**Appendix I**

# COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

**CURRICULUM & SYLLABUS REVISION**
**MCA**
**(2023 Admissions Onwards)**

**DEPARTMENT OF COMPUTER APPLICATIONS**
**COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY**
**KOCHI - 682022**

**Vision**

To become a Centre of excellence in Computer Applications and impart innovation-oriented education for building globally competent and socially committed professionals.

**Mission**

1. To develop technically competent professionals and equip them for research, innovations, higher studies, and entrepreneurship.
2. To mould software professionals with ethical values for developing technologies emphasizing on societal and industrial needs.
3. To provide a globally recognized academic environment through industry – academia collaborations, digital learning, and state of the art skill development.
4. To foster students by enriching universal human values to work in multidisciplinary domains exhibiting leadership qualities and teamwork.

**Program Educational Objectives**

PEO1: Apply principles of mathematics and computing to design, develop and test software for quality, security, and utility.

PEO2: Work in a multidisciplinary team to understand software requirements and engage in applying technologies for solving complex computing problems.

PEO3: Engage in lifelong learning to keep pace with changing landscape of technologies for professional advancement.

PEO4: Communicate effectively and demonstrate professional ethics with societal responsibilities.

**Programme Articulation Matrix**

| | M1 | M2 | M3 | M4 |
|---|---|---|---|---|
| **PEO1** | X | X | | |
| **PEO2** | X | X | | X |
| **PEO3** | | | | X |
| **PEO4** | | X | | |

**Programme Outcomes (PO's)**

**1.Computational Knowledge:** Apply knowledge of computing fundamentals, computing specialization, mathematics, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

**2.Problem Analysis:** Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences and relevant domain disciplines.

**3.Design/Development of Solutions:** Design and evaluate solutions for complex computing problems, and design and evaluate systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

**4.Conduct Investigations of Complex Computing Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**5.Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

**6.Professional Ethics:** Understand and commit to professional ethics and cyber regulations responsibilities, and norms of professional computing practice.

**7.Life-long learning:** Recognize the need and have the ability to engage in independent learning for continual development as a computing professional.

**8.Project management and finance:** Demonstrate knowledge and understanding of the computing and management principles and apply these to one's own work, as the member and leader in a team to manage projects and in multidisciplinary environments.

**9.Communication Efficacy:** Communicate effectively with the computing community, and with society at large, about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations and give and understand clear instructions.

**10.Societal and Environmental Concern:** Understand and assess societal, environmental, health, safety, legal and cultural issues within local and global context, and the consequential responsibilities to professional computing practice.

**11.Individual and Teamwork**: Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary environments.

**12.Innovation and Entrepreneurship:** Identify a timely opportunity and using innovation to pursue that opportunity to create value and wealth for the betterment of the individual and the society at large.

**MASTER OF COMPUTER APPLICATIONS**

**SYLLABUS REVISION (2023 admission onwards)**

| SEMESTER-1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Name** | **Marks** | | | **Hours** | | | **Credit** |
| | | **CA** | **ES** | **Total** | **L** | **T** | **P** | |
| **22-382-0101** | Mathematical Foundations for Computing | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0102** | Data Structures and Algorithm using C | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0103** | Digital Fundamentals and Computer Architecture | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0104** | Software Engineering | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0105** | Python Programming | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0106** | Data Structures Lab | 50 | 50 | 100 | 0 | 1 | 2 | 2 |
| **22-382-0107** | Python Programming Lab | 50 | 50 | 100 | 0 | 1 | 2 | 2 |
| | **TOTAL** | | | | | | | 24 |
| **SEMESTER-II** | | | | | | | | |
| **Course Code** | **Course Name** | **Marks** | | | **Hours** | | | **Credit** |
| | | **CA** | **ES** | **Total** | **L** | **T** | **P** | |
| **22-382-0201** | Computer Networks | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0202** | Operating Systems | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0203** | Machine Learning | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0204** | Object Oriented Programming | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0205** | Database Management Systems | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0206** | Java Lab (OOPS) | 50 | 50 | 100 | 0 | 1 | 2 | 2 |
| **22-382-0207** | Database Management Systems Lab | 50 | 50 | 100 | 0 | 1 | 2 | 2 |
| | **TOTAL** | | | | | | | 24 |

| SEMESTER-III | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Name** | **Marks** | | | **Hours** | | | **Credit** |
| | | **CA** | **ES** | **Total** | **L** | **T** | **P** | |
| **22-382-0301** | Web Technologies and Programming | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| **22-382-0302** | Cryptography and Network Security | 50 | 50 | 100 | 3 | 1 | 0 | 4 |
| | Elective1-InterdisciplinaryElective | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| | Elective2-MOOC | 0 | 100 | 100 | | | | 3 |
| | Elective 3 | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| **22-382-0303** | Mini Project | 50 | 0 | 50 | 0 | 1 | 6 | 4 |
| | **TOTAL** | | | | | | | 21 |
| **SEMESTER-IV** | | | | | | | | |
| **Course Code** | **Course Name** | **Marks** | | | **Hours** | | | **Credit** |
| | | **CA** | **ES** | **Total** | **L** | **T** | **P** | |
| **22-382-0401** | Internship/Project | 200 | 200 | 400 | 0 | 3 | 26 | 16 |

**ELECTIVES**

| | Subject |
|---|---|
| **ELECTIVE I - INTERDISCIPLINARY ELECTIVE** | |
| 24-382-0321 | **ELECTIVE 2 -MOOC** |
| **ELECTIVE 3** | |
| 22-382-0331 | Natural Language Processing |
| 22-382-0332 | Internet of Things |
| 22-382-0333 | Explainable AI |
| 22-382-0334 | Bioinformatics |
| 22-382-0335 | Blockchain Technology |
| 22-382-0336 | Social Network Analysis |
| 22-382-0337 | Malware Analysis |
| 22-382-0338 | Design Thinking |
| 22-382-0339 | Semantic web |
| 22-382-0340 | Computer Vision |
| 22-382-0341 | Software Testing |
| 22-382-0342 | Network Security Essentials |
| 22-382-0343 | Digital Image Processing |
| 22-382-0344 | Cloud Computing |
| 22-382-0345 | Theory Of Computation |
| 22-382-0346 | Software Project Management |
| 22-382-0347 | Soft Computing Techniques |
| 22-382-0348 | Cyber Forensic |
| 22-382-0349 | Android Application Programming |
| 22-382-0350 | Deep Learning |
| 22-382-0351 | Big Data Analytics |

| 22-382-0101 | MATHEMATICAL FOUNDATION FOR COMPUTING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Programming Fundamentals
**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| CO1 | Solve system of linear equations using various methods. | (Cognitive level: Apply) |
| CO2 | Apply various methods to find Eigenvalues and Eigenvectors. | (Cognitive level: Apply) |
| CO3 | Apply Bayes theorem and various discrete and continuous distributions. | (Cognitive level: Apply) |
| CO4 | Apply various optimization techniques for solving real life problems. | (Cognitive level: Understand) |
| CO5 | Apply various techniques for dimensionality reduction and density optimization. | (Cognitive level: Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO 2** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO 3** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO 4** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO 5** | 3 | 3 | 3 | | | | 1 | | | | | |

## 22-382-0101 MATHEMATICAL FOUNDATION FOR COMPUTING

**UNIT I (8 Hours)**
Linear Algebra- Solving systems of Linear Equations; Vector Spaces and sub spaces; Linear Independence; Basis and rank; Linear maps-Image and kernel, Metric space and normed space, Inner product space.

**UNIT II (10 Hours)**
Matrix decompositions-Determinant, Eigenvalues and eigenvectors, Trace, Orthogonal matrices, Diagonalization and symmetric matrices, Singular value decomposition; Vector calculus-Differentiation, partial differentiation and gradients, gradients of vector valued functions.

**UNIT III (12 Hours)**
Probability and statistics – Descriptive statistics, Basics of probability, joint, marginal and conditional probability, Bayes theorem examples of calculating probability, Discrete probability distributions –

Binomial, Poisson, and multinomial distributions. Continuous probability distributions – Normal, exponential and chi-square, problems related to discrete and continuous probability distributions, testing of hypothesis.

**UNIT IV (8 Hours)**
Optimization – Optimization using gradient descent, Constraint optimization and Langrage multipliers, convex optimization, Maximum likelihood estimation, least Square estimation, Linear regression, Linear regression as maximum likelihood, least squares and maximum likelihood.

**UNIT V (7 Hours)**
Dimensionality reduction and Density estimation – Feature extraction, feature selection, Principal component analysis, Discrete wavelet transform; Gaussian mixture model, Expectation maximization (EM) algorithm.

**Text Books/References**
1.“Mathematics for Machine Learning” by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, 2020, Cambridge University Press.
2.“Mathematics for Machine Learning”, by Jay Davani, Hands-on 2020 Packt publishers.
3.“Advanced Engineering Mathematics”, by Erwin Kreyszig, Edition 10, 2014 John Wiley &Sons.
4. “Information Theory, Inference and Learning Algorithms”, by David J.C. MacKay,2003 Cambridge University Press.

| 22-382-0102 | DATA STRUCTURES AND ALGORITHMS USING C | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Mathematical Fundamentals
**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Explain different constructs of the C programming language. | (Cognitive level: Understand) |
| **CO 2** | Describe functions, structures, and pointers in C. | (Cognitive level: Understand) |
| **CO 3** | Differentiate between linear and non-linear data structures. | (Cognitive level: Understand) |
| **CO 4** | Illustrate the use of various data structures ( Heap / Graph) for solving a given computational problem. | (Cognitive level: Analyse) |
| **CO 5** | Select appropriate sorting technique for a given scenario and storing the given dataset using appropriate hash function. | (Cognitive level: Analyse) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | | | | | | | | | |
| **CO2** | 3 | 3 | 2 | | | | | | | | | |
| **CO3** | 3 | 2 | 2 | 2 | | | | | | | | |
| **CO4** | 3 | 3 | 3 | 3 | | | | | | | | |
| **CO5** | 3 | 2 | 3 | | | | | | | | | |

## 22-382-0102 DATA STRUCTURES AND ALGORITHMS USING C

**UNIT I (10 Hours)**

Basic Programming Constructs of C: Character Set, Identifiers and Keywords, Variables, Constants, Operators and Expressions; Data Types: Basic data types, Array, String;Control Structures: Conditional statements, Branching, Looping, switch, break, continue, goto statements.

**UNIT II (12 Hours)**

Functions: function declaration, function definition, function prototype, function call, passing parameters to functions, Returning value, passing arrays to functions, Recursion, Macro; Structure: Declaration, initialization, nested structures;Union; Pointers: Pointer Variables, Dereferencing Pointers; Dynamic Memory Allocation: malloc, calloc, realloc and free functions.

**UNIT III (12 Hours)**

Elementary Data Structures: List, Stack, Queue-Array and Linked List Implementation. Non Linear Data Structure: Trees -Binary Trees, Binary Tree traversal (In Order, Pre Order, Post Order) Binary Search Tree: Searching an element in BST, Insertion and Removal of Elements

**UNIT IV (14 Hours)**

Heaps: Properties, Representations (Array Based and Linked). Min Heap, Max Heap. Insertion and deletion of elements, Heap implementation of priority queue.

Graphs: Properties, Representations (Edge List, Adjacency list, Adjacency Matrix), Graph Traversals (Depth First and Breadth First Search), Directed Graph.

**UNIT V (12 Hours)**

Sorting Techniques – Insertion Sort, Quick Sort, Merge Sort and Heap Sort

Dictionaries: Hash Tables, Hash Functions, Collision Handling Methods - Separate Chaining, Open Addressing - Linear & Quadratic Probing, Double Hash

**TEXTBOOK**


1. "Fundamentals of Data Structures in C", by Ellis Horowitz. SartajSahni and Anderson Freed, Edition 2, 2008, Universities Press.
2. " Mastering C", by K.R .Venugopal, S.R Prasad Edition 11, 2011 , Reprint, Tata McGraw-Hill.
3. "Introduction to Algorithms", by Thomas H. Cormen, Charles E. Leiserson, Ronald L,Edition 4.


**REFERENCE BOOKS**


1. "The C Programming Language",by Kernighan, Brain W and Ritchie, Dennis M,Edition 2,2007, Prentice Hall.
2. "Programming with C", Byron Gottfried,Edition 2, 2002,Schaum's outline series3.
3. "Data Structures using C",by Aaron M.Tanenbaum, Moshe J.Augenstein,1986, Prentice Hall International Inc, Englewood Cliffs, NJ.
4. "Data Structures using C", by Aaron M Tanenbaum,YedidyahLangsam, Moshe J Augenstein, 2009,Prentice Hall International, Inc.
5. " Algorithms and Data Structures :The Basic Toolbox" ,by Kurt Mehlhorn and Peter Sanders , 2008,Springer-Verlag Berlin Heidelberg.


**Web Resources**

*NPTEL*

- **Data Structures And Algorithms** - (**Computer Science and Engineering** course from **IIT Delhi**) NPTEL Lecture Videos by **Prof. Naveen Garg** from **IIT Delhi**

  https://www.nptelvideos.com/course.php?id=401

| 22-382-0103 | DIGITAL FUNDAMENTALS AND COMPUTER ARCHITECTURE | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite**: Basic Mathematics

**Course Outcomes**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| CO1 | Apply K-Map to simplify Boolean functions and solve number conversion related problems. | Cognitive level: Apply |
| CO2 | Compare different types of Mnemonic instructions, and employ Arithmetic, logical, shift, and rotate operations on these instructions. | Cognitive level: Analyze |
| CO3 | Discuss Computer Architecture related concepts such as memory hierarchy, memory technologies and Interrupts. | Cognitive level: Understand |
| CO4 | Apply binary addition, subtraction, multiplication and division using appropriate algorithms. | Cognitive level: Apply |
| CO5 | Explain various Instruction fetching, Execution and processing concepts. | Cognitive level: Understand |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | | | 1 | | | | | | |
| **CO2** | 3 | 3 | | | | 1 | | | | | | |
| **CO3** | 2 | 1 | | | | 1 | | | | | | |
| **CO4** | 3 | 3 | 2 | | 1 | 1 | | | | | | |
| **CO5** | 1 | 1 | | | | 1 | | | | | | |

## 22-382-0103 DIGITAL FUNDAMENTALS AND COMPUTER ARCHITECTURE

**UNIT I (12 Hours)**

Review of number systems: Binary, Octal, Hexadecimal, BCD,EBCDIC. Number base conversions. Boolean Algebra: Theorems and Properties, Sum Of Products, Product Of Sums and Canonical forms. Digital Logic gates, K-Maps, Simplification of Boolean Functions using K-Maps. Latches and flip-flops: SR, D, JK and T.

Timers and Counters

**UNIT II (12 Hours)**

Von-Neumann Architecture, Instruction set architecture: Arithmetic, logical, shift, and rotate operations. Instruction Set Architecture - Instructions and Instruction Sequencing, Addressing Modes, Subroutines, Condition Codes, Encoding of Machine Instructions

**UNIT III (12 Hours)**

Input /Output Organization - Accessing I/O Devices, Interrupts. The Memory System - Semiconductor RAM Memories, Read-only Memories, Memory Hierarchy, Cache Memories - Mapping Functions

**UNIT IV (12 Hours)**

Computer Arithmetic - 1's and 2's complement representations, Addition and Subtraction of Signed Numbers, Multiplication of Unsigned Numbers, Multiplication of Signed Numbers, Integer Division and Related problems

**UNIT V (12 Hours)**

Basic Processing Unit - Some Fundamental Concepts, Instruction Execution, Hardware Components. Instruction Fetch and Execution Pipelining: Basic Concept, Pipeline Organization, Pipelining Issues: Data Dependencies, Memory Delays, Branch Delays.

**Text Books**

1."Digital Design",by M. Morris Mano, Edition 6,2018, Prentice Hall of India Pvt. Ltd.
2. "Computer organization And Embedded Systems", by Hamacher, Vranesic, Zaky, Manjikian, Edition 6, 2012, McGraw-Hill.

**Reference Books**

1. "Computer Architecture And Organisation", by Manish Saraswat,Edition 1,2011, Vayu Education Of India.

2. "Structured Computer Organization", by Tanenbaum A.S ,Edition 5, Prentice Hall of India, 2006.

3. "Computer System Architecture", by Mano M M, Edition 3,2007,Prentice Hall of India.

4."Computer Architecture and Organization", by Hayes ,Edition 2,1998, McGraw Hill.

5. "Fundamentals of Logic Design", by Charles H. Roth, Jr, Edition 6, 2009,Brooks/Cole.

6. "Digital Fundamentals", by Thomas L, Edition 10,2009,Floyd & R P Jain, PHI.

**Web Resources**

1. NPTEL: https://onlinecourses.nptel.ac.in/noc19_ee51/preview
2. Coursera: https://www.coursera.org/learn/digital-systems
3. EDX/UPGRADE : https://www.edx.org/learn/electronics

| 22-382–0104 | SOFTWARE ENGINEERING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite: NIL**

**Course Outcomes:**

After completion of this course, students will be able to

| | | |
|---|---|---|
| **CO1** | Choose suitable life cycle models to be used in a particular context. | (Cognitive level : Apply) |
| **CO2** | Develop a Software Requirement Specification. | (Cognitive level : Apply) |
| **CO3** | Develop a UML Diagram from data. | (Cognitive level : Apply) |
| **CO4** | Compare different testing strategies. | (Cognitive level : Understand) |
| **CO5** | Summarize Software Quality Assurance | (Cognitive level : Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | | 1 | | | 2 | 1 | | | | |
| **CO2** | 2 | 2 | 2 | 1 | 2 | | 2 | 1 | | | | |
| **CO3** | 2 | 2 | 2 | 1 | 2 | | 2 | 1 | | | | |
| **CO4** | 2 | 1 | 2 | | | | 2 | 1 | | | | |
| **CO5** | 2 | 1 | 2 | | | | 2 | | | | | |

## 22-382-0104 SOFTWARE ENGINEERING

**UNIT I ( 12 Hours)**

Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - Software process models- Waterfall Model, V-process model, Spiral Model, Prototyping Model, Software Iterative and Incremental Method. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques- Scrum, Lean(LN),Extreme Programming (XP), Agile Unified Process (AUP). Agile Project Management. Overview of DevOps and Code Management – Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD).

**UNIT II( 8 Hours)**

Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Software Design- Overview of Software Design, How to characterize a good software design, Cohesion and coupling, Layered arrangement of modules, Approaches to Software Design.

**UNIT III( 8 Hours)**

Software Maintenance – Characteristics of Software Maintenance, Software Reverse Engineering, Software maintenance process models, Estimation of maintenance cost. Object Modeling using UML – Basic object Orientation concepts, Unified Modeling Language, UML diagrams, Use Case Model, Class Diagrams, Interaction Diagrams, Activity Diagram, State Chart diagram.

**UNIT IV( 8 Hours)**

Coding and Testing – Coding, code review, Software Documentation, Testing, Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation.

**UNIT V( 9 Hours)**

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks, Software measurement and metrics. Software Process Improvement (SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service (IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservice deployment

**Textbook:**


- "Fundamentals of Software Engineering",byRajib Mall, Edition 5, February 2019,PHI Learning Pvt. Ltd.,
- "Software Engineering–a Practitioner's approach" by Roger S Pressman, Edition 7,2017,McGraw Hill.
- "Software Engineering" by Ian Sommerville, Edition 10,October 2018,PEARSON INDIA.
- "Software Engineering A Precise Approach" by Pankaj Jalote, 2010, WILEY INDIA
- "Software Testing- Principles, Techniques and Tools", M G Limaye
- Software Quality Assurance from theory to implementation, Daniel Galin

| 22-382-0105 | PYTHON PROGRAMMING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Basic knowledge in Algorithms, Data structures

**Course Outcomes**
After completion of this course, students will be able to

| | | |
|---|---|---|
| **CO1** | Discuss various control structures and data structures in Python. | (Cognitive level : Understand) |
| **CO2** | Describe procedural and object oriented concepts | (Cognitive level : Understand) |
| **CO3** | Implement GUI programming, and exception handling | (Cognitive level : Apply) |
| **CO4** | Analysis of data with numpy, pandas. | (Cognitive level : Analyze) |
| **CO5** | Create visualizations using python | (Cognitive level : Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | | 1 | | 2 | | 2 | 2 | | | | |
| **CO2** | 2 | 2 | 2 | | 2 | | 2 | 2 | | | | |
| **CO3** | 2 | | 2 | | 3 | | 2 | 2 | | | | |
| **CO4** | 3 | 2 | 2 | 3 | 3 | | 2 | 2 | | | | |
| **CO5** | 2 | 2 | 2 | 3 | 3 | | 2 | 2 | | | | |

## 22-382-0105 PYTHON PROGRAMMING

**UNIT I (6 Hours)**
Introduction to computer programming: Python as a programming language. Python Data Types, Strings: Basic Operation, Indexing and Slicing, String Methods, String Formatting Expressions, String Formatting Method Calls, Comments, Expressions, Variables, and Assignments, Control Structures, Looping and Branching.

**UNIT II (8 Hours)**
List: Basic List Operations, List Iteration and Comprehensions, Indexing, Slicing, Two Dimensional Lists, Iterating through Two Dimensional Lists. Dictionaries: Basic Dictionary Operations, Changing Dictionaries in Place, Methods, Example: Movie Database. Tuples and Sets (Properties, Operators, and Methods). User-Defined Functions, Lambda Function, Zip Function, Parameter Passing (thrusting mutable and immutable parameters). Recursion, Memory Management During Recursive Function Calls. Global versus Local Namespaces.

**UNIT III (11 Hours)**

Objects and Classes, Defining a Class in Python, Constructors. Classes as Namespaces, Inheritance: Multiple and Multilevel Inheritance, Modifying Built in Classes Using Inheritance, Operator Overloading (Integer Class Operators only) Using Inheritance. Errors and Exceptions: Exception Types, Exception Handling using Try & Except. User Defined Exceptions. Graphical User Interfaces: Tkinter Widgets – Label, Text, Entry, Button, Canvas & Frames, Event-Based tkinter Widgets, Designing GUIs, OOP for GUIs.Turtle Graphics: Familiarization of various Turtle Graphics Methods, Moving and Repositioning Pointer, Drawing Geometric Shapes, Coloring of Drawings. Simple animations using Open CV.

**UNIT IV (12 Hours)**

Stack and Queue, Tree, Linked List : Operations (search, insert, delete). Decorators in Python. Database Programming in Python with sqlite3: Creating Tables, Querying (Inserting Tuples, Selecting Rows and Updating Tuples), Using Cursor to Iterate over Selected Tuples. Files: Opening Files, Using FileText and Binary Files, Storing Python Objects in Files: Conversions, Storing Native Python Objects: pickle, Storing Python Objects in JSON Format, Storing Packed Binary Data: struct. NumPy: Creating Arrays (array() and arange(), reshape(), sum(), min() and max() methods, Item wise arithmetic operations. Pattern Matching Using Regular Expressions: Python Standard Library Module RE.

**UNIT V (8 Hours)**

Introduction to Pandas: Pandas data structures – Series and DataFrame, Data wrangling using pandas: Loading a dataset into a dataframe, Selecting Columns from a dataframe, Selecting Rows from a dataframe, Adding new data in a dataframe, Deleting data from a dataframe. Introduction to Matplotlib: Scatter plot, Line plot, Bar chart, Histogram, Box plot. Visualize Distributions With Seaborn. Web scraping: Beautiful Soup.

**TEXT BOOKS/REFERENCES**


1. Mark Lutz, 'Learning Python', 5th Edition, O'Reilly Media, Inc.
2. LjubomirPerkovic, "Introduction to Computing Using Python: An Application Development Focus", Wiley, 2012.
3. Charles Dierbach, "Introduction to Computer Science Using Python: A Computational Problem-Solving Focus", Wiley, 2013.
4. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing,2016


**Web Resource:**

1. **https://onlinecourses.nptel.ac.in/noc19_cs41/preview**
2. https://nptel.ac.in/courses/106106212
3. https://www.coursera.org/specializations/python-3-programming
4. https://www.coursera.org/specializations/python

| 22-382-0106 | DATA STRUCTURES LAB | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | LAB | 0 | 1 | 2 | 2 |

**Prerequisite:** Programming Fundamentals

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO1** | Implement basic C programs. | (Cognitive level: Apply) |
| **CO2** | Develop programs using C data types, Functions with recursion, Pointers and Structures. | (Cognitive level: Apply) |
| **CO3** | Apply elementary data structures, Non linear data structures and binary search tree using C. | (Cognitive level: Apply) |
| **CO4** | Implement Heap and Graph operations using C. | (Cognitive level: Apply) |
| **CO5** | Apply sorting techniques and Dictionary operations using C. | (Cognitive level: Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | 3 | | | 3 | | | | | | |
| **CO2** | | | 2 | | | 3 | | | | | | |
| **CO3** | | | 3 | | 2 | 3 | | | | | | |
| **CO4** | | | 3 | | | 3 | | | | | | |
| **CO5** | | | 2 | | 2 | 3 | | | | | | |

**22-382-0106- DATA STRUCTURES LAB**

1. Write a C program to evaluate the arithmetic expression ((a -b / c * d + e) * (f +g)) and display its solution.
2. Create a C Program to read 3 integer values, find the largest among them.
3. Develop a C program to check if the number is Prime or not.
4. Develop a program to check whether the given number is armstrong or not.
5. Write a c program to read a string and count the number of vowels, consonants and spaces in it.
6. Using structure, write a program to read and print data of n employees (Name, Employee Id and Salary)
7. Write a C program to create a fibonacci series using recursive function.
8. Find the factorial of a given Natural Number n using
   i) a non recursive function
   ii) a recursive function

9 . Do the following using pointers
   i) add two numbers
   ii) swap two numbers using user defined function

10. Construct binary search trees to perform insertion, deletion, search
11. Apply Queue and stack in Breadth First Search and Depth First Search respectively
12. Write a program to create a binary search tree and find the number of leaf nodes
13. Create a binary search tree with the following operations:
   i)Insert a new node .
   ii)Inorder traversal.
   iii)Preorder traversal.
   iv)Postorder traversal.
   v)Delete a node.
14. Design, develop, and execute a program in C to create a max heap and perform the following operations
   i)Insertion
   ii)Deletion
   iii)Print Largest Value
15. Write a program to implement Depth First Search (DFS) graph traversal methods.
16. Write a program to implement Depth First Search (DFS) graph traversal methods.
17. Create a text file containing the name, height, weight of the students in a class. Perform Quick sort and Merge sort on this data and store the resultant data in two separate files. Also write the time taken by the two sorting methods into the respective files.

   Sony Mathew 5.5 60
   Arun Sajeev 5.7 58
   Rajesh Kumar 6.1 70

18. Write a program to sort a set of numbers using Heap sort and find a particular number from the sorted set using Binary Search.
19. Implement a Hash table using Chaining method. Let the size of hash table be 10 so that the index varies from 0 to 9.
20. Implement a Hash table that uses Linear Probing for collision resolution

| 22-382-0107 | PYTHON PROGRAMMING LAB | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | LAB | 0 | 1 | 2 | 2 |

**Prerequisite:** Programming Fundamentals

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO1** | Apply different data types based on the requirement | (Cognitive level : Apply) |
| **CO2** | Apply functions and object-oriented principles in programming | (Cognitive level : Apply) |
| **CO3** | Employ exception handling and database connectivity to develop robust applications in python | (Cognitive level : Apply) |
| **CO4** | Able to develop websites using Django framework | (Cognitive level : Apply) |
| **CO5** | Analyse data using Pandas library and Numpy package | (Cognitive level : Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | 3 | | | | | | | | | |
| **CO2** | 3 | | 3 | | | | | | | | | |
| **CO3** | 3 | | 3 | | | | | | | | | |
| **CO4** | 3 | | 3 | | 3 | | | | | | | |
| **CO5** | 3 | | 3 | | | | | | | | | |

## 22-382-0107 PYTHON PROGRAMMING LAB

**UNIT I :Data Types, Control Structures, Operators and Functions:**

Introduction to python, Python variables and assignments, Data types in python, Numbers, Strings, List and List processing, Tuple, Set, Dictionary. Operators. Flow Control: – Decision making statements and loops

**UNIT 2: Functions, Classes Files and Modules**:

Function and Function arguments, Anonymous functions, Recursive functions, User defined functions, Class, Constructor and methods. Inheritance, File handling in python:- Opening a file, Closing a file, Writing to a file, Reading from a file. Modules: - Modules and importing modules.

**UNIT 3: Exception Handling and Database Programming**

Exception Handling: -Built -in-Exceptions and user defined exceptions. Database programming:- python-SQLite connectivity

**UNIT 4: Web programming with Django**

Python web application framework - Django:- Introducing models, Views, Templates, urls, Custom user models, Permissions, Static and dynamic web pages, Deployment.

**UNIT 5: Data analysis with Pandas and NumPy**

Accessing and preparing data - Reading a file, indexing, selecting a subset. Data pre-processing with python: -Dropping columns in a dataframe, Changing the index of a dataframe, Tidying up fields in the data, Cleaning columns and data, Renaming columns and skipping rows. Numerical analysis using NumPy: - Handling arrays and analysing data

**Textbook & References**

1. An Introduction to Python by Guido Van Rossum, Fred L.Drake, Network Theory Limited.
2. Programming and Problem Solving with Python, Ashok NamdevKamthane& Amit Ashok Kamthane, McGrawHill Education (India) Private Limited
3. Django for Beginners: Build websites with Python and Django Paperback – March 7, 2018 by William S. Vincent
4. Python Data Science Handbook - Essential Tools for Working with Data , Jake VanderPlas,O'Reilly

**Online References**

http://www.tutorialspoint.com/python/,http://docs.python.org/tutorial/,
http://zetcode.com/tutorials/pythontutorial/,http://www.sthurlow.com/python/,
http://www.djangoproject.com/, http://www.djangobook.com/ ,https://realpython.co

| 22-382-0201 | COMPUTER NETWORKS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite: NIL**

**Course Outcomes**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Describe how computer networks are organized with the concept of layered approach | (Cognitive level : Understand) |
| **CO2** | Analyze topological and routing strategies for an IP based network | (Cognitive level : Analyze) |
| **CO3** | Compare protocols of computer networks, and how they can be used to assist in network design and implementation | (Cognitive level : Analyze) |
| **CO4** | Analyze congestion and flow control strategies | (Cognitive level : Analyze) |
| **CO5** | Implement network communication services for client/server and other application layouts (Create) | (Cognitive Level:Analyze) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | | | | | | | |
| **CO2** | 2 | 2 | | | | | | | | | | |
| **CO3** | 3 | 3 | | | | | | | | | | |
| **CO4** | 2 | 2 | | | | | | | | | | |
| **CO5** | 2 | 2 | | | 3 | | | | | | | |

## 22-382-0201 COMPUTER NETWORKS

**UNIT I (7 Hours)**

Introduction, history and development of computer networks, network topologies. Layering and protocols. Physical Layer: Different types of transmission media, errors in transmission: attenuation, noise. Repeaters. Encoding (NRZ, NRZI, Manchester, 4B/5B, etc.), MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols. Examples: Ethernet, including Gigabit Ethernet and WiFi (802.11), Token Ring, Bluetooth, WiMax

**UNIT II(8 Hours)**

The Services Provided by the Link Layer, Error-Detection and -Correction Techniques-Parity Checks, Checksumming Methods, Cyclic Redundancy Check (CRC), Switched Local Area Networks-Link-Layer Addressing and ARP, Ethernet, Link-Layer Switches, Virtual Local Area Networks (VLANs), Wireless Links and Network Characteristics-CDMA, 802.11 Architecture, 802.11 MAC Protocol, IEEE 802.11 Frame, Mobility in the Same IP Subnet

**UNIT III(10 Hours)**

IPv4 and IPv6 Addressing, IP Address – Subnetting / Super netting, Packet Forwarding with Classfull, Routing Algorithms-The Link-State (LS) Routing Algorithm, Distance-Vector (DV) Routing Algorithm, OSPF, Routing Among the ISPs: BGP-The Role of BGP, Advertising BGP Route Information, Determining the Best Routes, IP-Anycast, SDN Control Plane-SDN Controller and SDN Control Applications, Open Flow Protocol, Data and Control Plane Interaction, ICMP: The Internet Control Message Protocol, Simple Network Management Protocol (SNMP)

**UNIT IV (10 Hours)**

Transport-Layer Services, Multiplexing and Demultiplexing, Connectionless Transport-UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer, Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go-Back-N (GBN), Selective Repeat, Connection-Oriented Transport, TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control, causes and the Costs of Congestion, Congestion Control, TCP Congestion Control, Classic TCP congestion Control, Network-Assisted Explicit Congestion Notification and Delay-based Congestion Control, Fairness

**UNIT V (10 Hours)**

Principles of Network Applications-Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the Internet, Application-Layer Protocol, Web and HTTP, Electronic Mail in the Internet-SMTP, DNS—The Internet's Directory Service, Peer-to-Peer Applications, Video Streaming and Content Distribution Networks, Socket Programming: Creating Network Applications

**Text Books/References**


1. Kurose and Ross, Computer Networks A systems approach , Pearson Education.7th Edition . 2016.
2. AS Tanenbaum, DJ Wetherall, Computer Networks, 5th Ed., Prentice-Hall, 2010.
3. William Stallings, Data and Computer Communications, Pearson Education.
4. W. R. Stevens.*TCP/IP Illustrated, Volume 1: The protocols,*Addison Wesley, 1994.
5.G. R. Wright.*TCP/IP Illustrated, Volume 2: The Implementation,*Addison Wesley, 1995.
6. W. R. Stevens.*TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols,*Addison Wesley, 1996.
7. B.A. Forouzan, Data communication & networking, 5th Edition, Tata Mc-Graw Hills.

| 22-382-0202 | OPERATING SYSTEMS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite: NIL**

**Course Outcomes:**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Solve synchronization problems in operating systems and issues in distributed systems. | (Cognitive level : Apply) |
| **CO2** | Employ process scheduling algorithms and solve process scheduling problems. | (Cognitive level : Apply) |
| **CO3** | Compare various memory management schemes. | (Cognitive level : Analyze) |
| **CO4** | Solve problems using page replacement algorithms. | (Cognitive level : Apply) |
| **CO5** | Compare different access control mechanisms for protection. | (Cognitive Level:Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | | 1 | | | | | |
| **CO2** | 2 | 2 | | | | | 1 | | | | | |
| **CO3** | 2 | 2 | | | | | 1 | | | | | |
| **CO4** | 2 | 2 | | | | | 1 | | | | | |
| **CO5** | 2 | 2 | | | | | 1 | | | | | |

## 22-382-0202 OPERATING SYSTEMS

**UNIT I (10 Hours)**

Introduction to Operating Systems, Functions of Operating System,Design Approaches and Types of Advanced Operating Systems. Dual-mode operation, concept of multiprogramming, multiprocessing.Synchronization Mechanisms: Concept of Processes and Threads, Process states and processes state transition diagram, Process control block , process context, CPU Scheduling and Process Scheduling–The Critical Section Problem – Other Synchronization Problems:– Process Synchronization using semaphores & Monitors.

**UNIT II (8 Hours)**

Distributed Operating Systems:- Issues in Distributed Operating System, Deadlock prevention, avoidance and detection & recovery - Dead Lock Characterization, Methods for handling Deadlock, Deadlock Prevention, Deadlock avoidance, Deadlock detection & recovery

**UNIT III(10 Hours)**

Memory Management - Types of memory, Memory organization, Address binding Memory Partitioning, Dynamic memory Partitioning, buddy system, Paging, Demand Paging, Segmentation, Page replacement algorithms.

**UNIT IV(10 hours)**

File System - Directory structure - single level, two-level, tree, acyclic graph, general graph; File system mounting, Implementing File System: File system structure - Layered file system, file attributes, File control block; File system implementation Directory Implementation, Allocation Methods

**UNIT V(7 Hours)**

Security and Protection - Goals, Principles in normal OS for security, Access Control models and methods.

**Text Books**


1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, ' Operating System Concepts' 9th Edition, Wiley India 2015.
2. Bhatt P. C. P., An Introduction to Operating Systems: Concepts and Practice, 3/e, Prentice Hall of India, 2010
3. William Stallings, Operating Systems: Internals and Design Principles, Pearson Global Edition, 2015.

4. Andrew S Tanenbaum, Herbert Bos, Modern Operating Systems, Pearson, 4/e, 2015.
5. D.M.Dhamdhere, “Operating Systems”, 2nd Edition, Tata McGraw Hill, 201.

| 22-382-0203 | MACHINE LEARNING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Basic concepts related to data

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Describe various Data Reduction and transformation methods. | (Cognitive level : Understand) |
| **CO2** | Solve problems related to NN and DNN. | (Cognitive level : Apply) |
| **CO3** | Apply association rule mining algorithms for frequent pattern mining. | (Cognitive level : Apply) |
| **CO4** | Apply various Regression,classification and clustering algorithms. | (Cognitive level : Apply) |
| **CO5** | Compare the performance of various Machine Learning algorithms. | (Cognitive level : Analyze) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO 3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 1 | | | | | | | | | | |
| **CO 2** | 3 | 2 | | | | | | | | | | |
| **CO 3** | 3 | 2 | 1 | | 3 | | 2 | | | | | |
| **CO 4** | 3 | 2 | 3 | | 3 | | 2 | | | | | |
| **CO 5** | 3 | 2 | 2 | 3 | 3 | | 2 | | | | | |

## 22-382-0203 MACHINE LEARNING

### UNIT I(10 Hours)

Foundations of Learning - Components of learning – learning versus design – Introduction to Machine Learning - characteristics of machine learning – learning models – types of learning– training versus testing; Exploratory Data Analysis – mean, median, mode, quartile deviation, visualizing numeric variables – boxplots histograms, understanding categorical data – binomial and multinomial distributions, understanding numeric data – uniform, normal and chi-square distributions, Data Pre-processing - Data Cleaning, Missing Values, outliers, Noisy Data; Data Transformation and Discretization – Data Transformation Strategies, Data transformation by Normalization,various methods of Discretization.

**UNIT II (8 Hours)**

Association rule mining - Associations, and correlations, Market Basket Analysis, Frequent Itemsets and Association Rules, Mining Methods – The Apriori Algorithm, Generating Association Rules from Frequent Itemsets, Finding Frequent Itemsets without Candidate Generation, FP-Growth, FP-Tree.

**UNIT III(7 Hours)**

Regression and Classification - Regression – Simple Linear Regression, Multiple Regression, Assessing Performance, bias variance dichotomy, overfitting and underfitting, regularization. Classification- Decision tree induction, Bayes Classification, Rule Based Classification, Model evaluation and selection, Advanced Classification methods – Bayesian classification, Support vector Machines. Ensemble methods of classification, gradient boosting.

**UNIT IV(10 Hours)**

Cluster Analysis - Overview of Clustering Methods, Distance Measures, Partitioning methods - k-Means, k-Medoids; Hierarchical methods - Agglomerative versus Divisive Clustering, BIRCH, Chameleon, Density based methods - DBSCAN, Grid based methods – STING; Evaluation of Clustering. KNN algorithm.

**UNIT V(10 Hours)**

Neural Networks - Biological neuron, idea of computational units, McCulloch–Pitts unit and Threshold logic, Linear Perceptron, Multilayer Perceptron, Perceptron Learning Algorithm, Linear separability; loss functions – various types, hyper parameter tuning, Feed Forward Neural Networks, Forward propagation, activation functions and its derivatives, backpropagation and optimization functions, batch normalization, implementation.

**TEXT BOOKS**

1. Jiawei Han, Micheline Kamber, Jian Pei, “Data Mining - Concepts and Techniques” - Morgan Kaufmann Publishers, Third Edition, 2012.

2. T. M. Mitchell, “Machine Learning”, McGraw Hill, 2017.

**REFERENCES**

1. Ian H. Witten, Eibe Frank, “Data Mining - Practical Machine Learning Tools and Techniques”, Morgan Kaufmann Publishers, Third Edition, 2011.

2. Soman, Divakar and Ajay, “Data Mining – Theory and Practice”, PHI, 2006.

3. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Addison Wesley, 2006.

4. Arun K Pujari, “Data Mining Techniques”, Universities Press, 2001.

5. Margaret H Dunham, “Data Mining: Introductory and Advanced Topics”, Pearson Education India, 2006.

| 22-382-0204 | OBJECT ORIENTED PROGRAMMING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Programming Fundamentals.

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Explain OOP concepts | (Cognitive level : Understand) |
| **CO 2** | Apply OOP concepts like class, objects, constructors, methods, etc. using java. | (Cognitive level : Apply) |
| **CO 3** | Implement the concepts of inheritance, interfaces and packages | (Cognitive level : Apply) |
| **CO 4** | Apply the concepts of exception handling and multithreading | (Cognitive level : Apply) |
| **CO 5** | Design Graphical User Interface based application programs by using event handling features and Swing. | (Cognitive level : Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 1 | 1 | | 1 | | 2 | | | | | |
| **CO 2** | 2 | 2 | 2 | | 3 | 3 | 2 | | | | | |
| **CO 3** | 2 | 2 | 2 | | 3 | 3 | 2 | | | | | |
| **CO 4** | 2 | 2 | 2 | | 3 | 3 | 2 | | | | | |
| **CO 5** | 1 | 2 | 2 | | 3 | 3 | 2 | | | | | |

## 22-382-0204 OBJECT ORIENTED PROGRAMMING

### UNIT 1: (7 Hours)

Introduction to object oriented concepts and an Overview of Java : Principles of OOP, Applications of OOP, Java program structure and execution, Primitive data types, Type casting and conversion, Arrays, Operators, Control statements.

### UNIT 2: (10 Hours)

Object oriented programming in java : Class, objects, methods, basic input and output, Constructors, this keyword, Overloading methods and constructors, Using object as parameters and returning objects, Recursion, Access control, Static members, Final variables, Nested and inner classes, Handling Strings, Command line arguments.

**UNIT 3: (10 Hours)**

Inheritance : Inheritance basics, Access control during inheritance, the keyword super, method overriding, Abstract Classes and Methods, using final with Inheritance. Packages and Interfaces, File Handling.

**UNIT 4: (8 Hours)**

Exception Handling : Fundamentals and types, try Block and catch Clause, multiple catch clause, Nested try statements, throw, throws, finally, Creating custom exceptions. Multithreaded Programming : The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads,CustomThreads,Thread states, Thread synchronization.

**UNIT 5: (10 Hours)**

Event handling : Event Handling Mechanisms, Event Classes, Sources of Events, Event Listener Interfaces. GUI programming using Swing - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Database Connectivity.

**Text Book**


1. Java: The Complete Reference by Herbert Schildt, 11th Ed, 2018


**Reference Books**


1. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.
2. Horstmann and Coronell ,"Core Java -, Volume 1 and 2" , 10 th Ed, Pearson, 2016
3. E. Balagurusamy, Programming with Java, 6th Edition, McGraw-Hill Education, 2019.
4. Object-Oriented Design & Patterns, Cay Horstmann, Second Edition, Wiley 2006


**Web Resources**

1. https://onlinecourses.nptel.ac.in/noc21_cs56/preview
2. https://www.coursera.org/learn/object-oriented-programming-with-java

| 22-382–0205 | DATABASE MANAGEMENT SYSTEM | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Mathematical Fundamentals

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Employ ER diagram as a data modelling technique to represent entity framework. | (Cognitive level: Apply) |
| **CO 2** | Solve database queries using SQL and various database designs using logical database design principles including functional dependencies and normalization. | (Cognitive level: Apply) |
| **CO 3** | Explain the concepts of a database transaction and related database facilities (concurrency control and deadlock handling). | (Cognitive level: Understand) |
| **CO 4** | Describe the primary methods of organizing files of records on disk and the indexing techniques for files including B+ tree indexing and hash based indexing. | (Cognitive level: Understand) |
| **CO 5** | Differentiate between various types of databases including OODBMS, Distributed database, NOSQL Databases and Blockchain Database. | (Cognitive level: Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | 1 | | | | | | | | | |
| CO 2 | 3 | 2 | 2 | | | | | | | | | |
| CO 3 | 1 | 2 | | | 1 | | | | | | | |
| CO 4 | 3 | 3 | | | | | | | | | | |
| CO 5 | 2 | | 2 | | 3 | | | | | | | |

## 22-382-0205 DATABASE MANAGEMENT SYSTEM

### UNIT I (10 Hours)

Introduction:- Database-System Applications -Purpose of Database Systems- View of Data- Database Languages-Database design -Database Users and Administrators- History of Database Systems.Introduction to the Relational Model: Structure of Relational Databases- Database Schema- Key- Schema Diagrams. The Entity-Relationship Model-Attribute types- Mapping cardinalities- Weak Entity Set- Reducing E-R Diagrams to Relational Schemas.

**UNIT II (12 Hours)**
Relational Algebra- SQL Data Definition- Basic Structure of SQL Queries- Additional Basic Operations- Set Operations- Aggregate Functions- Nested Subqueries- Modification of the Database – Views – Integrity and Security – triggers, cursor, functions, procedure – Embedded SQL.Relational Database Design: Features of Good Relational Designs- Decomposition Using Functional Dependencies- Normal Forms(1NF, 2NF, 3NF, BCNF)

**UNIT III (8 Hours)**
Transaction concept–A Simple Transaction Model- ACID Properties- Serializability – testing Serializability- Concurrency Control – Locks- Two Phase locking – Deadlock handling – Timestamp based protocol, Recovery concepts.

**UNIT IV (8 Hours)**
Overview of Physical Storage Media- Database Storage Architecture- File Organization- Organization of records in files. Indexing - Basic Concepts- Ordered Indices- B+-Tree Index Files- Hash Indices.

**UNIT V (7 Hours)**
Object-Oriented Databases- Distributed databases –Distributed data Storage, Introduction to NOSQL Systems, Document-based NOSQL Systems and MongoDB

**Text Book**
1.Database System Concepts Seventh Edition. AviSilberschatz · Henry F. Korth · S. Sudarshan. McGraw-Hill
2.AviSilberschatz, Henry F. Korth, S. Sudarshan Database System Concepts, 7th Ed., McGraw Hill International Edition, 2019

**Reference Books**
1. Philip J. Pratt, Joseph J Adamski, ‘Database Management Systems’, Cengage Learning, 2011.
2. RameezElmasri, Shamkant B. Navathe, ‘Fundamentals of Database Systems’, 7th Ed., Pearson Education, 2015.
3. Arun K Majumdar, Pritimoy Bhattacharyya, ‘Database Management Systems’, TMH, 2017
4. Raghu Ramakrishnan, Johannes Gehrke ‘Database Management Systems’, McGraw Hill International Edition, 3 rd Edition, 2014

**Web Resource**

1.NPTEL: Course Name: Data Base Management System,
https://onlinecourses.nptel.ac.in/noc22_cs51/preview
2.Coursera:CourseName:DatabaseManagement Essentials,
https://www.coursera.org/learn/databasemanagement?action=enroll&authMode=signup trk_location=query-summary-list-link

| 22-382-0206 | JAVA LAB (OOPS) | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | LAB | 0 | 1 | 2 | 2 |

**Prerequisite:** Programming Fundamentals
**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Write basic java programs. | (Cognitive level : Apply) |
| **CO 2** | Implement basic OOPs concepts like class, objects, methods, etc. using java. | (Cognitive level : Apply) |
| **CO 3** | Write programs in java using inheritance, packages and interfaces. | (Cognitive level : Apply) |
| **CO 4** | Write programs in java using exception handling and multithreading concepts. | (Cognitive level : Apply) |
| **CO 5** | Develop interactive applications using GUI constructs , event handling methods and JDBC connectivity. | (Cognitive level : Create) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | 2 | 2 | 3 | 1 | 2 | | | | | |
| **CO2** | 2 | 2 | 3 | 3 | 3 | 3 | 2 | | | | 1 | 1 |
| **CO3** | 2 | 2 | 3 | 3 | 3 | 3 | 2 | | | | 1 | 1 |
| **CO4** | 2 | 2 | 3 | 3 | 3 | 3 | 2 | | | | 1 | 1 |
| **CO5** | 2 | 2 | 3 | 3 | 3 | 3 | 2 | | | | 1 | 1 |

## Experiment

1.Write a java program to display Fibonacci series up to a limit.
2.Write a java program that prints all real solutions to quadratic equation ax2+bx+c= 0.
3.Write a menu driven program to compute the area of a circle, triangle, square, rectangle, parallelogram and an ellipse (using switch case) . Display the menu to output the area as per users choice.
4.Write a java program that checks whether a given string is a palindrome or not.
5.Write a java program to multiply two given matrices.
6.Create a class ‘Account’ to represent a bank account. Write a program to deposit and withdraw amounts from the account.
7.Create a class Time with hh, mm, ss as data members. Write a java program to find the sum of two time intervals (Hint: Use object as parameter to function).

8.Write a program to add two complex numbers using this function.
9.Create a class Employee with ID, Name Designation and Dept. Create a child class salary with Basic, HRA, DA and Allowance. Write a program to compute the net salary assuming that HRA is 1250, DA, Allowance are 110% and 35% of the Basic salary.
10.Write a program to demonstrate inheritance hierarchy by using class a base class shape and TwoDim' and 'ThreeDim' as sub classes. Create classes ‘square’ and 'triangle' derived from TwoDim and 'sphere and 'cube' derived from ThreeDim. A reference variable of shape is used to determine area of various shapes.
11.Write a java program to find the volume of cube, rectangular box, cylinder using method overloading.
12.Write a program to demonstrate the use of the keyword “final” with variable, method, class.
13.Create an abstract class shape with two data members and an abstract method area. Create two child classes: rectangle and triangle. Write a program to display the area of the shapes.
14.Create an interface calculator having methods to perform basic arithmetic operations.
15.Built a package named mathperation,it should contain methods to calculate (i)Fibonacci numbers upto a limit (ii) prime numbers upto a limit, (iii) armstrong numbers in a range. Another file should import this package and demonstrate the use of all these methods.
16.Write a code to demonstrate arithmetic exception and array index out of bound exception. Assign values into array and demonstrate the same. Include the finally block along with the super class exception in the catch clause.
17.Create a user defined exception “MinBalExp“ to be invoked when the read number is less than a pre-set value, use try, catch, and finally.
18.Write a multithreaded java program for displaying odd numbers and even numbers up to a limit.
19.Write a java program that simulates a traffic light. Let the user select one of the three lights: red, yellow, or green with radio buttons. On selecting a button, an appropriate message with “stop” or “ready” or ”go” should appear above the buttons in a selected colour, initially there is no message shown.
20.Write a Java GUI program to accept the details of an employee and use JDBC to store the same on to a database table.

| 22-382–0207 | DBMS LAB | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | LAB | 0 | 1 | 2 | 2 |

**Prerequisite:** A sound knowledge of the basics of relational DBMS

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| CO 1 | Design a normalized database schema(upto 3NF) for a given problem domain using standard modeling techniques. | (Cognitive level : Apply) |
| CO 2 | Apply SQL (DDL/DML commands) to create, secure, populate, maintain, and query a database. | (Cognitive level : Apply) |
| CO 3 | Design and implement triggers and cursors. | (Cognitive level : Apply) |
| CO 4 | Employ integrity constraints on a database design using SQL. | (Cognitive level : Apply) |
| CO 5 | Implement stored functions, stored procedures, cursor, trigger using PL/SQL block. | (Cognitive level : Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | | 2 | 3 | | | | | | | | | 2 |
| **CO 2** | | 2 | 3 | | 3 | | | | | | | |
| **CO 3** | 3 | | 3 | | 3 | | | | | | | |
| **CO 4** | 2 | | 3 | | 3 | | | | | | | 2 |
| **CO 5** | 2 | | 3 | | 3 | | | | | | | |

**Text Books/References**


1. AviSilberschatz, Henry F. Korth, S. Sudarshan Database System Concepts, 7th Ed., McGraw Hill International Edition, 2019
2. Philip J. Pratt, Joseph J Adamski, ‘Database Management Systems’, Cengage Learning, 2011.
3. RameezElmasri, Shamkant B. Navathe, ‘Fundamentals of Database Systems’, 7th Ed., Pearson Education, 2015.
4. Arun K Majumdar, Pritimoy Bhattacharyya, ‘Database Management Systems’, TMH, 2017
5. Raghu Ramakrishnan, Johannes Gehrke ‘Database Management Systems’, McGraw Hill International Edition, 3 rd Edition, 2014.

**22-382–0207- DBMS LAB**

1. Design a database schema for any application with ER diagrams. Convert ER diagram into relational model. Normalize the above tables upto 3NF.
2. Create a table using SQL DDL commands. Apply integrity constraints (primary key, foreign key , not null) and change the existing schema definition using ALTER and DROP.
3. Modify the table by inserting, deleting, and updating records using SQL DML commands
4. Create a table Bank with the following fields (Acc_no integer primary key, Acc_namevarchar(20), branch_name varchar(20), Acc_type varchar(10), amount decimal(10,2)

Insert at least 5 records into the table.
1.Display the account details of "Savings Account" in Kochi branch.

2. Change the branch_name "Trivandrum" to "Thiruvanathapuram".

3.Display the details of customers in Thiruvananthapuram, Kochi and Palakkad.

4.List the details of customers in Thrissur branch having a minimum balance of Rs5000

5.Delete all the current accounts in the Mahe branch.

5. Use a Bank table and write SQL statements for the following.

1.Display the branch wise details of account holders in the ascending order of the amount.

2.Insert a new column named Minimum_amount into the table with default value 1000.

3.Update the Minimum_amount column with the value 1000 for the customers in branches

other than Alappuzha and Malappuram.
4.Find the number of customers who do not have the minimum amount 1000.

5..Remove the details of SB accounts from Thiruvananthapuram branch who have zero (0)

balance in their account.

6. Create table CLIENT_MASTER with attributes Client_No as primary key, Name, City,

Pincode and Bal_due.

Create table SALE_ORDER with attributes Order_No, Order_Date, Client_No,

Order_Status and Dely_Date.

Insert values into tables.

Write SQL queries to

1.List all details from the client_master table for clients whose Bal_due = 0.

2.Update table client_master, Change city of Client_no C00004 to Jaipur.

3.Retrieve records of clients residing in Mumbai.

4.Find the name and address of customer who has placed Order_no ‘O19003’ and ‘O19002’ respectively.

5.List the client_no, name, city and pincode of clients whose Order_status is “In process”

7. Create table supplier with attributes supplier number as primary key, supplier name and city.

Create a table parts with attributes partno as primary key, partname, color, weight and city.

Create a table shipment with attributes sno as references supplier number of supplier table, pno references partnumber of parts table, quantity, sno and pno as primary key.

Insert values into 3 tables.

Write SQL queries to

1.Change the city of suppliers whose sno is S1 to Hyderabad.

2.Update the quantity of all parts in the shipment table to quantity +10.

3.Get supplier name for all suppliers who supply part p1.

4.Get supplier number for suppliers who are located in same city as sno=S1.

5.Get supplier number for suppliers who supply at least one part supplied by sno=S2.

6. Get Sno’s for suppliers who do not supply any part supplied by sno=S2.

8. Student(snum: integer, sname: string, major: string, level: string, age: integer)

Class(name: string, meets at: time, room: string, fid: integer)

Enrolled(snum: integer, cname: string)

Faculty(fid: integer, fname: string, deptid: integer)

The meaning of these relations is straightforward; for example, Enrolled has one record per student-class pair such that the student is enrolled in the class.

Write the following queries in SQL.

1.Find the names of all Juniors (Level = JR) who are enrolled in a class taught by I. Teach.

2.Find the age of the oldest student who is either a History major or is enrolled in a course taught by I. Teach.

3.Find the names of all classes that either meet in room R128 or have five or more students enrolled.

4.Find the names of all students who are enrolled in two classes that meet at the same time.

5.Find the names of faculty members who teach in every room in which some class is taught.

9. Consider the following relations

Product (P_code, Description, Stocking_date, QtyOnHand, MinQty, Prices, Discount, V_code)

. Vendor (V_code, Name, Address, Phone).

Here a vendor can supply more than one product but a product is supplied by only one vendor. (NOTE: Identify the primary keys and foreign key from this statement)

Write SQL queries for the following:

1.List the names of all the vendors who supply more than one product.

2.List the details of the products whose prices exceed the average product price.

3.Create a view that contains Name, Address and Phone of the vendors who are currently not supplying any product.

10.Consider the following schema for a Library Database:

BOOK(Book_id, Title, Publisher_Name, Pub_Year)

BOOK_AUTHORS(Book_id, Author_Name)

PUBLISHER(Name, Address, Phone)

BOOK_COPIES(Book_id, Programme_id, No-of_Copies)

BOOK_LENDING(Book_id, Programme_id, Card_No, Date_Out, Due_Date)

LIBRARY_PROGRAMME(Programme_id, Programme_Name, Address)

Write SQL queries to

1.Retrieve details of all books in the library – id, title, name of publisher, authors, number of copies in each Programme, etc.

2.Get the particulars of borrowers who have borrowed more than 3 books, but from Jan 2017 to Jun 2017.

3 .Delete a book in BOOK table. Update the contents of other tables to reflect this data manipulation operation.

4.Partition the BOOK table based on year of publication.

5.Create a view of all books and its number of copies that are currently available in the

Library.

11. Consider the Company database

Employee(emp_no,emp_name, age, address, doj, mobile_no, dept_no,salary).

Department (dept_no, dept_name, location, budjet).

Write SQL queries to

1.Display records from Employee table whose age is between 25 and 45.

2.Display the details of all employees whose names staring with letter C

3.Display the details of all employees whose department is in the location Kochi in the decreasing order of their salary

4.Display the name of department whose budjet is less than the total salary of all employees in that deprtment

5.Create a view containing the empno empname mobile no, deptnodeptname in the alphabetical order of the department name.

12. Implementation of various control structures like IF-THEN,IF-THEN-ELSE, ,IF-THEN-ELSIF, CASE, WHILE using PL/SQL

13. Implementation of cursor

1.Create a table employee with empno, empname, empsal.

2.Insert values into table employee

3.Create another table temp with salary, eno and ename.

4.Write a program using cursor to find the first 5 highest paid employee and insert into temp.

14. Create a table Student(Rollno, Name, Sub1, Sub2, Sub3).

1.Insert values into the table.

2.Create another table Student_grade with Rollno, Total, percentage, grade.

3.Create a cursor to calculate total and percentage of students. Then find grade of students as given below:

< 40% FAIL

40 - 49.99% C

50 - 59.99% B

60 - 79.99% A

>= 80% HONORS

and insert into Student_grade.

15. Procedure for bank transaction**:**

1. Create a table with attributes id, nm, account number and balance.

2.Write a program for bank transaction using procedure.

16. Function for bank transaction:·

1.Create a table customer attributes id, num, accno , bal.

2.Write a program for bank transaction using function.

17. Trigger for loan generation:

1.Create a table account with attributes customerid, name and balance.

2.Create another loan with attributes cusid and amount.

3.Insert values into account table.

4.Create a trigger to check if the balance has gone below 0 , if so make necessary conditions

18. Create a table STUDENT with attributes student_ number, student_ name and total_ marks.
1.Insert values into the table.

2.Create a TRIGGER to check whether the total_ marks is less than zero if so then set it as

zero.

19. Create a table supplier with attributes supplier_ name , quantity, item_ name.
1.Enter values into the table.

2.Create a TRIGGER to check whether the quantity entered is zero if so then delete the entire

row.

20. Write a program to check whether a given number is Armstrong or not using the concept of stored procedure in MySQL.

| 22-382-0301 | WEB TECHNOLOGIES AND PROGRAMMING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Java Programming

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO1** | Employ XHTML tags and CSS constructs for Web Development | (Cognitive level : Apply) |
| **CO2** | Apply JavaScripts to do client-side processing in HTML forms | (Cognitive level : Apply) |
| **CO3** | Illustrate how MySql database tables are accessed using JDBC primitives for the insertion, retrieval and modification of data | (Cognitive level : Apply) |
| **CO4** | Use Java servlets to manage HTTP requests and responses and session tracking | (Cognitive level : Apply) |
| **CO5** | Apply the constructs of JSP, CSS and JavaScript and database technologies like XML and MySql to create user friendly websites and web based applications | (Cognitive level : Apply) |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | | | | | | | | |
| **CO2** | 2 | 2 | 2 | | | | | | | | | |
| **CO3** | 1 | 2 | 2 | | | | | | | | | |
| **CO4** | 1 | 1 | 1 | | | | | | | | | |
| **CO5** | 2 | 2 | 2 | | | | | | 2 | | | |

## 22-382-0301 WEB TECHNOLOGIES AND PROGRAMMING

**UNIT I(10 Hours)**

Overview of XHTML: Document Type Declarations, Familiarization of HTML syntax- characters and attributes. Headings, Spacing, Images, Links. Lists, Tables, Frames, Forms.

Creating Dynamic Web Pages using PHP. Introduction to Cascading Style Sheets. CSS attributes: background, color & font. Style Rule Cascading and Inheritance.

**UNIT II (14 Hours)**

JavaScript: Alert, Prompt and Confirm Windows.getElementById(), value and InnerHTML. Functions in JavaScript.Events in JavaScript: onclick, onmouseover, onmouseout, oninput, onfocus, onblur, onchange, onsubmit and onreset. Handling Strings, Numbers & Regular Expressions in JavaScript. Object Oriented Programming using JavaScript. Introduction to application development using AngularJs and JQuery and Struts.

**UNIT III (8 Hours)**

Java Servlets: Form GET and POST actions, HTTP client requests and server responses, Handling Sessions and Cookies.Java Database Connectivity: Connectivity with MySQL, Executing insert, update and select queries.

**UNIT IV (15 Hours)**

Java Server Pages: JSP Directives, Actions, JSP Implicit Objects, Processing HTML forms using JSP, File upload and Download.

**UNIT V (13 Hours)**

XML: Basic XML, Document Type Definition, XML Schema, Extensible Stylesheet Language (XSL) and XSL Transformation.XML and JSP: Processing XML files in JSP. Overview of AJAX. Introduction to Python based web application development using Django.

**Text Books**


1. Jeffrey C Jackson, "Web Technology – A computer Science perspective", Pearson Education, 2007
2. Deitel and Deitel and Nieto, "Internet and World Wide Web – How to Program", Prentice Hall, 5th Edition, 2011
3. Herbert Schildt, "Java-The Complete Reference", Eleventh Edition, Mc Graw Hill Professional, 2019
4. GuilioZambon, "Beginning JSP, JSF And Tomcat Java Web Development", Second Edition, Apress, 2012


**Reference Books**


1. Godbole, "Web Technologies", McGraw Hill Education, 2017
2. Laura Lemay, Rafe Colburn, Jennifer Kyrnin, "Mastering HTML, CSS &Javascript Web Publishing", BPB Publications, 2016
3. Jeffrey C and Jackson, "Web Technologies A Computer Science Perspective", Pearson Education, 2011


**Web Resources**

1. https://www.coursera.org/learn/html-css-javascript-for-web-developers
2. https://www.coursera.org/learn/java-database-connectivity-introduction
3. https://www.javatpoint.com/servlet-tutorial
4. https://www.tutorialspoint.com/jdbc/index.htm
5. https://www.w3schools.com/css/
6. https://www.w3schools.com/js/

| 22-382-0302 | CRYPTOGRAPHY AND NETWORK SECURITY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 1 | 0 | 4 |

**Prerequisite:** Basic Mathematics

**Course Outcomes**

After completion of this course, students will be able to

| | | |
|---|---|---|
| **CO1** | Solve the problems using Classical Cryptography. | (Cognitive level : Apply) |
| **CO2** | Compare Feistel and Non Feistel ciphers, and Describe Block Cipher modes of operation. | (Cognitive level : Analyze) |
| **CO3** | Apply public key cryptosystems – RSA,Elgamal and ECC for confidentiality. | (Cognitive level : Apply) |
| **CO4** | Describe the use of hash functions and explain hash algorithms MD5 and SHA. | (Cognitive level : Understand) |
| **CO5** | Discuss Digital Signature Schemes and Various Protocols. | (Cognitive level : Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 1 | 2 | | 2 | | | | |
| **CO2** | 3 | 3 | | | | | | | | | | |
| **CO3** | 3 | 3 | 2 | 2 | 1 | 2 | | 2 | | | | |
| **CO4** | 3 | 3 | | | | | | | | | | |
| **CO5** | 3 | 3 | | | | | | | | | | |

## 22-382-0302 - CRYPTOGRAPHY AND NETWORK SECURITY

**UNIT I (9 Hours)**

Classical cryptography: Shift cipher, Substitution cipher, Affine cipher, Vigenere cipher, Hill cipher, Permutation cipher, Stream ciphers, Product Ciphers: Playfair Cipher. LFSR, Cryptanalysis on Classical Ciphers.

**UNIT II (10 Hours)**

Block ciphers: Substitution Permutation Networks, Feistel cipher, Data Encryption Standard, Cryptanalysis: Differential Cryptanalysis and Linear Cryptanalysis, Multiple encryption: 3-DES, Advanced Encryption Standard, Analysis of AES, Block Cipher Modes of operation.

**UNIT III (13 Hours)**
Public Key Cryptosystems: Integer factorization problem, Discrete logarithm problem, RSA cryptosystem, Attacks on RSA, Diffie-Hellman Key agreement Protocol, ElGamal cryptosystem, Elliptic curve cryptography,Homomorphic Encryption, Secret Sharing Schemes

**UNIT IV (6 Hours)**
Pseudo Random Number Generators(PRNG): LCRNG, RSA, BBS. Cryptographic Hashes for Integrity, Hash functions: MD5, Secure Hash Algorithm(SHA1, SHA512, SHA1024), Message Authentication Code(MAC),Signature schemes: RSA signature, ElGamal signature, ECDSA.

**UNIT V (7 Hours)**
Network Security protocols:SSL,TLS,IPSec.Application Layer Security Protocols: PGP,S/MIME,SET.

**References:**


1. Behrouz A Forouzan, Cryptography and Network Security, Tata Mc Graw Hill, 2005.
2. Cryptography: Theory and Practice, (Third Edition), Douglas R. Stinson.
3. William Stalings, Cryptography and Network Security, Principles and Practices. 6th EdPearson Education, 2014.
4. Handbook of Applied Cryptography, (Second Edition), Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone.
5. Introduction to Modern Cryptography, (Second Edition), Jonathan Katz, Yehuda Lindell.
6. Understanding Cryptography: A Textbook for Students and Practitioners, (2010 Edition),ChristofPaar, Jan Pelzl.
7. Introduction to Cryptography with Coding Theory, (Second Edition),Wade Trappe, Lawrence C. Washington.
8. Network Security and Cryptography, Bernard Menezes.


**Web Resource:**

1. https://nptel.ac.in/courses/106/105/106105162/
2. https://nptel.ac.in/courses/106/105/106105183/
3. https://nptel.ac.in/courses/106/107/106107155/
4. https://www.coursera.org/learn/crypto

| 22-382-0303 | MINI PROJECT | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | PROJECT | 0 | 1 | 6 | 4 |

**Course Outcomes**

After completion of the mini project students will be able to

| | | |
|---|---|---|
| **CO 1** | Analyze the requirements and existing systems/literature for the identified problem. | (Cognitive Level: Analyze) |
| **CO 2** | Design a solution for the identified problem | (Cognitive level : Apply) |
| **CO 3** | Develop the solution using appropriate software tools | (Cognitive level : Create) |
| **CO 4** | Test and validate the solution | (Cognitive level : Evaluate) |
| **CO 5** | Deploy the developed product and document the project | (Cognitive level : Apply) |

Mapping of course outcomes with program outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | | | | | | | | | |
| **CO 2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | | | | |
| **CO 4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | 3 | |
| **CO 5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Mark Division**

| | |
|---|---|
| Continuous Assessment by Guide | 15 |
| Internal Evaluation | 10 |
| Final Panel Evaluation | 25 |

## 22-382-0401 Internship/Project Work

**Course Outcomes**

**After completion of the project work students will be able to**

| | | |
|---|---|---|
| **CO 1** | Analyse the requirements and existing systems/literature considering realistic constraints. | (Cognitive Level: Analyse) |
| **CO 2** | Examine the literature and describe solution for the identified problem | (Cognitive level: Analyse) |
| **CO 3** | Develop the solution using appropriate software tools | (Cognitive level: Create) |
| **CO 4** | Test and validate the solution | (Cognitive level: Evaluate) |
| **CO 5** | Deploy the developed product and document the project | (Cognitive level: Apply) |

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | 3 | | | | | | | | | |
| CO 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | |
| CO 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | | | | |
| CO 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | 3 | |
| CO 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Mark Division**

| | |
|---|---|
| **Continuous Assessment by Guide** | 100 |
| **Internal Evaluation by Guide** | 100 |
| **Final Panel Evaluation** | 100 |
| **Demonstration and report submission** | 100 |

**ELECTIVES**

**ELECTIVE 1- INTERDISCIPLINARY ELECTIVE**

**ELECTIVE 2- MOOC**

**ELECTIVE 3**

| 22-382-0331 | NATURAL LANGUAGE PROCESSING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** Basic Data Structures

**Course Outcomes:** After the completion of the course the student will be able to

| | |
|---|---|
| **CO 1** | Describe language models in NLP |
| **CO 2** | Explain preprocessing steps in NLP and describe grammars and how a language is built based on grammar |
| **CO 3** | Discuss various vectorization techniques and apply them in various datasets |
| **CO 4** | Explain Neural Language Models and apply supervised ML techniques to various datasets |
| **CO 5** | Describe various DL techniques that are used with NLP |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 1 | | | | | | | | | | |
| CO 2 | 2 | 2 | | | | | | | | | | |
| CO 3 | 2 | | 3 | | 3 | | | | | | | |
| CO 4 | 2 | 2 | 3 | | 3 | | | | | | | |
| CO 5 | 2 | 1 | | | | | | | | | | |

## 22-382-0331 NATURAL LANGUAGE PROCESSING

**UNIT I (7 Hours)**

Regular Expressions, Text Normalization, Edit Distance, Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance, N-gram Language Models, N-Grams, Evaluating Language Models

**UNIT II(10 Hours)**

Preprocessing: Handling corpus-raw text - Stemming and Lemmatization for raw text, Stop word removal, Feature Engineering: Understanding feature engineering, a Basic feature of NLP - Parsers and parsing, Types of grammar, POS tagging and POS taggers, n-grams, Bag of words, TF-IDF, Encoders, and decoders, Probabilistic models,NLTK

**UNIT III (5Hours)**

Advanced Feature Engineering: Word embedding, Understanding the basics of word2vec, Understanding the components of the word2vec model, Main processing algorithms - CBOW, Skip-gram, Applications of word2vec, and simple examples

**UNIT IV (6 Hours)**

Understanding ML algorithms for NLP: Supervised ML algorithms: Decision tree, Random forest, Naive Bayes, Support vector machines,UnSupervised ML algorithms:-K means clustering,DBSCAN

**UNIT V (7Hours)**

Neural Networks and Neural Language Models: Training Neural Nets, Neural Language Models ,Deep Learning Architectures for Sequence Processing: Recurrent Neural Networks, Managing Context in RNNs: LSTMs and GRUs, Self-Attention Networks: Transformers Case studies: Word sense disambiguation system, Automatic Question Answering system

**TEXTBOOK**


1. Jurafsky, Dan. Speech & language processing. Pearson Education India, 2020.
2. Thanaki, Jalaj. Python natural language processing. Packt Publishing Ltd, 2017.


**REFERENCE BOOKS**


1. Goldberg, Yoav. "Neural network methods for natural language processing." Synthesis lectures on human language technologies 10.1 (2017): 1-309.
2. Manning, Christopher, and Hinrich Schutze. Foundations of statistical natural language processing. MIT Press, 1999.
3. Kulkarni, Akshay, and Adarsha Shivananda. Natural language processing recipes: Unlocking text data with machine learning and deep learning using python. Apress, 2019.

| 22-382-0332 | INTERNET OF THINGS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** Nil

**Course Outcome:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Describe general concepts of Internet of Things. | (Cognitive level : Understand) |
| **CO 2** | Compare M2M and IoT Architectures. | (Cognitive level :Analyse) |
| **CO 3** | Describe about various devices, sensorsrequired for IoT applications | (Cognitive level : Understand) |
| **CO 4** | Design IoT Applications using Arduino IDE. | (Cognitive level : Create) |
| **CO 5** | Develop various use cases for IoT | (Cognitive level : Create) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 3 | | | | | | | | | | |
| CO 2 | 2 | 2 | | 3 | | | | | | | | |
| CO 3 | 2 | | | | | | | | | | | |
| CO 4 | 3 | 3 | 3 | | 3 | 2 | 2 | | | | 1 | |
| CO 5 | 3 | 3 | 3 | | 3 | 2 | 2 | | | 3 | 1 | |

## 22-382-0332- INTERNET OF THINGS

**UNIT I (10 Hours)**

Internet of Things - Definition and Characteristics of IoT, Sensors, Actuators,
Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing, Embedded Systems,

**UNIT II (8 Hours)**

Design of IoT, IoT Application Areas, Domain Specific IoTs – Home, City, Environment, Energy, Agriculture and Industry, IoT Examples, Layered architecture of IoT.Protocols for IoT- IEEE 802.15.4-, Zigbee, Zigbee Architecture ,WiFi, LowPAN, LoRaWAN. Machine to Machine communication – Differences and Similarities between M2M and IoT, CoAP.

**UNIT III(7 Hours)**

IoT Data Management - Device Management Gateways.Data Acquiring and Storage foR IoT Services.

**UNIT IV (10 hours)**

Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Raspberry Pi, Create Designs using Tinkercad.Prototyping and Designing the Software for IoT Applications- Programming using Arduino-Arduino Programs to Blink LED, Arduino Program to control traffic lights, Create Applications using sensors-Ultrasonic Sensor, Temperature Sensor, Moisture Level Sensor,

**UNIT V (10 Hours)**

Data Analytics for IoT, Web server for IoT, Blockchain and IoT,Cloud computing for data storage,Big data platform for the internet of things, Big Data Management Systems for the Exploitation of Pervasive Environments - Big Data challenges and requirements coming from different IoT based applications. Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture

**Textbooks/References**


1. Simon Monk, Raspberry Pi Cookbook, Software and Hardware Problems and Solutions, O'Reilly (SPD), 2016.

2. ArshdeepBahga and Vijay Madisetti,Internet of Things - A Hands-on Approach, Universities Press, 2015

| 22-382-0333 | EXPLAINABLE AI | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Course Outcomes**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Explain the need of Explainable AI in the context of machine learning. | (Cognitive level : Understand) |
| **CO2** | Analyse Global and local explanations using SHAP and LIME | (Cognitive level : (Analyze) |
| **CO3** | Develop interpretable CNN, use unsupervised learning to perform exploratory analysis on a model | (Cognitive level : Analyze) |
| **CO4** | Analyse counterfactual, contrastive XAI and interpret methods for multivariate forecasting and sensitivity analysis | (Cognitive level : Analyze) |
| **CO5** | Evaluate adversarial (evasion and poisoning) attacks on machine learning models | (Cognitive Level : Analyze) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | 1 | | 2 | 2 | | | | 1 | | |
| CO2 | 2 | 3 | 2 | 2 | 3 | | | | | 1 | | |
| CO3 | 2 | 3 | 2 | 2 | 3 | | | | | 1 | | |
| CO4 | 2 | 3 | 2 | 2 | 3 | | | | | 1 | | |
| CO5 | 2 | 3 | 2 | 2 | 3 | 2 | | | | 1 | | |

## 22-382-0333- EXPLAINABLE AI

**UNIT I (7 Hours)**

Machine Learning and Explainable AI, Need for XAI, Explainability and interpretability,XAI flow, Making ML models Explainable: Intrinsic Explanations, Post Hoc Explanations,Global or Local Explainability, Properties of Explanations.

**UNIT II (8 Hours)**

Intrinsic Explainable models: Loss Function, Linear Regression, Logistic Regression, Decision Trees, KNN.

Model Agnostic Methods For XAI: Global Explanations, Local Explanations, shap.KernelExplainer, Local Linear Surrogate Models (LIME): mathematical representation, creating agnostic AutoML template, Bagging classifier, Boosting classifier, Decision Tree, Extra Trees, Creating Lime Explainer, SHAP for Boosted Trees

**UNITIII (10 Hours)**

Explaining Deep Learning Models: Agnostic Approach-Adversarial features, Augmentations, Occlusions as augmentations, Occlusion as an Agnostic XAI method.

Opening Deep Networks: Layer Explanation,CAM and Grad-CAM,DeepShap/DeepLift, Explainability batch normalizing layer by Layer, Unsupervised methods

**UNIT IV (10 Hours)**

Counterfactual Explanations Method: Visualizing datapoint using What-If-Tool, Exploring data points, the logic of counterfactual explanations, contrastive explanations method (CEM), CEM applied to example dataset using CNN, Autoencoders, Interpretation methods for multivariate forecasting and sensitivity analysis: accessing time series models with traditional interpretation, Generating LSTM attribution with integrated gradients, compute local and global attribution

**UNIT V (10 hours)**

Understanding the effect of irrelevant features, feature engineering, detecting and mitigating bias, Adversarial attacks, evasion attacks, defending against targeted attacks with preprocessing, Shielding against evasion attacks via adversarial training, evaluating and certifying adversarial robustness

**Text Books**

[1] Explainable AI with Python, Antonio Di Cecco and Leonida Gianfagna, Springer, 2021

[2] Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps, Denis Rothman, Packt publisher, 2020

[3] Interpretable Machine Learning with Python: Learn to build interpretable high-performance models with hands-on real-world examples, by SergMasís , Packt publisher, 2021

**References**

[1] Interpretable Machine Learning, by Christoph Molnar
https://christophm.github.io/interpretable-ml-book/
[2] Deep Learning with Python, François Chollet, O'Reilly, ISBN 9781617294433, 2017

| 22-382-0334 | BIOINFORMATICS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** Basic of Biology and Algorithm Thinking

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Describe the basic concepts of molecular Biology, different biological databases & various data retrieval tools | (Cognitive level: Understand) |
| **CO 2** | Apply the sequence alignment algorithms for any given sequences. | (Cognitive level: Apply) |
| **CO 3** | Apply various algorithms of molecular phylogenetics | (Cognitive level:Apply) |
| **CO 4** | Analyze the primary and secondary protein structure prediction methods. | (Cognitive level: Analyze) |
| **CO 5** | Develop a solution using machine learning techniques for problems in Bioinformatics. | (Cognitive level: Create) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | | | 3 | 3 | | | | 2 | | |
| CO2 | 3 | 3 | 3 | 2 | 3 | | | | | 2 | | |
| CO3 | 3 | 3 | 3 | 2 | 3 | | | | | 2 | | |
| CO4 | 2 | 2 | 3 | 2 | 2 | | | | | 2 | | |
| CO5 | 2 | 2 | 3 | 2 | 3 | 3 | | 3 | | 2 | | 2 |

## 22-382-0334 BIOINFORMATICS

**UNIT I (12 Hours)**

Basics of Molecular Biology- Cell as a unit of life-Nucleic Acid, Protein. Central Dogma of Molecular Biology, Genetic Code, Informatics in Biology- Bioinformatics and Computational Biology – Nature & Scope. Biological Databases – Primary DBs - Nucleotide Sequence databases, Protein Sequence databases. Secondary Dbs. Molecular Structure database. Literature database. Data Retrieval Tools – Entrez, SRS. Basic file formats- Ethical issues in Bioinformatics.

**UNIT II (10 Hours)**

Sequence Alignment- Basic concepts of sequence similarity, identity and homology. Scoring schemes, Gaps. Pairwise Sequence Alignment and Multiple Sequence Alignment; Global and Local Alignments. PAM and BLOSUM matrices. Database Search: BLAST. Tools: EMBOSS Needle, Clustal Omega.

**UNIT III (10 Hours)**

Molecular Phylogenetics –Need & applications, Dendrogram, Cladogram; Rooted/ Unrooted tree; Distance Based tree construction – UPGMA, NJ algorithm. Character Based Methods – Maximum Parsimony. Validating – Jack Knifing, Bootstrapping. Tree calibration, Tool: MEGA

**UNIT IV (6 Hours)**

Structural Bioinformatics: Structure Visualization using Pymol. Protein Structure- Primary, Secondary – alpha helics, beta-sheets & turns, Tertiary and Quaternary structures. Protein Structure Prediction. Structure and function.

**UNIT V (7 Hours)**

Overview of branches: Nature and Scope of Computational Genomics, Computational Proteomics, Systems Biology & Synthetic Biology, Computer-Aided Drug Design, Next Generation Sequencing. Applications of Machine Learning in Bioinformatics- classification and clustering problems. HMM in bioinformatics.

**Text Books**

1. Lesk, Arthur, Introduction to genomics, Oxford University Press, 2017
2. Zvelebil, Marketa J., and Jeremy O. Baum. Understanding bioinformatics. Garland Science, 2007.
3. Xiong, Jin.Essential bioinformatics. Cambridge University Press, 2006.

**Reference Books**

1. Bergeron, Bryan P, Bioinformatics Computing, Prentice Hall Professional, 2003

2. Neil James, Pavel A Pevnezer, An Introduction to Bioinformatics Algorithms, MIT Press, 1st ed, 2004

3. Gibas , Cynthia, Developing bioinformatics computer skills, O'reilly 2003

**Web Resources**

**[1] NPTEL** ***https://nptel.ac.in/courses/102/106/102106065/***

**[2] Coursera** ***https://www.coursera.org/specializations/bioinformatics***

| 22-382-0335 | BLOCKCHAIN TECHNOLOGY | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite: Nil**
**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | To classify different types of blockchain platforms and consensus protocols | Understand |
| **CO 2** | To examine a Smart Contract with Solidity | Analyze |
| **CO 3** | To solve real world problems using Code chain | Apply |
| **CO 4** | To differentiate the various security and performance tools in blockchain | Analyze |
| **CO 5** | To discuss different types of use-case of blockchain network | Understand |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | | | | | | | |
| **CO2** | 2 | 2 | 2 | 1 | 2 | | | | | | | |
| **CO3** | 2 | 2 | | 1 | 2 | | | | | | | |
| **CO4** | 2 | 2 | 2 | 1 | 2 | | | | | | | |
| **CO5** | 2 | 2 | | | | | | | | | | |

## 22-382-0335 BLOCKCHAIN TECHNOLOGY

**UNIT I (8 Hours)**

Introduction to Blockchain, Bitcoin Blockchain: Structure, Operations, Features, Consensus Model, Incentive Model. The Double-Spend Problem, Byzantine Generals' Computing Problems, Public-Key Cryptography, Hashing, Distributed Systems, Distributed Consensus, Proof of Work, Proof of Stake, Delegated Proof of Stake, Proof of Elapsed Time, Deposit based consensus, Proof of importance, Federated consensus or federated Byzantine consensus, Reputation-based mechanisms, Practical Byzantine Fault Tolerance.

**UNIT II (10 Hours)**

Smart Contracts: Definition and Need, Features of Smart Contracts, Life Cycle of a Smart Contract, Introduction to Ethereum Higher-Level Languages.Building A Simple Smart Contract with Solidity, Ethereum Contract ABI, Remix-IDE for Smart Contract Development. Introduction to Solidity: Contracts, Constructors & Functions, Variables, Getters & Setters, Arrays, Memory v/s Storage, Mappings in Solidity, Structs, Error Handling & Restrictions, Libraries, Global Variables in Solidity, Abstract Contracts, Inheritance, And Interfaces, Events Truffle Framework & Ganache: Environment Setup for Truffle & Ganache, Truffle Project Creation, Truffle Compile, Migrate and Create

Commands.

**UNIT III (10 Hours):** Permissioned Blockchains: Hyperledger Fabric Services, Model and Functions, Hyperledger Composer, Microsoft Azure Blockchain Platform and Services, Other Platforms: IOTA, TRON, Zilliqa, Cosmos, Ripple.Go languages: Native data types, Native data structures, Functions, and methods, Object-Oriented Programming, Error handling, Interfaces. Design and Implementation of Chaincode

**UNIT IV (9 Hours):** Security Issues: Blockchain Related Issues, Higher-Level Language (Solidity) Related Issues, EVM Bytecode Related Issues, Real-Life Attacks on Blockchain Applications Smart Contracts, Trusted Execution Environments.Security Tools for Smart Contracts: Working, Advantages, And Disadvantages of Tools- Oyente, Security, Maian, SmartCheck.

**UNIT V (8 Hours):** Alternative Decentralized Solutions: Interplanetary File System (IPFS), Blockchain Use Cases: Financial Services Related Use Cases, Revolutionization of Global Trade, Digital Identity, Auditing Services, Supply Chain Management, Healthcare Related Services, Blockchain and IOT, Blockchain and AI.

**Text Books**


1. Tiana Laurence, Blockchain for Dummies, 2 nd Edition 2019, John Wiley & Sons.
2. Building Blockchain Projects, Narayan Prusty, Packt Publishing.
3. Mastering Ethereum: Building Smart Contracts and Dapps Book by Andreas
4. Antonopoulos and Gavin Wood, Shroff Publisher/O′Reilly Publisher.
5. Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks by Imran Bashir, Packt Publishing (March 17, 2017).
6. Blockchain: Blueprint for a New Economy by Melanie Swan, Shroff Publisher publisher/O'Reilly Publisher Media; 1 st edition (2015).
7. Andreas M. Antonopoulos, Mastering Bitcoin - Programming the Open Blockchain, O'Reilly Media, Inc., 2017
8. Melanie Swan, Blockchain - Blueprint for a new economy, O'Reilly Media, Inc., 2015.
9. Abhijit Das and VeniMadhavan C. E., Public-Key Cryptography: Theory and Practice: Theory and Practice, Pearson Education India, 2009.
10. Joseph J. Bambara and Paul R. Allen, Blockchain – A practical guide to developing business, law, and technology solutions, McGraw Hill, 2018.


**Web Resources**

1. https://www.coursera.org/learn/smarter-contracts
2. Introduction to Blockchain Technology and Applications,

https://swayam.gov.in/nd1_noc20_cs01/preview

3. https://nptel.ac.in/courses/106105184/
4. https://www.coursera.org/learn/blockchain-platforms
5. https://www.edx.org/course/blockchain-and-fintech-basics-applications-and-imitations
6. https://www.accenture.com/in-en/insight-blockchain-technology-how-banks-buildingreal-time
7. https://medium.com/search?q=decentralized%20exchange
8. Emerging Technology Projection: The Total Economic Impact TM Of IBM Blockchain https://www.ibm.com/downloads/cas/QJ4XA0MD
9. https://www.globallegalinsights.com/practice-areas/blockchain-laws-and-regulations/ india#chaptercontent1
10. https://www.eduonix.com/blockchain-and-cryptoc

| 22-382-0336 | SOCIAL NETWORK ANALYSIS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** Basic Data Structures, Basic Mathematics

**Course Outcomes:**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Interpret social networks. | Cognitive level: Understand |
| **CO2** | Explain different terminologies of graph and representation of graphs. | Cognitive level: Understand |
| **CO3** | Calculate centrality, betweenness centrality and directional relations. | Cognitive level: Apply |
| **CO4** | Explain structural relations | Cognitive level: Understand |
| **CO5** | Analyze social networks using UCINET, PAJEK, ETDRAW, StOCNET, SplusR, NodeXL,SIENA and RSIENA. | Cognitive level: Analyse |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | | | | | | | |
| **CO2** | 2 | 2 | | | | | | | | | | |
| **CO3** | 3 | 3 | | | | | | | | | | |
| **CO4** | 2 | 2 | | | | | | | | | | |
| **CO5** | 3 | 3 | | | 3 | | | | | | | |

## 22-382-0336- SOCIAL NETWORK ANALYSIS

**UNIT I (8 Hours)**

Introduction to Social Network Analysis, Mathematical representations of Social Networks: Notations for Social Network data – Graph theoretic, sociometric. Graphs – Subgraphs, Dyads, Triads, Nodal degree, Density, Walks, trails and paths, Connected graphs and components, Geodesics, distance and diameter, Connectivity, Isomorphic graphs and subgraphs.

**UNIT II(10 Hours)**

Directed graphs – Dyads, Nodal indegree and outdegree, Density, directed walks, paths and semi paths, Reachability and connectivity, Geodesics, distance and diameter. Signed graphs and signed directed graphs Matrices – for graphs, digraphs, valued graphs, two-mode networks, Basic matrix operations, Computing simple network properties.

**UNIT III (10 hours)**

Centrality: Actor centrality, Nondirectional relationships – degree, closeness, betweenness centrality, Directional relations – centrality.

**UNIT IV( 7 Hours)**

Structural relationships – strong and weak ties, homophily, positive and negative relationships, Link analysis.

**UNIT V( 10 Hours)**

Network dynamics – cascading behavior, small-world phenomenon, epidemics. Tools for Social Network Analysis - UCINET-PAJEK-ETDRAW-StOCNET- Splus-R-NodeXL-SIENA and RSIENAReal world Social Networks (Facebook-Twitter etc.)

**Text Books**

[1] Social Network Analysis: Methods and Applications, Book by Katherine Faust and Stanley Wasserman Cambridge ; New York : Cambridge University Press, 8th series.

[2] Networks, Crowds, and Markets: Reasoning about a Highly Connected World Book by David Easley and Jon Kleinberg

[3]. Social and Economic Networks Book by Matthew O. Jackson, Illustrated, 21 November 2010

**Web Resources**

[1] NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs66/preview
[2] Courseera: https://www.coursera.org/learn/social-network-analysis
[3] EDX/UPGRAD: https://www.edx.org/course/social-network-analysis-sna

| 22-382-0337 | MALWARE ANALYSIS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Pre-requisites:** Algorithms, Discrete Mathematics, Foundations of Cryptography

**Course Outcomes**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Describe nature of malware and its capabilities | (Cognitive level : Understand) |
| **CO2** | Examine scientific and logical limitations on ability to combat malware. | (Cognitive level : Analyze) |
| **CO3** | Explain social, economic and historical context in which malware occurs. | (Cognitive level : Understand) |
| **CO4** | Apply static and dynamic analysis techniques to synthetic with real-life examples | (Cognitive level : Apply) |
| **CO5** | Apply suitable measures based on the context to detect and mitigate popular infection methods. | (Cognitive level : Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | 3 | | | 3 | | | | | | | | |
| CO3 | 2 | | | | | | | | | | | |
| CO4 | 3 | | | 3 | 2 | | | | | | | |
| CO5 | 3 | | | 3 | 2 | | | | | | | |

## 22-382-0337- MALWARE ANALYSIS

**UNIT I (5 Hours)**

Introduction: The taxonomy of malware and its capabilities: viruses, Trojan horses, rootkits, backdoors, worms, targeted malware; History of malware, The social and economic context for malware: crime, anti-malware companies, legal issues, the growing proliferation of malware

Basic Analysis: Signature generation and detection; clone detection method

**UNIT II (8 Hours)**

Static analysis theory: program semantics, and abstract interpretation framework

Static Analysis: System calls: dependency analysis issues in assembly languages; semantic invariance of system call sequences; abstract interpretation as a formal framework for detection; constraint-based analyses; semantic clones

**UNIT III (8 Hours)**

Dynamic Analysis: virtualization: semantic gap; reverse engineering; hybridisation with static analysis; Overview of Windows file format, PEView.exe, Patching Binaries , Disassembly(objdump, IDA Pro),

**UNIT IV (12 Hours)**

Similarity metrics: Kolmogorov Complexity; association metrics; other entropy based metrics; NLP based approaches Problems in large scale classification: scalability; triage methods; Required FP rate.

Hiding: Polymorphism: compression encryption virtualization; Metamorphism: high level code obfuscation engines, on-board metamorphic engines, semantics-preserving rewritings; Frankenstein. The theory of malware: Rice's theorem and the undecidability of semantic equivalence; Adleman's proof of the undecidability of the presence of a virus; Cohen's experiments on detectability and self-obfuscation

**UNIT V (12 Hours)**

Advanced Dynamic Analysis: debugging tools and concepts, Malware Behavior - malicious activities and techniques, Analyzing Windows programs – WinAPI, Handles, Networking , COM, Data Encoding, Malware Countermeasures, Covert Launching and Execution, Anti Analysis- Anti Disassembly, VM, Debugging -, Packers – packing and upacking, Intro to Kernel – Kernel basics, Windows Kernel API, Windows Drivers, Kernel Debugging - Rootkit Techniques- Hooking, Patching, Kernel Object Manipulation, Rootkit Anti-forensics, Covert analysis.

**References**


1. Michael Sikorski, Andrew Honig, *Practical Malware Analysis: The Hands-On Guide Dissecting Malicious Software,* No Starch Press, 2012 (for lab work).
2. Jamie Butler and Greg Hoglund, *Rootkits: Subverting the Windows Kernel*, Addison-Wesley, 2005
3. Dang, Gazet, Bachaalany, *Practical Reverse Engineering*, Wiley, 2014.
4. Reverend Bill Blunden, *The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System,* Second Edition, Jones & Bartlett, 2012.

| 22-382-0338 | DESIGN THINKING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite: NIL**

**Course Outcomes:**
After completion of this course, students will be able to

| | | |
|---|---|---|
| **CO1** | Examine the given project | (Cognitive level : Apply) |
| **CO2** | Examine different idea refinement techniques | (Cognitive level : Analyze) |
| **CO3** | Analyze design prototype and implementation details | (Cognitive level : Analyze) |
| **CO4** | Describe design thinking process in IT and agile software development. | (Cognitive level : Understand) |
| **CO5** | Describe design techniques related to variety of software services | (Cognitive level : Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | | | | | | | |
| **CO2** | 1 | 2 | 2 | 2 | | | | | | | | |
| **CO3** | 3 | | | 2 | | | | | | | | |
| **CO4** | | 1 | | 3 | | | | | 2 | | 1 | |
| **CO5** | | | 3 | 1 | | | | | 2 | | 1 | |

## 22-382-0338- DESIGN THINKING

**UNIT I ( 7 Hours)**

Stages of thinking – The design process and stages- define the problem, conduct research, define, research, ideate, prototype, select, implement and learn. Example project.

**UNIT II( 10 Hours)**

Research – Identifying drivers-drivers, barriers. Information Gathering-Quantitative, Qualitative-Diagram Technique. Target Groups-Character Profile, Secondary Research and Resources, Samples and feedback. Idea Generation – Basic Design directions- Point of difference or unique selling point (USP), Clustering, Inclusive design, Themes of Thinking- Keep It Short and Simple (KISS), Inspiration and References, Brainstorming-rules, Value, Inclusion, Sketching, Presenting Ideas.

**UNIT III( 10 Hours)**

Refinement – Thinking in Images, Thinking in Signs, Appropriation, Humour, Personification, Visual Metaphors, Modification, thinking in words, Words and Language, Type "faces", Thinking in shapes, thinking in proportions, Thinking in color. Prototyping – Developing Designs, Types of Prototype, Vocabulary. Implementation – Format, Materials, Finishing, Media, Scale, Series/Continuity. Live Case Implementation of the Design Thinking Process.

**UNIT IV( 10 Hours)**

Design Thinking in Information Technology, Design thinking in Business process model, Design thinking for agile software development, virtual collaboration, multiuser and multi account interaction, need for communication, TILES toolkit, Cloud implementation.

**UNIT V( 8 Hours)**

Design thinking for service design: How to design a service, Principles of service design, Benefits of service design, Service blueprint, Design strategy, organization, principles for information design, principles of technology for service design.

**Textbook:**


1. Design Thinking The act or practice of using your mind to consider design by Gavin Ambrose and Paul Harris (pdf version) Production by AVA Book Production Pvt. Ltd., Singapore.
2. AdersRiiseMaehlum, "Extending the TILES Toolkit" from Ideation to Prototyping. (
3. Marc stickdorn and Jacob Schneider, "This is Service Design Thinking", Wiely, 2011

| 22-382-0339 | SEMANTIC WEB | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** NIL

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Describe rationale behind the semantic web and structured web documents with XML | (Cognitive level : Understand) |
| **CO 2** | Explain ontologies with RDF | (Cognitive level : Understand) |
| **CO 3** | Employ ontology querying using SPARQL | (Cognitive level : Apply) |
| **CO 4** | Show knowledge representation for the Semantic Web with OWL | (Cognitive level : Apply) |
| **CO 5** | Analyse principles of Ontology Engineering and applications | (Cognitive Level:Analyze) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | | | | | | | |
| **CO2** | 3 | 3 | 3 | | | | | | | | | |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | | |
| **CO4** | 3 | 3 | 3 | 2 | 2 | | | | | | | |
| **CO5** | 3 | 3 | 3 | 2 | | | | | | | | |

## 22-382-0339 SEMANTIC WEB

### UNIT I(8 Hours)

HTML to XML - Building Models - Exchanging Information - Ontologies and semantic web - Semantic Web Technologies - A Layered Approach - Introduction to XML Language - Addressing and Querying XML Documents - tree model of XML documents - XML Schema

### UNIT II (1Hours)

Introduction to RDF - Basic Ideas - RDF: XML- Based Syntax - RDF Schema, An Axiomatic Semantics for RDF and RDF Schema - A Direct Inference System for RDF and RDFS - Querying in RQL.

**UNIT III (9Hours)**

SPARQL Infrastructure - Matching pattern - filters - constructs-organising results sets - other forms of SPARQL queries - Querying schema.

**UNIT IV (9Hours)**

OWL and RDF/RDFS - OWL syntax and intuitive semantics- The forthcoming OWL2 standard - Description Logics - Requirements for Ontology languages- compatibility of OWL2 with RDF/RDS - OWL2 profiles

**UNIT V (9Hours)**

Ontology engineering: Requirement analysis - Quality assurance of ontologies - Constructing Ontologies Manually - Reusing Existing Ontologies - Semiautomatic Ontology Acquisition - Ontology Mapping - Exposing Relational Databases - Semantic Web Application - Architecture
Applications : web data exchange and syndication - semantic wiki- semantic portals -semantic metadata in data formats semantic web in life science

**Text Books/References**


1. Hitzler, P., Krotzsch, MRudolph, S., “Foundations of Semantic Web Technologies”,1st ed., Chapman and Hall/CRC. (2010).
2. Groth, Paul., Antoniou, Grigoris., Hoekstra, Rinke., Van Harmelen, Frank. A Semantic Web Primer. United Kingdom: MIT Press, 2012.
3. Fensel, Dieter, Holger Lausen, Axel Polleres, Jos de Bruijn, Michael Stollberg, Dumitru Roman, and John Domingue. "Enabling Semantic Web Services: The Web Service Modelling Ontology." (2006).
4. Fisher, Matthew, Ryan Blace, John Hebeler, and Andrew Perez-Lopez. Semantic web programming. John Wiley & Sons, 2011.
5. Yu, Liyang. Introduction to the Semantic Web and Semantic Web Services, CRC Press, 2007.


**Web Resources**

[1] Knowledge Engineering with Semantic Web Technologies | openHPI
[2] Web of Data | Coursera
[3]https://doi.org/10.1201/9781420090512

| 22-382-0340 | COMPUTER VISION | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite : Nil**

**Course Outcomes**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Describe digital image formation and representation to perform low level image processing | (Cognitive level: Understand) |
| **CO2** | Compare Feature detection and image transformation techniques | (Cognitive level: Analyze) |
| **CO3** | Apply segmentation and Feature-based alignment | (Cognitive level: Apply) |
| **CO4** | Apply structure from motion and perform dense motion estimation. | (Cognitive level: Apply) |
| **CO5** | Apply depth estimation, Object Detection, Face recognition, Instance recognition and understand multi-camera views. | (Cognitive level: Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | 2 | | | | | |
| **CO2** | 3 | 2 | 1 | 1 | 2 | | 2 | | | | | |
| **CO3** | 3 | 2 | 1 | 1 | 2 | | 2 | | | | | |
| **CO4** | 3 | 2 | 1 | 1 | 2 | | 2 | | | | | |
| **CO5** | 3 | 2 | 1 | 1 | 2 | | 2 | | | | | |

## 22-382-0340 COMPUTER VISION

**UNIT I (9 Hours)**

Digital Image Formation and Representation: Fundamentals of Image Formation, Geometric Primitives and Transformations: Orthogonal, Euclidean, Affine, Projective; Photometric Image Formation, Digital Camera, Low-level Image processing: Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

**UNIT II (8 Hours)**

Feature Detection: Edges - Canny, Laplacian of Gaussian (LoG), Difference of Gaussian (DoG); Lines - Hough Transform, Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

**UNIT III (8 Hours)**

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, Markov Random Field Segmentation, Texture Segmentation; Feature-based Alignment: 2D and 3D Feature-based alignment, Pose estimation, Geometric intrinsic calibration.

**UNIT IV (10 Hours)**

Structure from motion: Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, constrained structure and motion; Dense motion estimation – Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion.

**UNIT V (10 Hours)**

Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, 3-D reconstruction framework; Autocalibration. Stereo; Recognition - Object Detection, Face recognition, Instance recognition

**TEXT BOOK**

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

**REFERENCE BOOKS**

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

| 22-382-0341 | SOFTWARE TESTING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** Software Engineering

**Course Outcomes:**
After completion of this course, students will be able to

| | | |
|---|---|---|
| **CO1** | Describe software engineering testing process. | (Cognitive level : Understand) |
| **CO2** | Examine different software testing techniques and strategies. | (Cognitive level : Analyze) |
| **CO3** | Describe different types of software testing. | (Cognitive level : Understand) |
| **CO4** | Compare different testing tools in different scenarios. | (Cognitive level : Analyze) |
| **CO5** | Write test cases for a given scenario. | (Cognitive level :Apply) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | | 1 | | | 2 | 1 | | | | |
| **CO2** | 2 | 2 | 2 | 1 | | | 2 | 1 | | | | |
| **CO3** | 2 | 2 | 2 | 1 | | | 2 | 1 | | | | |
| **CO4** | 2 | 1 | 2 | | 2 | | 2 | 1 | | | | |
| **CO5** | 2 | 1 | 2 | | 2 | | 2 | | | | | |

## 22-382-0341 SOFTWARE TESTING

**UNIT I ( 8 Hours)**
Fundamentals of Software Testing- Definition, Essentials of testing, Misconceptions about testing, test policy, challenges in testing, Cost aspect, test strategy or test approach. STLC. Categories of Defects, Defect, Error or Mistakes in Software. Testing techniques and tools- Levels of testing – Proposal Testing, Requirement Testing, Design Testing, Code Review, Unit Testing, Module Testing, Integration Testing, Big Bang Testing, Sandwich Testing, Critical Path First, Subsystem Testing, System Testing, Testing Stages.

**UNIT II ( 7 Hours)**
Acceptance testing - Acceptance Testing Criteria, Importance of Acceptance Criteria, Acceptance Criteria, Alpha Testing, Beta Testing, Gamma Testing, Acceptance Testing During Each Phase of Software Development, Consideration of Alpha and Beta Acceptance Testing Process, Developing

Acceptance Test Plan, Software Acceptance Plan, User Responsibilities in Acceptance Test Plan, Executing Acceptance Plan.

**UNIT III ( 10 Hours)**

Special Tests: Complexity Testing, Graphical User Interface Testing, Compatibility Testing, Security Testing, Performance Testing, Volume Testing and Stress Testing, Recovery Testing, Installation Testing, Requirement Testing (Specification Testing), Regression Testing, Error Handling Testing, Manual Support Testing, Intersystem Testing, Control Testing, Smoke Testing, Sanity Testing, Adhoc Testing(Monkey Testing, Exploratory Testing, Random Testing), Parallel Testing, Execution Testing, Operations Testing, Compliance Testing, Usability Testing, Decision Table Testing(Axiom Testing), Documentation Testing, Training Testing, Rapid Testing, Control Flow Graph, Generating Tests on the Basis of Combinatorial Designs, State Graph.

**UNIT IV (10 Hours)**

Risk associate with new technologies, Process Maturity Level of Technology, Testing Adequacy of control in New Technology Usage, Object Oriented Application Testing, Testing of Internal Controls, 'COTS' Testing, Client-Server Testing, Web Application Testing, Mobile Application Testing(PDA Devices), e Business / eCommerce Testing, Agile Development Testing, Data Warehousing Testing. Testing tools – Features of Test Tool, Guidelines for Selecting a Tool, Tools and Skills of Tester, Static Testing Tools, Dynamic Testing Tools, Advantages of Using Tools, Disadvantages of Using Tools, When to use Automated Test tools, Testing using Automated tools, Difficulties while introducing new tools, Process of Procurement of COTS (Readily Available Tool from Market), Procurement of Tools from Contractor, Advantages of Tools Developed By External Organizations, Contracting a Software, Process of Procurement of Tools from Contractor.

**UNIT V (10 Hours)**

Testing process: Test policy, Test plan, Test cases, Test Scripts. Test metrics and Test reports – Testing Related Data, Defect Data, Efficiency/Productivity Data, and Categories of the Product/Project Test Metrics, Estimated Budgeted, Approved and Actual, Resources Consumed in Testing, Effectiveness of Testing, Defect Density, Defect Leakage Ratio(Defect Life), Residual Defect Density (RDD), Test Team Efficiency, Test Case Efficiency, Rework, MTBF/MTTR, Implementing Measurement Reporting System in an Organization, Test Reports, Project Test Status Report, Integration Test Report, System Test Report, Acceptance Test Report, Guidelines for Writing and Using Report, Final Test Reporting, Test Status Report, Benchmarking.

**References:**


1. Software Testing- Principles, Techniques and Tools, M G Limaye, Tata Mc Graw Hill, 2009.
2. Software Quality Assurance from theory to implementation, Daniel Galin, Pearson Education Limited.

| 22-382-0342 | NETWORK SECURITY ESSENTIALS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Course Outcomes**

After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Give examples for Vulnerability, Threat, Attacks, Countermeasures and malicious softwares | (Cognitive Level : Understand) |
| **CO2** | Examine vulnerabilities leads to different attacks and Discuss authentication protocols and network layer protocols for security | (Cognitive level : (Analyze) |
| **CO3** | Differentiate PGP and S/MIME and compare SSL and SET | (Cognitive level : Analyze) |
| **CO4** | Compare different wireless security protocols | (Cognitive level : Analyze) |
| **CO5** | Describe cyber threat intelligence for security | (Cognitive Level : Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | 2 | 2 | 2 | | | 2 | | |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | | | 2 | | |
| **CO3** | 3 | 3 | | | 2 | 2 | 2 | | | | | |
| **CO4** | 3 | 3 | 3 | | 2 | 2 | 2 | | | | | |
| **CO5** | 2 | 2 | | 3 | 3 | 2 | 2 | 3 | | 2 | | |

## 22-382--0342 NETWORK SECURITY ESSENTIALS

**UNIT I ( 8 Hours)**

Vulnerability, Threat, Attacks and Countermeasures(Cryptography, Controls, Firewalls, IDS, Digital Signatures)Introduction to network security - Security requirements, Challenges of security, Network security models.

**UNIT II (10 Hours)**

Malicious programs- Worms, Viruses, Trojans, Spyware, Adware. Attacks,Side channel Attacks,ARPpoisoning,Spoofing,DoS,DDos,Tor,Session Hijacking, Buffer overflow. Network Security Protocols- Authentication Protocols - Challenge Response Protocol, Zero Knowledge protocol, Kerberos , Onion Layer protocol.HTTPS Transport Layer protocols - SSL, TLS IP Layer Protocol -IPSec - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases, VPN.

**UNIT III (7 Hours)**

Application Layer Protocols , PEM,PGP, S/MIME, Digital Certificates, SET.Wireless Network Security - IEEE 802.11 Wireless LAN - components, types, Services. wireless LAN security - Services,

**UNIT IV (10 Hours)**

Wireless Security Protocols - RC4, 4 way handshaking, Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2 , WPA3.

**UNIT V (10 Hours)**

Threat modeling, Cyber Threat Intelligence and Its Role,sources to collect adversary data and how to exploit and pivot off,Indicators of Compromise (IOC), Collecting Indicators, Storing threat data , analysis.

**Text Books:**

1.Behrouz A. Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security”, 3/e, Tata McGraw Hill.
2. Tyler Wrightson, “Wireless Network Security A Beginner’s Guide”, 2012, Tata McGraw Hill.
3. William Stallings, “Network Security Essentials: Applications and Standards”, 4/e, Prentice Hall.

**Web Resources**

https://www.coursera.org/learn/ibm-cyber-threat-intelligence
https://www.cse.iitk.ac.in/pages/CS698M.html

| 22-382-0343 | DIGITAL IMAGE PROCESSING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite: Basic knowledge on Signals and Systems**

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Explain the basics and fundamentals of Digital Image Processing and to manipulate images based on spatial domain techniques. | Cognitive Level: Understand |
| **CO 2** | Apply image transforms. | Cognitive Level : Analyze |
| **CO 3** | Employ Image Restoration and Denoising. | Cognitive Level : Apply |
| **CO 4** | Compare various methods of Image Segmentation and Morphological Image Processing. | Cognitive Level : Analyze |
| **CO 5** | Apply image compression and video processing techniques. | Cognitive Level : Apply |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | 2 | 3 | | | | | | 1 |
| **CO2** | 3 | 2 | 2 | | 2 | 3 | | | | | | 1 |
| **CO3** | 3 | | 2 | | 2 | 3 | | | | | | 1 |
| **CO4** | 3 | 2 | 1 | | 2 | 3 | | | | | | 1 |
| **CO5** | 3 | 2 | 1 | | 2 | 3 | | | | | | 1 |

## 22-382-0343 DIGITAL IMAGE PROCESSING

### UNIT I (7 Hours)

Introduction- Fundamental steps in image processing; Components of image processing system; Pixels; coordinate conventions; Imaging Geometry; sampling and quantization; Basic relationship between pixels; Spatial Domain; Frequency Domain;ColourModels.Image Enhancement in spatial domain-Intensity transformations; contrast stretching; histogram equalization; Correlation and convolution; Smoothing filters; sharpening filters; gradient and Laplacian; Unsharp Masking and High Boost Filtering

**UNIT II (10 Hours)**

Image transforms and its properties – Unitary transform; Fourier Transforms and properties; Frequency domain filtering- Smoothing Frequency Domain Filters; Sharpening Frequency Domain Filters; Homomorphic Filtering Wavelet-based Image Processing: Wavelet, Wavelet Transform Discrete and Continuous,Wavelet- Examples, Multiresolution Analysis. Contourlet Transform, Image Pyramid.

**UNIT III (8 Hours)**

Image Restoration and Denoising : Image Degradation, Image Blur-Types, Image Restoration Techniques Classification, Image Restoration Model, Linear and Nonlinear Image Restoration Techniques.Image Denoising, Noises in Image-Classification, Mean Filtering,Order Statistics-Adaptive Filters-Band reject filters,Band Pass filters,Notch Filters, Weiner filtering- Applications of Digital Image Restoration.

**UNIT IV (10 Hours)**

Image segmentation: Point, Line and Edge segmentation. Edge linking and Boundary detection. Segmentation using thresholding, Region based segmentation.Morphological Image Processing-Structuring Element,Dilation,Erosion,opening and Closing, Hit or Miss transformation,Basic Morphological Algorithms

**UNIT V (10 Hours)**

Image Compression: Fundamentals, Some Basic Compression Methods - Run Length Coding,Huffman Coding, Arithmetic Coding, Bit Plane Coding, Block Truncation Coding. JPEG Compression.Basic Steps of Video Processing:Analog Video, Digital Video. Time-Varying Image Formation models:Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation,Sampling of Videosignals, Filtering operations.

**TEXT BOOK**


1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (English) 3rd Edition,Pearson India, 2013.
2. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
3. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya–quin Zhang.1st Ed., PH Int


**REFERENCE BOOKS**


1. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Procesing, McGraw Hill Education , 2009.

2.Digital Video Processing – M. Tekalp, Prentice Hall International.


**Web Resources**

*NPTEL*

- **Digital Image Processing** - (Course from **IIT Kharagpur**)
- NPTEL Lecture Videos by **Prof. P K Biswas** from **IIT Kharagpur** https://nptel.ac.in/courses/117105079

| 22-382-0344 | CLOUD COMPUTING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite: Nil**

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO1** | Describe the features of cloud computing architecture and different computing models | Cognitive level : Understand |
| **CO2** | Explain various public cloud platforms and software environments | Cognitive level : Understand |
| **CO3** | Apply virtualization techniques such as VMM and Hypervisor | Cognitive level : Apply |
| **CO4** | Analyze different aspects of cloud security including security defense strategies | Cognitive level : Analyze |
| **CO5** | Discuss advanced cloud computing concepts | Cognitive level : Understand |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | | | | | | | |
| **CO2** | 2 | | | 2 | | | | | | | | |
| **CO3** | | 3 | | | | | | | | | | |
| **CO4** | 2 | | 2 | 3 | | | | | | | | |
| **CO5** | 2 | | | | | | | | | | | |

## 22-382-0344 CLOUD COMPUTING

**UNIT I (8 Hours)**

Introduction-Evolution of new computing models: Parallel computing, Edge computing, Grid Computing, Cloud computing. Cloud computing Basics: Architecture, Storage, Services, Applications. Significance of Cloud computing in modern era: Example-Server crashes/Failures-Preventing server Failures-Solution.

**UNIT II (8 Hours)**

Cloud deployment models: Public, Private, Hybrid, Community -Cloud Service models: software as a Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Service Oriented Architecture (SoA)- Public Cloud Platforms: GAE – AWS – Azure, Emerging Cloud

**UNIT III (10 Hours)**

Virtualization: Introduction to virtualization-Need of Virtualization in Cloud Computing- Hypervisors-Categories of Virtualization: Full Virtualization- Paravirtualization, Levels of implementing virtualization: Hardware, Operating System, Application- Advantages and disadvantages of virtualization- Case studies: VMware, Eucalyptus.

**UNIT IV (10 Hours)**

Cloud security: Cloud security risks- Security aspects: privacy, trust-Securing the Cloud Infrastructure: Access control, Key Management - Secure Cloud Architecture- Operating System and Network Security, Data Security in cloud, Virtual Machine Security- Advanced Cloud Computing Security : Advanced Security Architectures for Cloud Computing- Side- Channel Attacks and Defenses on Cloud Traffic.

**UNIT V (9Hours)**

Cloud Programming and Software Environments: (Hadoop, GFS, Map Reduce, NoSQL systems) -Fog computing- Green cloud-Sensor cloud computing- ubiquitous computing Containers: Docker, IOT cloud.

**References:**


1. RajkumarBuyya, Christian Vecchiola and ThamaraiSelvi S, “Mastering Cloud Computing”, Tata McGraw Hill Education Private Limited,New Delhi,2013.
2. Dan C. Marinescu , Cloud computing: Theory and Practice, Morgan Kaufmann, 2013.
3. David S Linthicium, “Cloud computing and SOA convergence in your enterprise”, Pearson, USA,2010.
4. Diane Barrett and Gregory Kipper, “Virtualization and Forensics: A Digital Forensic Investigators Guide to Virtual Environment”, Elsevier, USA,2010.
5. John R. Vacca, “Cloud Computing Security”/O′Reilly Publisher.
6. Toby Velte, Anthony Velte, Robert Elsenpete. “Cloud Computing, A Practical Approach”/*O 'Reilly Publisher.*.


**Web Resources:**

*1.NPTEL :: Computer Science and Engineering - NOC:Cloud computing*

*2. Introduction to Cloud Computing | Coursera*

*3. Cloud Computing Basics (Cloud 101) | Coursera*

| 22-382-0345 | THEORY OF COMPUTATION | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite: Basic Mathematics**

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO1** | Apply the concept of Finite Automata. | (Cognitive level : Apply) |
| **CO2** | Apply regular languages, grammar and expressions to perform conversions with Finite automata. | (Cognitive level : Apply) |
| **CO3** | Solve push-down automata and context-free grammar representations for context-free languages. | (Cognitive level : Apply ) |
| **CO4** | Apply Turing Machines for accepting recursively enumerable languages | (Cognitive level : Apply ) |
| **CO5** | Analyze the Decidability and Undecidability of various problems | (Cognitive level :Analyze ) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO2** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO3** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO4** | 3 | 3 | 3 | | | | 1 | | | | | |
| **CO5** | 3 | 3 | 3 | | | | 1 | | | | | |

## 22-382-0345- THEORY OF COMPUTATION

**UNIT I (10 Hours)**

Introduction to Automata Theory and its significance.

Finite state automata – Properties of transition functions, Designing finite automata, NFA, Finite Automata with Epsilon Transitions, Equivalence of NFA and DFA, Conversion of NFA to DFA, Equivalence and Conversion of NFA with and without Epsilon Transitions.

**UNIT II (10 Hours)**

Regular Languages - Regular Grammar, Regular Expressions, Equivalence of regular expressions and NFA with epsilon transitions. Converting Regular Expressions to NFA with epsilon transitions Equivalence of DFA and regular expressions, converting DFA to Regular Expressions. Pumping Lemma for Regular Languages.

**UNIT III( 10Hours)**

Context-Free Languages (CFL), Context-Free Grammar (CFG), Derivation trees, Ambiguity, Simplification of CFG, Chomsky Normal Form, Greibach normal forms, Pumping Lemma for CFG. Push Down Automata, Deterministic PushDown Automata, Non-Deterministic Pushdown Automata (NPDA). Equivalence of acceptance by final state and empty stack in PDA. Equivalence between PDA and CFG. Equivalence between CFG and PDAs.

**UNIT IV( 8Hours)**

Context-sensitive Grammar. Linear Bounded Automata. Turing Machine (TM) – Basics and formal definition, TMs as language acceptors, TMs as Transducers, Designing Turing Machines, Variants of TMs -Universal Turing Machine, Multi- tape TMs, Non Deterministic TMs.

**UNIT V( 7Hours)**

Computability and Decidability - halting problem - reductions - post correspondence problem. Computational complexity - Time and space bounded simulations, Classes P and NP - NP completeness - Cook's theorem.

**Text Books/References :**


1. John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Introduction to Automata Theory, Languages, and Computation, 3/e, Pearson Education, 2007
2. John C Martin, Introduction to Languages and the Theory of Computation, TMH, 2007
3. Michael Sipser, Introduction To Theory of Computation, Cengage Publishers, 2013
4. K.Krithivasan and R.Rama; Introduction to Formal Languages,Automata Theory and Computation; Pearson Education, 2009.
5. H.R. Lewis and CH.Papadimitriou, Elements of Theory of Computation, 2nd Edition, Prentice Hall, ISBN: 0132624788.
6. J. E. Savage, Models of Computation, Exploring the Power of Computing, Addison Wesley, 1998, Available at http://cs.brown.edu/~jes/book/.


**Web Resources**

*NPTEL*

- Theory of Automata, Formal Languages and Computation NPTEL Lecture Videos by **Prof. Kamala Krithivasan** from **IIT Madras**. https://www.nptelvideos.com/course.php?id=451

| 22-382-0346 | SOFTWARE PROJECT MANAGEMENT | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** Software Engineering

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Choose suitable life cycle models to be used based on the requirement. | (Cognitive level : Apply) |
| **CO 2** | Describe the concepts of managing software projects. | (Cognitive level : Understand) |
| **CO 3** | Apply software estimation approaches for effort and cost estimation. | (Cognitive level : Apply) |
| **CO 4** | Describe the concepts of risk management and resource allocation. | (Cognitive level : Understand) |
| **CO 5** | Describe project monitoring and control, organize people and teams. | (Cognitive level : Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | | 1 | | | 2 | 1 | | | | |
| **CO2** | 2 | 2 | 2 | 1 | 2 | | 2 | 1 | | | | |
| **CO3** | 2 | 2 | 2 | 1 | | | 2 | 1 | | | | |
| **CO4** | 2 | 1 | 2 | | | | 2 | 1 | | | | |
| **CO5** | 2 | 1 | 2 | | | | 2 | | | | | |

## 22-382-0346 SOFTWARE PROJECT MANAGEMENT

**UNIT I( 10 Hours)**

Introduction to software engineering: - Software engineering a layered technology – processes, methods, and tools. Software process models. Introduction to Software project management:- software project vs other types of projects. Types of software projects. Factors in Designing a Project Structure, Types of Project Organization Structures, Definition of management- management principles- management control. Functions and activities of management- planning, organizing, staffing, directing, and controlling. Importance of software project management- major issues of software project management, Activities in software project management.

**UNIT II ( 7Hours)**

Project Planning- Planning Objectives, Project Plan, Types of project plan, Elements of a Project Plan. Stepwise project planning activities,. Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Methods of representing WBS, Application of the WBS. Structure of a Software Project Management Plan.

**UNIT III (8 Hours)**

Project Evaluation: - Evaluation of individual projects- technical Assessment, Cost-benefit analysis, cash flow forecasting, cost-benefit evaluation techniques, Risk evaluation. Selection of an appropriate project approach. Choosing Technologies, technical plan contents list, choice of process models, structure versus speed of delivery. Software effort Estimation: Basis for software estimation- Software effort estimation techniques Bottom-up and Top-down estimation- Function Point Analysis- COCOMO II. Cost Estimation- Staffing Pattern- Schedule compression.

**UNIT IV ( 10 Hours)**

Activity Planning and Risk Management : Objectives- Project Schedules- Projects and Activities- Sequencing and Scheduling Activities- Network Planning Models- Forward Pass- Backward pass- Identifying Critical Path and Critical Activities- Activity-on-arrow networks. Risk Management: Risk- Categories of Risk- Risk Identification- Risk Assessment- Risk Planning- Risk management- Risk Evaluation- PERT, Monte Carlo Simulation, Critical Chain. Resource Allocation: Nature of Resources- Identifying and Scheduling Resources- Creating Critical Paths- Cost Schedule- Scheduling sequence

**UNIT V ( 10 Hours)**

Monitoring and Control: Creating the framework, collecting data, Visualizing Progress- Gantt Chart, Slip Chart, Timeline. Cost Monitoring- Earned Value Analysis-prioritizing monitoring. Getting the project back to target- Change control. Software Configuration Management- Managing Contracts- Types of contracts, Stages in contract placement, terms of a contract, Contract Management, Acceptance. Managing people and organizing teams- Organizational Behavior, Selecting the right person- Motivation, The Oldham – Hackman job characteristic model – Stress – Health and Safety – Ethical and Professional concerns, working in teams – Decision making Organization and Team Structures- Dispersed and Virtual teams, Leadership.

**Text Books**

1. Bob Hughes and Mike Cotterell, “Software Project Management”, Tata McGraw-Hill, Edition 2004.

**Reference Books**

1. Robert K. Wysocki, Effective Software Project Management – Wiley Publication, 2011
2. E. M. Bennatan, Software project management: a practitioner's approach (2nd ed.), McGraw Hill, (1995)
3. Royce, Software Project Management, Pearson Education (1999)

**Web Resources**

[1] NPTEL: Software Project Management, IIT Kharagpur (Prof.RAJIB MALL): https://nptel.ac.in/courses/106105218

| 22-382-0347 | SOFT COMPUTING TECHNIQUES | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite: Nil**

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO 1** | Discuss various constituents of soft computing and artificial neural networks. | Understand |
| **CO 2** | Examine different learning methods for training of ANNs. | Analyze |
| **CO 3** | Apply fuzzy logic techniques to control a system. | Apply |
| **CO 4** | Examine genetic algorithm techniques to find the optimal solutions for a given problem. | Analyze |
| **CO 5** | Compare different hybrid systems | Analyze |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | **2** | **1** | **1** | | | | | | | | | |
| **CO 2** | **3** | **2** | **2** | **3** | **3** | | | | | | | |
| **CO 3** | **3** | **2** | **2** | | | | 1 | | | | | |
| **CO 4** | **3** | **2** | **2** | **3** | | 2 | | | | 1 | | |
| **CO 5** | **3** | **2** | **2** | **3** | **3** | | | | | | | |

## 22-382-0347- SOFT COMPUTING TECHNIQUES

**UNIT I (8 Hours)**

**Introduction**: Soft and Hard Computing, Evolution of soft computing, Soft computing constituents.**Artificial Neural Networks**: Biological foundations –ANN models - Characteristics of ANNTypes of activation function - McCulloch-Pitts neuron model, Realization of logic gates using McCulloch-Pitts neuron model - simple perceptron.

**UNIT II (8 Hours)**

**Neural network architectures** - single layer, multilayer, recurrent networks.Knowledge representation - Learning process - Supervised and unsupervised learning,Learning algorithms– Hebbian learning – Boltzmann learning -competitive learning- Backpropagation algorithm- Case study-Radial basis function networks- Hopfield network- Kohonen Self organizing maps

**UNIT III (10 Hours)**

**Fuzzy Logic**: Introduction to crisp sets and fuzzy sets, Properties, Basic fuzzy set operations, Fuzzy relations, Membership functions ,**Fuzzycontroller.**Neuro-Fuzzy Hybrid Systems. Rough Set theory-Knowledge, Imprecise Categories,Approximation and rough sets,Reduction of knowledge, Knowledge representation,reasoning about knowledge

**UNIT IV (9 Hours)**

**Genetic Algorithm**: Genetic algorithms basic concepts, encoding, fitness function, reproduction-Roulette wheel,tournament, rank, and steady state selections, Convergence of GA, Applications of GA case studies.Neuro-Genetic Hybrid Systems,Fuzzy-Genetic Hybrid Systems.

**UNIT V (10 Hours)**

**Introduction to Swarm Intelligence** – Essence of an Algorithm, Algorithms and Self –Organization, Links between Algorithms and Self-Organization, Characteristics of Metaheuristics; Swarm Intelligence based algorithms – Ant Algorithms; Bee Algorithms; Particle Swarm Optimization and Krill Herd Algorithms; Strategies for state space search in AI- Depth First and Breadth First Search Heuristic Search- Best First Search and Hill Climbing.

**Text Books**

1. N.P.Padhy, S.P.Simon, “Soft Computing with MATLAB Programming”, Oxford University Press, 2015.
2. S.N.Sivanandam , S.N.Deepa, “Principles of Soft Computing”, Wiley India Pvt. Ltd., 2nd Edition, 2011.
3. S.Rajasekaran, G.A.Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications “, PHI Learning Pvt. Ltd., 2017.
4.Xin-She Yang, Zhihua Cui, Renbin Xiao, Amir Hossein Gandomi, Mehmet Karamanoglu, “Swarm Intelligence and Bio-Inspired Computation, Theory and Applications”, Elsevier 2013.

**Reference**

1.Genetic Algorithms: Search and Optimization, E. Goldberg.
2.Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI
3.Kennedy J and Russel C Eberhart, “Swarm Intelligence”, Morgan Kaufmann Publishers, USA, 2001.

**Web Resources**

1. https://www.digimat.in/nptel/courses/video/106105173/L01.html
2. https://onlinecourses.nptel.ac.in/noc22_ee21/preview
3. https://www.digimat.in/nptel/courses/video/127105006/L01.html
4. https://www.youtube.com/watch?v=xbYgKoG4x2g

| 22-382-0348 | CYBER FORENSICS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite: Nil**

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO1** | Explain systematic approach to computer investigations. | (Cognitive level: Understand) |
| **CO2** | Apply forensic procedure to collect and recoverdigital evidence using tools. | (Cognitive level : Apply) |
| **CO3** | Judge the validity of digital evidence beforepresenting using cryptographic hashes. | (Cognitive level : Analyze) |
| **CO4** | Create forensic duplicates for investigation using tools and commands for capturing digital evidence . | (Cognitive level : Create) |
| **CO5** | Describe steps to follow for network , email andmobile forensics. | (Cognitive level : Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | | | 2 | 2 | | | 2 | | |
| CO2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | | | 2 | | |
| CO3 | 2 | 2 | | | | 2 | 2 | | | 2 | | |
| CO4 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | | | 2 | | |
| CO5 | 2 | 2 | | | | 2 | 2 | | | 2 | | |

## 22-382-0348 CYBER FORENSICS

### UNIT I (8 Hours)

Computer Forensics Fundamentals: Computer Crime, challenges with computer crime, different types of computer crime-Identity Theft, Identity fraud, Email and internet Fraud, Theft of financial data , Corporate Data Theft, Cyber extortion-Ransomware attack, Phishing, Hacking, Spoofing, Harassment, Intellectual property Theft , Ethical Hacking, Windows Hacking . Computer Forensics Fundamentals-Type of Computer Forensics Technology, Computer forensics specialist approaches - Scientific method in forensic analysis, Computer Forensics Services.

**UNIT II (10 Hours)**

Computer Forensics Evidence and Capture , Data Recovery-Evidence collection - archiving , artifacts , systematic collections steps, controlling contamination , reconstructing the attacks . Data Seizure - Duplication and preservation of Digital Evidence, Computer image verification and Authentication-Cryptographic Hashes. Data Acquisition. Investigating Cybercrime, Duties Support Functions and Competencies.

**UNIT III (10 Hours)**

Types of Evidence: The Rules of Evidence, Volatile Evidence, order of volatility- Why Collect Evidence in the first place, Collection Options Obstacles. Computer forensics and network forensics, systematic procedure for network forensics analysis. Incident - Incident Response Methodology - Steps, Activities in Initial Response Phase after detection of an incident, Creating response toolkit.

**UNIT IV (9 Hours)**

Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system, Forensic Duplication, Qualified Duplication, Forensic Duplicates as Admissible Evidence, Forensic Duplication using Linux commands, Creating windows Forensic Duplicate using tool, Forensic Duplicate of a Hard Disc.

**UNIT V (8 Hours)**

Collecting Network-Based Evidence - Investigating Routers - Network Protocols - Email Tracing - Internet Fraud. Hackers Tools. Cellphone and mobile device forensics. Forensics hardware and software, Information Security Investigations, Corporate Cyber Forensics, Investigating large scale Data breach cases, Analyzing Malicious software.

**Text Books**


1. John R. Vacca, Computer Forensics: Computer Crime Scene Investigation Laxmi Publications, 2015 reprint.
2. 1. Dr.Darren R Hayes, A Practical guide to Computer Forensics investigation, Pearson 2015.
3. 2. Aaron Philipp, David Cowen, Chris Davis , Computer Forensics Secrets & Solutions , McGraw-Hill Osborne Media, 2006
4. 3. Kenneth C.Brancik “Insider Computer Fraud” Auerbach Publications Taylor & Francis Group– 2008.
5. 4. Bill Nelson,Amelia Philips and Christopher Steuart, “Guide to computer forensics and investigations”, Cengage Learning; 4th edition, 2009.
6. 5. Dejey ,Murugan ,” Cyber Forensics”, OXFORD,2018.


**Web Resources**

1. *https://www.coursera.org/learn/smarter-contracts*

| 22-382-0349 | ANDROID APPLICATION PROGRAMMING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite**: Java

**Course Outcomes**
After completion of this course, the students will be able to

| | | |
|---|---|---|
| **CO1** | Explain the fundamentals of Android Programming. | (Cognitive level : Understand) |
| **CO2** | Describe Native Capabilities, Messaging, and Location based services. | (Cognitive level : ( Understand) |
| **CO3** | Create applications that work with databases to store data using Shared preferences and SQLite database. | (Cognitive level : Analyze) |
| **CO4** | Apply built in widgets and components in mobile app | (Cognitive level : Apply) |
| **CO5** | Create GUI based applications. | (Cognitive level : Create) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | | 2 | | | | 2 | | | |
| CO2 | | 2 | 2 | 2 | 2 | | | | | | | |
| CO3 | 2 | 2 | 2 | 2 | | | | | | | | |
| CO4 | 3 | 2 | 2 | 2 | 1 | | | | | | | |
| CO5 | 3 | 2 | 2 | | | | | | | | | 1 |

## 22-382-0349 ANDROID APPLICATION PROGRAMMING

**UNIT I (13 Hours)**
Introduction to Android Architecture: Introduction, History, Features and Android Architecture. Application Environment and Tools, Android Studio, Android SDK, AVD. Application Components- Activity, Content providers, Broadcast receivers, Services. Intents- Explicit and Implicit Intents, Intent Filter, Manifest File. Debugging android application.

**UNIT II (14 Hours)**
User Interface Design: User Interface Design: Views &View Groups, Views : Button, Text Field, Radio Button, Toggle Button, Checkbox, Spinner, Image View, Image switcher, Event Handling, Listeners, Layouts : Linear, Relative, List View, Grid View, Table View, Web View, Adapters. Creating the user interface programmatically, Managing changes to screen orientation, Displaying notifications- Setting up notifications, Notification manager. Designing for Tablets – Working with tablets: Developing for different android platforms, Fragments, combining fragments into a multilane UI, Specialized Fragments

**UNIT III (13 Hours)**

Mobile Data Management :Shared Preferences – Saving and Loading User Preferences, Persisting Data to Files, Creating and using Databases, SQLite Databases. Content Providers - Using a Content Provider, Built in Content Provider - Browser, CallLog, Contacts, Media Store and Settings. Creating Your Own Content Providers -Uri, CRUD access

**UNIT IV (12 Hours)**

Native Capabilities, Messaging, Location based services Camera, Audio, Sensors and Bluetooth: Android Media API: Playing audio/video, Media recording. Sensors - how sensors work, listening to sensor readings. Bluetooth , Messaging – SMS Messaging, Broadcast Receiver, Sending Email . Maps & Location: Maps : Map - Based Activities, How to load maps, To find map API key, GPS, Working with Location Manager, Working with Google Maps extensions, Location based Services. Location Updates, location-based services (LBS), Location Providers, Selecting a Location Provider, Finding Your Location

**UNIT V (11 Hours)**

Threading, Services, Web services Tasks & Processes: Tasks, Switching between Task, Process, Process lifecycle. Threads, Thread Life cycle, Worker Threads, Thread Handlers, Threads &Loopers and IPC.Services: Services and Notifications – bound/unbound services, Starting and stopping services, Android Interface Definition Language, Handler and Messenger, Passing objects over IPC, Scheduling of services. Web Services – Android Server Communication: communication protocols, interacting with server-side applications, developing clients forwebservices, Exchanging Data over the Internet data parsing using json and xml parsing. Integrating with 3rd party Apps using Web Services.

**TEXTBOOK**


1. Beginning Android Programming with Android Studio, 4ed, by J. F. DiMarzio, 2016 BookS
2. Android Application Development Cookbook, by Wei-Meng Lee, John Wiley and Sons, 2013 2. Professional Android 4 Development by Reto Meier, John Wiley and Sons, 2012 3. Android in Action, Third Edition, by W. Frank Ableson, RobiSen, Chris King, C. Enrique Ortiz, 2012


**Web Resources**

[1] https://nptel.ac.in/courses/106/106/106106147/

[2] https://www.coursera.org/learn/androidapps

| 22-382-0350 | DEEP LEARNING | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | CORE | 3 | 0 | 0 | 3 |

**Prerequisite:** Basic knowledge in Machine learning

**Course Outcomes**

After completion of this course, students will be able to

| | | |
|---|---|---|
| **CO1** | Discuss the basics concepts of neural networks. | (Cognitive level :Understand) |
| **CO2** | Describe the basic concepts in CNN | (Cognitive level :Understand) |
| **CO3** | Examine the working of different types of Autoencoders and Generative Adversarial Networks | (Cognitive level : Analyze) |
| **CO4** | Employ various RNN cell variants | (Cognitive level : Apply) |
| **CO5** | Describe the basic concepts in Reinforcement Learning and Unsupervised learning. | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes - Low=1, medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 2 | 1 | | | 2 | | | | |
| CO2 | 2 | 1 | 1 | 2 | 1 | | | 2 | | | | |
| CO3 | 2 | 1 | 1 | 2 | 1 | | | 2 | | | | |
| CO4 | 2 | 1 | 1 | 2 | 2 | | | 2 | | | | |
| CO5 | 2 | 1 | 1 | 2 | 1 | | | 2 | | | | |

## 22-382-0350 DEEP LEARNING

**UNIT I (8 Hours)**
Introduction to Neural Networks**:** Perceptron, Multi-layer perceptron, Regularization, Hyperparameter tuning, GPUs,TPUs.
Regression: Linear Regression, Multiple linear regression, Multivariate linear regression, Logistic regression.

**UNIT II (8 Hours)**

Convolution Neural Networks:Convolution operations,DCNN, VGG16

Advanced Convolution Neural Networks: AlexNet, Residual networks, DenseNets, Xception.

**UNIT III (9 Hours)**
Autoencoders:Introduction, Vanilla autoencoders, Sparse encoders, Denoising autoencoders, Stacked autoencoders,Variational Autoencoders.

Generative Adversarial Networks: DCGAN, SRGAN, Cycle GAN, Info GAN.

**UNIT IV (10 Hours)**
Recurrent Neural Network**:** RNN cell, RNN cell variants, RNN variants, RNN topologies, Encoder-Decoder architecture, Attention mechanism, Transformer architecture.

**UNIT V (10 Hours)**
Unsupervised Learning: Principal Component analysis, Self-organizing maps, Restricted Boltzmann Machines.

Reinforcement Learning: Deep reinforcement learning agents,Deep Q-Networks, Deep deterministic policy gradient.

**TEXTBOOK/ References:**

1. Deep learning with Tensor flow 2 and Keras,AntonioGulli,Amita Kapoor, Sujith Pal,2019
2. Dive into Deep Learning, Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola,2020
3. Deep Learning, Ian Goodfellow and YoshuaBengio and Aaron Courville, MIT Press, 2016.
4. Yuxi( Hayden), Liu and Savansh Mehta, “Hands -on Deep Learning Architectures with Python”, Packt, 2019
5. Josh Patterson & Adam Gibson, “Deep Learning: A Practitioners Approach”, published by O’Reilly Media.,2017
6. Nikhil Ketkar, “Deep Learning with Python”, published by Apress Media,2017

| 22-382-0351 | BIG DATA ANALYTICS | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| | | ELECTIVE | 3 | 0 | 0 | 3 |

**Prerequisite:** Data Mining

**Course Outcomes:** After the completion of the course the student will be able to

| | | |
|---|---|---|
| **CO1** | Solve the problems using MapReduce programming paradigm. | (Cognitive level : Apply) |
| **CO2** | Apply spark libraries for solving distributed applications. | (Cognitive level : Apply) |
| **CO3** | Analyze streaming data using Spark Streaming libraries | (Cognitive level : Analyze) |
| **CO4** | Demonstrate the usage of MongoDB, Hbase and Hive | (Cognitive level : Apply) |
| **CO5** | Explain the concepts of Spark MLlib libraries and Visualization tools | (Cognitive level : Understand) |

Mapping of Course Outcomes with Programme Outcomes - Low=1, Medium=2, High=3

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 3 | | 3 | 2 | 2 | | | 1 | | |
| **CO 2** | 2 | 2 | 3 | | 3 | 2 | 2 | | | | | |
| **CO 3** | 2 | 2 | 3 | 3 | 3 | 2 | 2 | | | | | |
| **CO 4** | | | 3 | | 2 | 2 | 2 | | | | | |
| **CO 5** | 1 | | | | | | | | | | | |

## 22-382-0351 BIG DATA ANALYTICS

**UNIT I (7 Hours)**

Introduction to Big Data: Big Data – Introduction, data life cycle, Structuring Big Data, Characteristics of Big Data, Big data applications, Technologies for handling big data – Distributed and Parallel Computing for Big Data, Introducing Hadoop – Hadoop multi node cluster architecture, Introduction to data lake, data cleansing and transformations, Data lake reference architecture, HDFS and MapReduce. HDFS Concepts– MapReduce Execution, Algorithms using MapReduce, Limitations of Hadoop, Overcoming the limitations of Hadoop

**UNIT II (8 Hours)**

Apache Spark: Eco system, Components of the Spark unified stack-Spark SQL, Spark Streaming, Spark GraphX, Spark MLLib. Spark context, spark stage, spark executor.Spark Architecture, RDD and RDD Operations-RDD Features and limitations, RDD- Persistence and Cashing mechanism, DAG, spark cluster management, performance tuning, DataFrames and Dataset – In-memory distributed processing using Apache Spark. Spark shell commands.

**UNIT III (10 Hours)**

Streaming Data: Streaming Architectures - Lambda architecture, Kappa architecture, Spark Streaming-Streaming system components, Discretized stream processing, Spark streaming architecture, Transformations on Dstreams, Window operations, Join and output operations, Caching, Checkpointing, Structured Streaming, Managing Distributed Data Flow with Apache Kafka-Kafka Fundamentals, Use case and applications, Architecture, Kafka Topics, Producer and consumer-Producer and consumer configuration and execution, In-Sync Replicas, Kafka Consumer groups

**UNIT IV (10 Hours)**

NoSQL Databases: Types NoSQL Databases, Introduction to MongoDB, Data model design, CRUD operations on MongoDB, Projection, limiting and sorting records, indexing, Aggregation, replication and sharding, Analyzing queries, Introduction to HBase, HBase data model, regions, HBase Architecture, zookeeper,Dataflow, WAL and Memstore, HFile, CRUD operations, Meta table, Merge and compaction, Introduction to Hive – Hive data types, Hive file formats,Hive database and table operations, partitioning, Built in operators and functions, Views and indexes, Spark on Hive.

**UNIT V (10 Hours)**

Analytics and Visualization: Spark MLLib for Machine Learning, ML Pipeline, Feature extraction and Transformations, Classification and Regression-Binary classification-SVM, logistic regression and linear regression, Multiclass classification – DT, Naive Bayes, Clustering- K Means, Hyperparameter Tuning and Cross-validation, Optimization. Building visualizations on Big Data- Power BI, Tableau, and Case Studies on applications of Big Data Analytics

**Text books**


1. Bill Chambers AndMateiZaharia, “Spark: The Definitive Guide: Big Data Processing Made Simple”, O'Reilly Media, 2018
2. Tathagata Das, Jules S. Damji, Brooke Wenig, Denny Lee, “Learning Spark: Lightning-Fast Data Analytics,” Second Edition, O’Reilly Media, 2020


**Reference books**


1. DT Editorial Services,“Big Data, Black Book : Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization”, DreamTech Press, 2016
2. Natraj Dasgupta, “Practical Big Data Analytics”, Packt, 2018
3. Gerard Maas, Francois Garillot “Stream Processing with Apache Spark”, O'Reilly Media, 2019
4. Bart Baesens, “Analytics in Big Data World," Wiley, 2014
5. Tom White, “HADOOP: The definitive Guide”, O Reilly 2012.
6. Kristina Chodorow and Michael Dirolf, “MongoDB: The Definitive Guide”,O'Reilly Media, 2019
7. Andy Konwinski, Holden Karau, MateiZaharia, and Patrick Wendell, “Learning Spark: LightningFast Big Data Analysis," O Reilly, 2015.


**Web Resources**

1. Coursera -Introduction to Big Data with Spark and Hadoop Introduction to Big Data with Spark and Hadoop.