.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand Web standards, features, Distributed web data, limits of the web, Need of languages | K1, K2 |
| 2 | Understand the concept of Ontology, Knowledge representation, scheme classification | K6 |
| 3 | Understand the platform to model, semantic web tools: Triple stores, Development environments, Inference engines | K4 |
| 4 | Understand the Semantic web layer for integration, Issues addressed, Representation formats, Mining stack and knowledge graphs. | K2-K4 |
| 5 | Analyze various domains, Platform, Mapping of knowledge models, and semantic processing framework of domains of Transportation. | K4-K5 K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| Unit:1 | Introduction to Semantic Web | 12-- hours |
|---|---|---|

Web 2.0 and 3.0 – Meaning of Semantic Data – Distributed web of data – Metadata - Features of semantic web – Data across the web – The basics of semantic web - The Limits of the web – The vision of the semantic web – Semantic web standards – RDF – RDF Scheme (RDFS) – OWL Web Ontology Language – SPARQL Protocol – RDF Query Language (SPARQL) - Need of RDFS – Machine Readability – core elements of RDFS – XML Schema – RDF schema

| Unit:2 | Knowledge Representation Methods | 12-- hours |
|---|---|---|

The concept of Ontology - SKOS – Representation of thesauri - Glossaries – Scheme classification – Taxonomies – Controlled Vocabularies - Hierarchical Structure – Formal Representations - Standard Namespaces – JSON based serialization for Linked Data - RDF Triple stores – Turtle – RDFa – Internal Identifiers - URI – RDFS – Classes – Resources – Inferred

| | | |
|---|---|---|
| Property Characterization – Literals – Linked Open Data – DBpedia – Querying RDF Graphs – Vocabularies – Graph based validation - Shape constraint Language (SHACL) | | |
| | | |
| **Unit:3** | **Tools** | **12-- hours** |
| **Triple store:** Jena – Allegro Graph – Mulgara – Sesame – Flickurl - Top Braid – Suite – Virtuoso Environment – Content Management System: Falcon – Drupal 7 – Redland – Pellet, **Development Environment:** Protégé – Ontotext – Open Anzo – RDF Gateway – RDFLib – DartGrid – Zitgist, **Inference Engines:** SWI-Prolog, Semantic Works –Ontobroker | | |
| | | |
| **Unit:4** | **Data Integration Semantic Layer** | **12-- hours** |
| Data Integration issues- Data Interoperability – Data Migration – Data Representation Formats – Data Silos – Linked Data Management – Knowledge Mining Stack – NLP – Named Entity Recognition – Machine Learning – Knowledge Graphs | | |
| | | |
| **Unit:5** | **Use cases** | **12-- hours** |
| Use cases Specifications and Discussion: - Transportation: Data Sources – Representation – Linked Data Mapping - Knowledge Modeling – Telecommunication – Knowledge Modeling – Customer Care Support Documents – Internal Reports – Named Entity Recognition – Linked Data Mapping | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2-- hours** |
| Customer provider mismatch – Interlinking domain specific information – Combining different services from different providers – contrast with contemporary web applications<br><br>Markup languages – Object Access Protocols – Service description – Discovery – Integration | | |
| | | |
| | **Total Lecture hours** | **62-- hours** |

| **Text Book(s)** | |
|---|---|
| 1 | Dean Allemang, James Hendler: "Semantic Web for the Working Ontologist Effective Modeling in RDFs and OWL", 2nd Edition, 2008. |
| 2 | Liyang Yu, "Introduction to the Semantic Web and Semantic web services" Chapman & Hall/CRC, Taylor & Francis group, 2007. |
| 3 | Toby Segaran, Colin Evans, Jamie Taylor, "Programming the Semantic Web", 1st Edition, July 2009. |
| 4 | Pollock, J.T.: Semantic web for dummies. Wiley Publishing, Inc., Indianapolis, 2009. |
| **Reference Books : EBooks** | |
| 1 | Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, The MIT Press (2004), ISBN: 0262012103 |
| 2 | *P. Hitzler, R. Sebastian, M. Krötzsch: Foundation of. Semantic Web Technologies, 2009.* |
| 3 | Kalfoglou, Yannis, Cases on Semantic Interoperability for Information Systems Integration - Practices and Applications. IGI Global 2009, ISBN 978-1-60566-894-9 |

| | |
|---|---|
| 4 | Martin Große-Rhode, Semantic Integration of Heterogeneous Software Specifications, Springer-Verlag Berlin and Heidelberg GmbH & Co. KG, 2010, ISBN 978-3-64207-306-9 |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | Course Title | Duration | Provider |
|---|---|---|---|
| 1. | Semantic Web Technologies (Free) | 6 Weeks | OpenHPI |
| 2. | Linked Data Engineering (Free) | 6 Weeks | OpenHPI |
| 3. | Introduction to a Web of Linked Data | 4 Weeks | Fun Inria |
| 4. | Web of Data | 17 hours | Coursera |
| 5. | Dynamics of Knowledge Organization (Free) | 2 hours | Udemy |

**Web link**

1. http://www.linkeddatatools.com/semantic-web-basics
2. http://www.cambridgesemantics.com/blog/semantic-university/intro-semantic-web
3. https://www.mkbergman.com
4. http://euclid-project.eu

Course Designed by: Dr.V.Bhuvaneswari

**Mapping with Programme Outcomes**

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

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

| Course code | 21CSEGE10 | GRAPH DATABASES | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 2 | 2 | 4 |
| Pre-requisite | | Basics of Data, Graphs and databases | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand Non-relational databases
2. To compare the services and activities of NoSQL databases
3. To apply and understand graph oriented database features.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand databases, transaction problem, graph theory, new generation databases, non-standardized query language. | K1, K2 |
| 2 | Understand the database tools, characteristics, different types of non-relational databases. | K4 |
| 3 | Understand Graph oriented databases, indexes, paths and networking | K4 |
| 4 | Understand the Graph database platform Neo4j, Components, setup development environment, parameter constraints | K5 |
| 5 | Implement the query using text mining techniques using the graph database platform Neo4j, Use predictive and descriptive analysis, cypher script. | K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| Unit:1 | Introduction to NoSQL Database | 18-- hours |
|---|---|---|

Database – Transactions – Graph – Graph theory – Relational Databases – NoSQL – Store Connected Data – Data models – The Labeled property graph model - Data Structure – Unstructured Data – Development model – New Generation Databases – Non-relational – Distributed – Open source – Benefits – High Performance - Schema less – Horizontal Scalable – Issues - Non-Standardized query language – Transaction problem – Integrity - Querying graph – Cypher.

| Unit:2 | NoSQL Database Tools | 18-- hours |
|---|---|---|

Predictive Analysis – Transactional Systems — Characteristics – CAP – Consistency – Availability – Partition Tolerance – Use Base Property – Types of non-relational database – Key –value storage – column oriented databases – Document – oriented database – Graph Oriented Database

**Tools:** Column Oriented Databases: Amazon DynamoDB, Cassandra, Voldemort – RAMCloud – Flare, Document Oriented Databases: CouchDB – MongoDB – Cloudkit – XML Databases – DB2 pureXML, Graph Oriented Databases: Neo4j – Hyperbase-DB - InfoGrid

**Characteristic Comparison:** Performance – Scalability – Flexibility – Complexity – Functionality

| Unit:3 | Connected Data | 18-- hours |
|---|---|---|
| Graph Oriented Database – Indexes – Properties - Graph – Relationships – Nodes - Directed Graphs – Non Directed Graphs – Traversal – Paths – Algorithm - Network representation – Implementation – Neo4J – Hyperbase-DB – InfoGrid – The Graph Store. | | |
| | | |
| **Unit:4** | **Graph Oriented Database Platform: Neo4j** | **18-- hours** |
| Graph Databases – Model relational data – Property graph model – Neo4j Graph Platform – Components – Features – Benefits of Neo4j – Setup Development Environment – Neo4j Sandbox – Neo4j Desktop – Cypher – Match – Graph node retrieval – Graph relations retrieval – Graph properties retrieval – Nodes – Relationships – Merge data into graph – Parameter constraints – Monitor query execution – Indexes – Relational Data. | | |
| | | |
| **Unit:5** | **Use cases** | **18-- hours** |
| **Implement Graph Database with Neo4j**<br>NoSQL Database – Neo4j – Queries – Text Mining techniques – Descriptive and Predictive Analysis – University – Journal Conference Publications – Capture data – Design Graph Database – Populate – Obtain Machine Learning Groups – Journal Article Numbers – Publishes Articles – Cypher script – Graph Data. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2-- hours** |
| Maintaining consistency of data, modelling highly interconnected data, Performance issues, Indexing, Inter-regional communications, Connection between different schemas. | | |
| | | |
| | **Total Lecture hours** | **92-- hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | AnkurGoel, Neo4j Cookbook, PACKT publishing, 2015, ISBN: 978-1-78328-725-3 |
| 2 | Chris Kemper, Beginning Neo4j, 2015, Apress, ISBN: 978-1-4842-1227-1 |
| 3 | Mahesh Lal, Neo4j Graph Data Modeling, PACKT publishing, 2015, ISBN: 978-1-78439-344-1 |
| 4 | Thomas Frisendral, Graph Data Modeling for NoSQL and SQL, Technis Publications, 2016, ISBN: 978-1-634-621-212. |

**Reference Book: EBook**

| | |
|---|---|
| 1 | Ian Robinson, Jim Webber & Emil Eifrem, Graph Databases New Opportunities for Connected Data, O'Reilly, 2nd edition, 2015, ISBN: 978-1-491-93200-1 |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | Course Title | Duration | Provider |
|---|---|---|---|
| 1. | Introduction to Neo4j (Free) | 5 Weeks | Graph Academy |
| 2. | NoSQL Systems (Free) | 4 Weeks | Coursera |

| **Web link** |
|---|
| 1. https://neo4j.com/developer/graph-database/ |
| Course Designed by: Dr.V.Bhuvaneswari |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | L | S | S | L | L | L | L | L | S |
| **CO2** | L | M | L | L | L | L | L | L | L | M |
| **CO3** | M | L | L | L | L | L | L | S | M | L |
| **CO4** | L | L | L | S | M | M | L | M | L | L |
| **CO5** | M | L | M | L | L | L | S | L | L | L |

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

| Course code | 21CSEGE11 | HEALTH CARE DATA ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 2 | 2 | 4 |
| Pre-requisite | | Basics on Statistics and Linear Algebra | Syllabus Version | | 2020-2021 | |

**Course Objectives:**

1. To understand the Process ,Concepts and Procedures in Health Care Data Digital Systems
2. Understand Data standards used in Health Care Domain
3. Design Integrated Health Care Data Models for Data Analytics
4. Understand and Remember the Ethics of Managing and Analyzing Health Care Data

**Expected Course Outcomes:**

| | | |
|---|---|---|
| CO1 | Understand the Process and Data Functionalities of Health Care Data | K1, K2 |
| CO2 | Understand the various Data Sources, diagnostic standards and Components of Data Analytics | K2, K1 |
| CO3 | Understand and design Integrated Data Model for analytics | K2, K5 |
| CO4 | Apply ETL for data analysis and create dashboards | K3, K4 |
| CO5 | Create and evaluate prediction models in healthcare applications for preventive care and personalized medicines | K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Health Care Systems | 18-- hours |
|---|---|---|

Introduction :Health Care Entities – Electronic Health Care Records – Clinical Data - Health Care Big Data Sources– Patient Data – Administrative Data – Genomics Data – Imaging Data- Insurance Data – Diagnostic Data – Clinical Data— Social Media – Survey Data – Family Data – Data Quality – Data Ethics – Data Integration Challenges

| Unit:2 | Data Models and Data Standards | 18-- hours |
|---|---|---|

Data Models : Relational Models – Hierarchical Models — Data warehousing Models – Star Schema – Normalized Data and Deformalized – Health Care Knowledge Representation Ontologies – Diagnosis Standards – ICD 9/10 - DSMI – DSM II –Drug Standards SNOWMED – LOINC – Laboratory Standards – Data Challenges in Data Mapping -Data Standards as Linked Data

| Unit:3 | Big Data and Data Analytics | 18-- hours |
|---|---|---|

Data Analytics: Data Cleaning and Pre-Processing – Data Processing and Modeling - Classification – Clustering – Dimensionality Reduction - Prediction Machine Learning – Microsoft Azure Cloud -Data Visualizing – Histogram – Boxplot- Scatter Plot – Bar – Pie – Mosaic Plot – Trends Lines – Heat Maps – Density Plots - Dashboard – Creation - Presentation

| Unit:4 | Advanced Health Care Analytics | 18-- hours |
|---|---|---|

Genomics Data Analysis – Microarray Data – Sequence Data – Research Survey Analysis – Text Mining – Tele Health – Virtual HealthCare Assistance -

| Unit:5 | Health Care Use case | 18-- hours |
|---|---|---|
| Prediction of Risk of Co morbidity Individuals – Outbreak – Epidemics - Personalized Medical Care – Pharmaceuticals and Patient Data Integration – Clinical Data | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Challenges and Gap – Health Care Data Integration – Analysis of Developing Countries | | |
| | **Total Lecture hours** | **62-- hours** |

**Text Books:**

| | |
|---|---|
| **1** | Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2006 |
| 2 | Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012 |
| 3 | EthemAlpaydin, "Introduction to Machine Learning 3(Adaptive Computation and Machine Learning Series)", Third Edition, MIT Press, 2014 |
| 4 | Tom M Mitchell, "Machine Learning", First Edition, McGraw Hill Education, 2013. |

**Reference Books**

| | |
|---|---|
| 1 | JannesKlaas, "Machine Learning for Finance", ISBN: 978178936364, 2019 [Packt] |
| 2 | Giuseppe Bonaccorso, "Machine Learning Algorithms", Second Edition, ISBN: 9781789347999, 2018 [Packt] |
| 3 | Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009 |
| 4 | Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning", Second Edition, Springer, 2008 |
| 5 | Yuxi Liu, "Python Machine Learning By Example", 2017 [Packt] |
| 6 | John Paul Mueller, Luca Massaron, "Machine Learning (in Python and R) For Dummies", First Edition, Wiley Publisher, ISBN: 9788126563050, 2016 |
| 7 | U Dinesh Kumar ManaranjanPradhan,,"Machine Learning using Python". ) Publisher: Wiley, ISBN: 9788126579907, 2019 |

**Online Course:**

| S. No | Course Title | Duration | Provider -Free |
|---|---|---|---|
| 1. | Machine Learning | 12 hours | Simplilearn |
| 2. | Machine Learning for Data Analysis | 4 Weeks | Coursera |
| 3. | Machine Learning Foundations: A Case Study Approach | 6 Weeks | Coursera |
| 4. | Machine Learning : Regression | 6 Weeks | Coursera |
| 5. | Introduction to Machine Learning | 12 Weeks | Swayam - NPTEL |
| 6 | Deep Learning Specialization | 4 Courses | Coursera |

**Web Link - Video:**

1. https://www.packtpub.com/data/hands-on-machine-learning-with-scikit-learn-and-tensorflow-2-0-video
2. https://www.packtpub.com/data/machine-learning-projects-with-tensorflow-2-0-video
3.https://www.packtpub.com/application-development/complete-machine-learning-course-python-video

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | M | L | L | L | S | S | S | S |
| **CO2** | M | M | M | S | L | L | S | S | S | S |
| **CO3** | S | S | S | S | S | M | S | S | S | S |
| **CO4** | 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