

**PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018
(AUTONOMOUS)**

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS

REGULATIONS 2015

CURRICULUM AND SYLLABUS

III – IV SEMESTER



M.C.A.Programme

(3 Years Duration)

PAAVAI ENGINEERING COLLEGE

(Autonomous)

Vision

To strive to be a globally model Institution all set for taking 'lead-role' in grooming the younger generation socially responsible and professionally competent to face the challenges ahead.

Mission

- To provide goal- oriented, quality – based and value – added education through state – of – the – art technology on a par with international standards.
- To promote nation – building activities in science, technology, humanities and management through research
- To create and sustain a community of learning that sticks on to social, ethical, ecological, cultural and economic upliftment.

PAAVAI ENGINEERING COLLEGE

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DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS

Vision

To strive to be globally model institutions all set for taking lead role in grooming the younger generation socially responsible and professionally competent to face the challenges ahead

Mission

- To upgrade the academic activities by continuous improvement in the teaching - learning process with value based education.
- To enhance social responsibilities of the students necessary for successful practice of the profession.
- To facilitate research and industrial interaction.
- To mould the students into competent and creative technocrats to meet the growing global changes and challenges.
- To encourage the students as entrepreneurs and leaders of the society for the betterment of the Country.

| Programme Educational Objectives (PEOs) | | |
|---|-----------------------|--|
| Master of Computer Applications Graduates will be able to : | | |
| PEO1 | Global Reputation | To create value added, disciplined high profile Master of Computer Applications professionals for successful careers in their related industry that makes them globally reputed. |
| PEO2 | Fundamental Knowledge | To develop the students with a sound foundation in mathematical, scientific and engineering fundamentals necessary to synthesize the technical core concepts focusing on skill development and knowledge up gradation which will lead to technical innovations. |
| PEO3 | Continuous Learning | To practice and demonstrate the ability to use the domain knowledge and expertise through periodic assignments, performances and projects to continuously prove the functionality of Master of computer applications learning in social environmental aspects and to make allowances for further improvements. |

| Programme Outcomes (POs) | | |
|---|--|--|
| Master of Computer Applications Graduates will be able to : | | |
| PO1 | Engineering knowledge | Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| PO2 | Problem Analysis | Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| PO3 | Design/Development of Solutions | Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| PO4 | Conduct investigations of complex 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. |
| PO5 | Modern Tool Usage | Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. |

| | | |
|------|--------------------------------|--|
| PO6 | The engineer and society | Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice |
| PO7 | Environment and sustainability | Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| PO8 | Ethics | Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| PO9 | Individual and team work | Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO10 | Communications | Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| PO11 | Project management and finance | Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments |
| PO12 | Life-long learning | Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

| Programme Specific Outcomes (PSOs) | | |
|---|------------------------|--|
| PSO1 | Core Competencies: | Students attain deep domain knowledge in the fields of basic science to engineering applications and to enhance linguistic skills for effective communication and an ability to use conceptual knowledge of Surveying, fluid mechanics, hydrology and water resources and identify the environmental issues to propose suitable solutions. |
| PSO2 | Creativity and Design: | Students gain profound knowledge in the area of Planning, analyzing, design and estimation of civil engineering structures with professional ethics and managerial skills for economic design and suggests suitable materials and techniques for construction and rehabilitation works. |

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(AUTONOMOUS)

MASTER OF COMPUTER APPLICATIONS

REGULATIONS 2015

CURRICULUM

SEMESTER I

| Course | Course Title | L | T | P | C |
|---------------|---|----------|----------|----------|----------|
| PMA15108 | Mathematical Foundation for Computer Applications | 3 | 2 | 0 | 4 |
| CA15101 | Computer Organization | 3 | 0 | 0 | 3 |
| CA15102 | Problem Solving Techniques | 3 | 0 | 0 | 3 |
| CA15103 | Programming in C | 3 | 0 | 0 | 3 |
| CA15104 | Data structures and Algorithms | 3 | 0 | 0 | 3 |
| CA15105 | Programming in C Laboratory | 0 | 0 | 4 | 2 |
| CA15106 | Data Structures and Algorithms Laboratory | 0 | 0 | 4 | 2 |
| CA15107 | Office Automation Laboratory | 0 | 0 | 4 | 2 |
| Total | | 15 | 2 | 12 | 22 |

SEMESTER II

| Course | Course Title | L | T | P | C |
|---------------|--|----------|----------|----------|----------|
| CA15201 | Object Oriented Programming | 3 | 0 | 0 | 3 |
| CA15202 | Database Management Systems | 3 | 0 | 0 | 3 |
| CA15203 | System Software | 3 | 0 | 0 | 3 |
| CA15204 | Operating Systems | 3 | 0 | 0 | 3 |
| CA15205 | Computer Graphics and Multimedia | 3 | 0 | 0 | 3 |
| CA15206 | Object Oriented Programming Laboratory | 0 | 0 | 4 | 2 |
| CA15207 | DBMS Laboratory | 0 | 0 | 4 | 2 |
| CA15208 | Graphics and Multimedia Laboratory | 0 | 0 | 4 | 2 |
| Total | | 15 | 0 | 12 | 21 |

SEMESTER III

| Course | Course Title | L | T | P | C |
|---------------|---|----------|----------|----------|----------|
| PMA15301 | Resource Management Techniques | 3 | 2 | 0 | 4 |
| CA15301 | Computer Communication Networks | 3 | 0 | 0 | 3 |
| CA15302 | Object Oriented Analysis and Design | 3 | 0 | 0 | 3 |
| CA15303 | Software Engineering | 3 | 0 | 0 | 3 |
| CA15304 | Web Programming | 3 | 0 | 0 | 3 |
| CA15405 | Software Development- Case Tools Laboratory | 0 | 0 | 4 | 2 |
| CA15306 | Web Programming Laboratory | 0 | 0 | 4 | 2 |
| PEN15201 | Communication and Soft Skills Laboratory | 0 | 0 | 2 | 1 |
| Total | | 15 | 2 | 10 | 21 |

SEMESTER IV

| Course | Course Title | L | T | P | C |
|---------------|--------------------------------------|----------|----------|----------|----------|
| CA15401 | C# and .NET Framework | 3 | 0 | 0 | 3 |
| CA15402 | Free Open Source Software | 3 | 0 | 0 | 3 |
| CA15403 | Data Mining and Data Warehousing | 3 | 0 | 0 | 3 |
| CA15404 | Big Data Analytics | 3 | 0 | 0 | 3 |
| CAE15*** | Elective I | 3 | 0 | 0 | 3 |
| CA15405 | Free Open Source Software Laboratory | 0 | 0 | 4 | 2 |
| CA15406 | C# and .NET Programming Laboratory | 0 | 0 | 4 | 2 |
| CA15407 | Technical Seminar and Report Writing | 0 | 0 | 4 | 2 |
| PCA15408 | Career Development Laboratory | 0 | 0 | 2 | 1 |
| Total | | 15 | 0 | 14 | 22 |

SEMESTER V

| Course | Course Title | L | T | P | C |
|---------------|--|----------|----------|----------|----------|
| CA15501 | Web Application Development | 3 | 0 | 0 | 3 |
| CA15502 | Software Project Management | 3 | 0 | 0 | 3 |
| CA15503 | Mobile Computing | 3 | 0 | 0 | 3 |
| CAE15*** | Elective II | 3 | 0 | 0 | 3 |
| CAE15*** | Elective III | 3 | 0 | 0 | 3 |
| CA15504 | Advanced Internet Programming Laboratory | 0 | 0 | 4 | 2 |
| CA15505 | XML and Web Services Laboratory | 0 | 0 | 4 | 2 |
| CA15506 | Mini Project (Socially Relevant) | 0 | 0 | 4 | 2 |
| Total | | 15 | 0 | 12 | 21 |

SEMESTER VI

| Course | Course Title | L | T | P | C |
|---------------|---------------------|----------|----------|----------|----------|
| CA15601 | Project Work | 0 | 0 | 24 | 12 |

TOTAL CREDITS : 119

LIST OF ELECTIVES

ELECTIVE I

| Course | Course Title | L | T | P | C |
|----------|------------------------------------|---|---|---|---|
| CAE15401 | Energy Aware Computing | 3 | 0 | 0 | 3 |
| CAE15402 | Information Security | 3 | 0 | 0 | 3 |
| CAE15403 | Distributed Computing | 3 | 0 | 0 | 3 |
| CAE15404 | Enterprise Application Integration | 3 | 0 | 0 | 3 |
| CAE15405 | Game Programming | 3 | 0 | 0 | 3 |
| CAE15406 | Soft Computing | 3 | 0 | 0 | 3 |

ELECTIVE II

| Course | Course Title | L | T | P | C |
|----------|--|---|---|---|---|
| CAE15501 | Network Protocols | 3 | 0 | 0 | 3 |
| CAE15502 | High Performance Computing | 3 | 0 | 0 | 3 |
| CAE15503 | Cloud Computing | 3 | 0 | 0 | 3 |
| CAE15504 | Green Computing | 3 | 0 | 0 | 3 |
| CAE15505 | Software Testing and Quality Assurance | 3 | 0 | 0 | 3 |
| CAE15506 | Ad hoc and Sensor Networks | 3 | 0 | 0 | 3 |

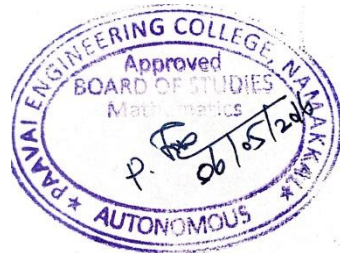
ELECTIVE III

| Course | Course Title | L | T | P | C |
|----------|--------------------------------|---|---|---|---|
| CAE15507 | Internet of Things | 3 | 0 | 0 | 3 |
| CAE15508 | M-Commerce | 3 | 0 | 0 | 3 |
| CAE15509 | Health Care Management | 3 | 0 | 0 | 3 |
| CAE15510 | Geological Information Systems | 3 | 0 | 0 | 3 |
| CAE15511 | Human Resource Management | 3 | 0 | 0 | 3 |
| CAE15512 | Semantic web | 3 | 0 | 0 | 3 |

REFERENCES

1. Taha H.A., "Operations Research : An Introduction" 8th Edition, Pearson Education, 2011.
2. A.M.Natarajan, P.Balasubramani, A.Tamilarasi, "Operations Research", Pearson Education, Asia, 2013.
3. Prem Kumar Gupta, D.S. Hira, "Operations Research", S.Chand & Company Ltd, New Delhi, 3rd Edition, 2013.
4. John W. Chinneck "Feasibility and Infeasibility in Optimization Algorithms and Computational Methods" Springer, 2013
5. Ravindran, Phillips, Solberg, "Operations Research: Principles And Practice", 2nd Edition, JohnWiley& Sons, 01-Jul-2012

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|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
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| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 |
| CO2 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable the students to

- understand networking concepts and basic communication model
- understand network architectures and components required for data communication
- analyze the function and design strategy of physical, data link, network layer and transport layer
- acquire knowledge of various application protocol standard developed for internet
- analyze the trace for the flow of information from one node to another node in the network

UNIT I INTRODUCTION 9

Data Communications – Networks – Protocols and Standards. Network Models – OSI Model – Layers– TCP/IP Protocol Suite–Addressing. Digital Transmission – Digital-to-Digital Conversion – Analog-to-Digital Conversion– Transmission Modes. Analog Transmission – Digital-to-Analog Conversion – Analog-to-analog Conversion. Transmission Media – Guided and Unguided Media.

UNIT II DATA LINK LAYER 9

Error – detection and correction – Parity – LRC – CRC – Hamming code – Flow Control and Error control – stop and wait – go back-N ARQ – selective repeat ARQ- sliding window – HDLC. - LAN - IEEE 802.4 - IEEE 802.5IEEE 802.11 – FDDI - SONET – Bridges.

UNIT III NETWORK LAYER 9

Internetworks–Circuit Switching- Packet Switching and Datagram approach – IP addressing methods– Subnetting– Routing – Distance Vector Routing – Link State Routing – BGP -Routers.

UNIT IV TRANSPORT LAYER 9

Duties of transport layer – Multiplexing – Demultiplexing – Sockets – User Datagram Protocol (UDP)– Transmission Control Protocol (TCP) – Congestion Control – Quality of services (QOS) – Integrated Services.

UNIT V APPLICATIONS 9

Domain Name Space (DNS) – SMTP – FTP – HTTP - WWW – Security – Cryptography.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- identify the components required to build different types of networks
- understand the functionalities needed for data communication into layers
- choose the required functionality at each layer for given application
- understand the working principles of various application protocols
- acquire knowledge about security issues and services available

REFERENCES

- 1 Larry L. Peterson & Bruce S. Davie, “Computer Networks – A systems Approach”, Fourth Edition, Harcourt Asia / Morgan Kaufmann, 2013.
2. William Stallings, “Data and Computer Communications”, Ninth Edition, Prentice Hall, 2013.
3. Forouzan, “ Data Communication and Networking”, Fifth Edition , TMH 2013
4. Andrew S. Tannenbaum David J. Wetherall, “Computer Networks” Fifth Edition , Pearson Education 2013
5. James F. Kurose, Keith W. Ross, “Computer Networking: A Top-down Approach, Pearson Education, Limited, sixth edition, 2013

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
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| CO1 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 |
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| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 2 | 1 | 2 | 3 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 1 | 2 | 3 | 2 | - | - | - | 2 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable the students to

- understand the basic concept of OOPs concept
- provide a brief, hands-on overview of object-oriented analysis in software process
- discuss Case studies based project specifications to develop object-oriented models and identify implementation strategies
- demonstrate and apply basic object oriented techniques to create and modify object oriented analysis
- understand and apply testing techniques for object oriented software

UNIT I INTRODUCTION 9

An overview – Object basics – Object state and properties – Behavior – Methods – Messages – Information hiding– Class hierarchy – Relationships – Associations – Aggregations- Identity – Dynamic binding – Persistence – Meta classes – Object oriented system development life cycle.

UNIT II METHODOLOGY AND UML 9

Introduction– Survey – Rumbugh, Booch, Jacobson methods – Patterns – Creational - Abstract Factory – Factory Method – Behavioral – Momento – Mediator - Structural – Decorator - Facade – Concurrency Patterns–Lock–Reactor–Scheduler- Frameworks – Unified approach – Unified modeling language – Staticand Dynamic models–UML diagrams– Class diagram – Usecase diagrams – Dynamic modeling – Model organization – Extensibility.

UNIT III OBJECT ORIENTED ANALYSIS 9

Identifying Usecase – Business object analysis – Usecase driven object oriented analysis – Usecase model – Documentation – Classification – Identifying object, relationships, attributes, methods – Super-sub class – A part of relationships Identifying attributes and methods – Object responsibility

UNIT IV OBJECT ORIENTED DESIGN 9

Design process and benchmarking – Axioms – Corollaries – Designing classes – Class visibility – Refining attributes – Methods and protocols – Object storage and object interoperability – Databases – Object relational systems – Designing interface objects – Macro and Micro level processes – The purpose of a view layer Interface-OOUI - MVC Architectural Pattern and Design – Designing the system.

UNIT V QUALITY AND TESTING 9

Quality assurance – Testing strategies – Test cases – Automated Testing Tools – Case Study - Cryptanalysis–Health Care Systems- Inventory Control System - Rational Rose Suite.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- understand the basic concepts to identify state & behavior of real world objects
- able to learn the various object oriented methodologies and choose the appropriate one for solving the problem with the help of various case studies
- understand the concept of analysis, design & testing to develop a document for the project
- able to implement analysis, design & testing phases in developing a software project
- able to understand the testing strategies and know about automated testing tools

REFERENCES

1. Taha H.A., "Operations Research : An Introduction" 8th Edition, Pearson Education, 2011.
2. Craig Larman, Applying UML and Patterns, 2nd Edition, Pearson, 2013.
3. Brahma Dathan, Sarnath Ramnath, "Object-Oriented Analysis, Design and Implementation", Universities Press 2013.
4. Grady Booch, James Rumbaugh, Ivar Jacobson, "The Unified Modeling Language User Guide", Addison Wesley Long man, 2013
5. Bernd Bruegge, Allen H. Dutoit, Object Oriented Software Engineering using UML, Patterns and Java, Pearson 2012

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
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| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 3 | 1 | 2 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 1 | 2 | 3 | 1 | 2 | - | - | 1 | - | - | - | 3 | 1 | 2 |



COURSE OBJECTIVES

To enable the students to

- understand the software life cycle
- provide an insight into the processes of software development
- understand and practice the various fields such as analysis, design, development testing
- understand the software metrics
- apply metrics and testing techniques to evaluate the software

UNIT I INTRODUCTION 9

Software Engineering paradigms – Waterfall Life cycle model –Spiral Model – Prototype Model – fourth Generation Techniques–Planning – Software Project Scheduling – Risk analysis and management –Requirements and Specification – Case Study for Project Plan and SRS

UNIT II SOFTWARE DESIGN 9

Abstraction–Modularity–Software Architecture – Cohesion – Coupling – Various Design Concepts and notations– Real time and Distributed System Design – Documentation – Dataflow Oriented design – Jackson System development – Designing for reuse – Programming standards – Case Study for Design of anyApplication Project.

UNIT III SOFTWARE TESTING AND MAINTENANCE 9

Software Testing Fundamentals – Software testing strategies – Black Box Testing – White Box Testing– System Testing – Object Orientation Testing – State based Testing - Testing Tools – Test Case Management –Software Maintenance Organization – Maintenance Report – Types of Maintenance – Case Study for Testing Techniques

UNIT IV SOFTWARE METRICS 9

Scope – Classification of metrics – Measuring Process and Product attributes – Direct and Indirect measures – Cost Estimation - Reliability – Software Quality Assurance – Standards – Case Study for COCOMO model

UNIT V SCM & WEB ENGINEERING 9

Need for SCM–Version Control – SCM process – Software Configuration Items – Taxonomy –CASE Repository– Features – Web Engineering

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- get an insight into the processes of software development
- able to understand the problem domain for developing SRS and various models of software engineering
- able to Model software projects into high level design using DFD,UML diagrams
- able to Measure the product and process performance using various metrics
- able to Evaluate the system with various testing techniques and strategies

REFERENCES

1. Roger S. Pressman, “Software Engineering: A Practitioner Approach”, Seventh edition, McGrawHill, 2013.
2. Richard Fairley, “ Software Engineering Concepts”, Tata McGraw Hill Edition, 2012
3. Ali Behforrooz, Frederick J.Hudson, “Software Engineering Fundamentals”, Oxford Indian Reprint, 2013
4. Sommerville, “Software Engineering”, Sixth Edition, Addison Wesley-Longman, 2013.
5. Kassem A. Saleh, “Software Engineering”, First Edition, J.Ross Publishing, 2012.

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| CO3 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | | 3 | 1 | 2 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 1 | 2 | 2 | 1 | 2 | - | - | 1 | - | - | - | 3 | 1 | 2 |



COURSE OBJECTIVES

To enable the students to

- understand the concepts and architecture of the World Wide Web
- understand and practice mark-up languages
- understand and practice embedded dynamic scripting on client side Internet Programming
- understand and practice of java concept
- understand and practice web development techniques on client-side

| | | |
|---|--------------------------------------|-----------|
| UNIT I | BASIC NETWORK AND WEB CONCEPT | 9 |
| Internet standards – TCP and UDP protocols – URLs – MIME – CGI – Introduction to SGML | | |
| UNIT II | MARKUP LANGUAGE | 9 |
| Introduction to HTML and HTML5-Formatting and Fonts-Commenting Code– Anchors – Backgrounds – Images– Hyperlinks – Lists – Tables – Frames - HTML Forms. | | |
| UNIT III | STYLESHEET | 9 |
| The need for CSS, Introduction to CSS – Basic syntax and structure - Inline Styles – Embedding Style Sheets - Linking External Style Sheets – Backgrounds - Manipulating text - Margins and Padding -Positioning using CSS. | | |
| UNIT IV | JAVAPROGRAMMING | 9 |
| Java features – Java Platform – Java Fundamentals – Expressions, Operators, and Control Structures –Classes, Packages and Interfaces – Exception Handling | | |
| UNIT V | PACKAGES | 9 |
| AWT package – Layouts – Containers – Event Package – Event Model – Painting – Garbage Collection– Multithreading – Language Packages. | | |
| TOTAL PERIODS | | 45 |

COURSE OUTCOMES

At the end of the course the students would be able to

- acquire knowledge about functionalities of world wide web
- explore mark-up languages features and create interactive web pages using them
- learn and design Client side validation using scripting languages
- acquire knowledge about Open source JavaScript libraries
- able to design front end web page and connect to the back end databases.

REFERENCES

1. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, "Internet and World Wide Web – How to Program", Fifth Edition, Pearson Education, 2013.
2. Achyut S Godbole and Atul Kahate, "Web Technologies", Second Edition, Tata McGraw Hill, 2012
3. Thomas A Powell, Fritz Schneider, "JavaScript: The Complete Reference", Third Edition, Tata McGraw Hill, 2013.
4. Deitel, Deitel and Nieto, "Internet and World Wide Web – How to program", Pearson Education Publishers, 2013.
5. R. Krishnamoorthy & S. Prabhu, "Internet and Java Programming", New Age International Publishers, 2013

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
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| CO1 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 |
| CO2 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 3 | - | - | - | - | | 2 | 2 | 1 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 2 | 2 | 3 | 2 | - | - | - | 1 | - | - | - | 2 | 2 | 2 |



COURSE OBJECTIVES

To enable the students to

- understand and practice the various fields such as analysis, design, development testing of Software Engineering
 - develop skills to construct software of high quality with high reliability
1. Practicing the different types of case tools such as Rational Rose / other Open Source to be used for all the phases of Software development life cycle.
 2. Data modeling
 3. Source code generators
 4. Apply the following to typical application problems:
 - a. Project Planning
 - b. Software Requirement Analysis
 - c. Software Design
 - d. Data Modeling & Implementation
 5. Software Estimation
 6. Software Testing
 7. A possible set of applications may be the following:
 - a. Library System
 - b. Student Marks Analyzing System
 - c. Text Editor.
 - d. Create a dictionary.
 - e. Telephone directory.
 - f. Inventory System.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of the course the students would be able to

- model software projects into high level design using DFD,UML diagrams
- measure the product and process performance using various metrics

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
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| CO1 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO2 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable the students to

- understand and practice embedded dynamic scripting on client side Internet Programming
 - understand and practice of java concept
1. Create a web page with the following using HTML5
 - a. To embed an image map in a web page
 - b. To fix the hot spots
 - c. Show all the related information when the hot spots are clicked.
 2. Create a web page with all types of Cascading style sheets.
 3. Writing Java programs by making use of class, interface, package, etc for the following
 - a. Different types of inheritance study
 - b. Uses of 'this' keyword
 - c. Polymorphism
 - d. Creation of user specific packages
 - e. Creation of jar files and using them
 - f. User specific exception handling

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of the course the students would be able to

- explore mark-up languages features and create interactive web pages using them
- acquire knowledge about Open source JavaScript libraries

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO2 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable the students to

- develop the ability to communicate effectively in spoken English
- draft flawless resume in English and participate successfully in group discussions
- enhance their soft skills and interpersonal skill
- equip the learners to make effective presentations on topics in engineering and technology

UNIT I FORMAL & INFORMAL CONVERSATION PRACTICE 6

Role Play1- with family members, neighbours, friends, relatives etc. Simple Expressions – agreeing /disagreeing, persuading, wishing, consoling, advising, arguing, expressing opinions etc- Professional dialogues with the superiors-Conversation with different professionals- Situations like - Government and Corporate Offices, Official Meetings, Educational Institutions, (At the railway junction, malls, post office, bank) etc.

UNIT II ORAL REVIEW, RADIO SHOW & NARRATIVE TECHNIQUES 6

Oral review of movies and discussion or sharing the view on various concepts of the movie, Presentation of various radio programs like news, announcements, advertisements, entertainment programs etc. as a team activity, Understanding the basic narrative techniques-Narrating short stories with message, Narrating real life experiences.

UNIT III RÉSUMÉ / LETTER WRITING 6

Preparation of résumé–structure – use of words and language style – Types of letter – structure of a letter – format for writing letters – use of language in letters

UNIT IV PRESENTATION SKILLS & GROUP DISCUSSION 6

Elements of effective presentation – Structure of presentation - Presentation tools – Voice modulation – effective use to presentation tools - Audience analysis - Body language – Video samples- Importance of GD – GD in selection process - Structure of GD – Moderator – led and other GDs - Strategies in GD – Team work – Body Language - Mock GD -Video samples

UNIT V INTERVIEW SKILLS 6

Kinds of interviews – Required Key Skills – Corporate culture – Mock interviews-Video samples.

TOTAL PERIODS 30

At the end of the course the students would be able to

- speak effectively and confidently in English
- attend job interviews with confidence
- write effective job applications with resume.
- participate in GD with involvement and confidence.

REFERENCES

- 1.Kalpana. V & Co., “Communication Skills Laboratory Manual”, Vijay Nicole Imprints Pvt. Limited, Chennai. 2013
- 2.Anderson, P.V. “Technical Communication”, Thomson Edition, New Delhi, 2012.
- 3.Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi, 2012
- 4.Kumar Sanjay, PushpLata, “Communication Skills (With CD)”, Oxford University Press, New Delhi. 2011
- 5.Dutt, Kiranmai P and GeethaRajeevan, “BasicCommunication Skills”, Foundation Books, New Delhi. 2012.

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | - | - | - | - | - | 2 | - | - | 3 | 3 | - | - | - | - |
| CO2 | - | - | - | 3 | 3 | - | 2 | 2 | 3 | - | - | - | - | - |
| CO3 | - | - | 2 | 1 | 3 | - | 3 | 3 | 3 | 3 | 2 | 3 | - | - |
| CO4 | - | - | - | 2 | - | - | - | 3 | 3 | 3 | 3 | - | - | - |



COURSE OBJECTIVES

To enable the students to

- learn the .NET framework concept and understand the syntax of basic C# Programs
- learn C# elements and OOPS concepts
- learn fundamentals of window application programming and how to create a window application
- develop web-based applications and learn advanced features of C#
- understand the foundation of CLR execution

UNIT I INTRODUCTION TO C# 8

Introducing C#, Understanding .NET, Overview of C#, Literals, Variables, Data Types, Operators, Expressions, Branching, Looping, Methods, Arrays, Strings, Structures, Enumerations.

UNIT II OBJECT ORIENTED ASPECTS OF C# 9

Classes, Objects, Inheritance, Polymorphism, Interfaces, Operator Overloading, Delegates, Events, Errors and Exceptions.

UNIT III APPLICATION DEVELOPMENT ON .NET 8

Building Windows Applications, Accessing Data with ADO.NET.

UNIT IV WEB BASED APPLICATION DEVELOPMENT ON .NET 8

Programming Web Applications with Web Forms, Programming Web Services.

UNIT V THE CLR AND THE .NET FRAMEWORK 12

Assemblies, Versioning, Attributes, Reflection, Viewing MetaData, Type Discovery, Reflecting on a Type, Marshaling, Remoting, Understanding Server Object Types, Specifying a Server with an Interface, Building a Server, Building the Client, Using SingleCall, Threads.

TOTALPERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- use Visual Studio .NET to implementing the .NET application and to Know the basic C# elements
- know the C# OOPS Concepts
- know the basic ADO.NET structures and understand the ADO.NET database connectivity
- understand the ASP.NET Programming Model and able to create ASP pages for web applications
- understand the internal functions of CLR and develop Web based applications on .NET CLR

REFERENCES

1. E. Balagurusamy, "Programming in C#", Tata McGraw-Hill, 2014. (Unit I, II)
2. J. Liberty, "Programming C#", 2nd ed., O'Reilly, 2013. (Unit III, IV, V)
3. Herbert Schildt, "The Complete Reference: C#", Tata McGraw-Hill, 2014.
4. Robinson et al, "Professional C#", 2nd ed., Wrox Press, 2013.
5. Andrew Troelsen, "C# and the .NET Platform", A1 Press, 2014.

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Week | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
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| CO1 | - | - | - | - | - | - | - | 2 | 2 | 3 | 3 | 1 | 3 | 1 |
| CO2 | - | - | - | 2 | 3 | - | 1 | 2 | - | 3 | 3 | 1 | 2 | 2 |
| CO3 | - | - | - | - | - | - | - | - | - | 3 | 1 | 1 | 2 | - |
| CO4 | - | - | - | - | 3 | 1 | 1 | - | 2 | 3 | 3 | 1 | 3 | 2 |
| CO5 | - | - | - | - | - | 2 | - | 2 | 1 | 3 | 1 | 1 | 3 | 2 |



COURSE OBJECTIVES

To enable the students to

- know of how to do project for the open source software process
- learn the open source database during the analysis of the project
- understand the open source languages
- learn the basics of python concept
- understand the basics of Perl

UNIT I INTRODUCTION 9

Introduction to Open sources – Need of Open Sources – Advantages of Open Sources– Application of Open Sources Open source operating systems: LINUX Introduction–General Overview – Kernel Mode and user mode– Process–Advanced Concepts– Scheduling – Personalities – Cloning – Signals – Development with Linux.

UNIT II OPEN SOURCE DATABASE 9

MySQL: Introduction – Setting up account – Starting, terminating and writing your own SQL programs – Record selection Technology – Working with strings – Date and Time– Sorting Query Results – Generating Summary – Working with metadata – Using quences – MySQL and Web.

UNIT III OPEN SOURCE PROGRAMMING LANGUAGES 9

PHP: Introduction–Programming in web environment– variables – constants – data types – operators – Statements – Functions – Arrays – OOP – String Manipulation and regular expression – File handling and data storage– PHP and SQL database–PHP and LDAP– PHP Connectivity – Sending and receiving E-mails – Debugging and Error handling – Security – Templates.

UNITIV PYTHON 9

Syntax and Style–Python Objects–Numbers–Sequences– Strings – Lists and Tuples – Dictionaries – Conditionals and Loops – Files – Input and Output – Errors and Exceptions – Functions – Modules – Classes and OOP– Execution Environment.

UNIT V PERL 9

Perl backgrounder – Perl overview – Perl parsing rules – Variables and Data – Statements and Control structures –Subroutines, Packages, and Modules- Working with Files –Data Manipulation.

TOTALPERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- prepare and do project for the open source software process
- understand the cost estimation techniques during the analysis of the project
- learn the quality concepts for ensuring the functionality of the software
- learn the Database concept
- practice and demonstrate various open source software

REFERENCES

1. Remy Card, Eric Dumas and Frank Mevel, “The Linux Kernel Book”, Wiley Publications, 2013
2. Steve Suchring, “MySQL Bible”, John Wiley, 2012
3. Rasmus Lerdorf and Levin Tatroe, “Programming PHP”, O’Reilly, 2012
4. Wesley J. Chun, “Core Python Programming”, Prentice Hall, 2012
5. Martin C. Brown, “Perl: The Complete Reference”, 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2012.

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
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| CO1 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 |
| CO2 | 1 | 2 | 3 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 1 | 2 | 2 | 3 | 3 | - | 1 | - | - | | 2 | 2 | 1 | 2 |
| CO4 | 2 | 1 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 2 | 2 | 2 | 1 | - | - | - | 2 | - | - | - | 3 | 2 | 2 |



COURSE OBJECTIVES

To enable the students to

- expose the students to the concepts of Data warehousing Architecture and Implementation
- understand Data mining principles and techniques and Introduce DM as a cutting edge business intelligence
- understand the concept of classification for the retrieval purposes
- know the clustering techniques in details for better organization and retrieval of data
- identify Business applications and Trends of Data mining

UNIT I DATA WAREHOUSE 8

Data Warehousing-Operational Database Systems vs.Data Warehouses-Multidimensional Data Model – Schemas for Multidimensional Databases – OLAP Operations – Data Warehouse Architecture – Indexing –OLAP queries & Tools.

UNIT II DATA MINING & DATA PREPROCESSING 9

Introduction to KDD process – Knowledge Discovery from Databases - Need for Data Pre-processing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation.

UNIT III ASSOCIATION RULE MINING 8

Introduction-Data Mining Functionalities-Association Rule Mining - Mining Frequent Item Sets with and without Candidate Generation - Mining Various Kinds of Association Rules - Constraint-Based Association Mining.

UNIT IV CLASSIFICATION & PREDICTION 10

Classification vs. Prediction–Data preparation for Classification and Prediction – Classification by Decision Tree Introduction–Bayesian Classification – Rule Based Classification – Classification by Back Propagation –Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods –Prediction–Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods–Model Section.

UNIT V CLUSTERING 10

Cluster Analysis:-Types of Data in Cluster Analysis–A Categorization of Major Clustering Methods– Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High- Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

TOTALPERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- understanding the Store voluminous data for online processing
- prepare the Pre-process the data for mining applications
- learn the association rules for mining the data
- practice and deploy appropriate classification techniques
- understand the high dimensional data for better organization of the data

REFERENCES

1. Jiawei Han and MichelineKamber, “Data Mining Concepts and Techniques” Second Edition, Elsevier, Reprinted 2012.
2. K.P. Soman, ShyamDiwakar and V. Ajay, “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2012.
3. G. K. Gupta, “Introduction to Data Mining with Case Studies”, Easter Economy Edition, Prentice Hall of India,2013.
4. BERSON, ALEX & SMITH, STEPHEN J, Data Warehousing, Data Mining, and OLAP, TMH Pub. Co. Ltd,New Delhi, 2012
5. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “Introduction to Data Mining”, Pearson Education, 2012

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
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| CO1 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |
| CO2 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | - | - | 1 | - | - | - | - | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable the students to

- understand the Bigdata concept
- understand mining data stream system
- understand the Hadoop concept
- understand usage of file systems
- understand how to build up framework

UNIT I INTRODUCTION TO BIG DATA 8

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data-Analytic Processes and Tools- Analysis vs Reporting- Modern Data Analytic Tools – Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT III HADOOP 10

History of Hadoop- The Hadoop Distributed File System – Components of Hadoop- Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS- Basics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features

UNIT IV HADOOP ENVIRONMENT 9

Setting up a Hadoop Cluster-Cluster specification-Cluster Setup and Installation- Hadoop Configuration- Security in Hadoop- Administering Hadoop – HDFS - Monitoring-Maintenance-Hadoop benchmarks- Hadoop in the cloud

UNIT V FRAMEWORKS 9

Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphereBigInsights and Streams. Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications

TOTALPERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- write API based programs
- design and implement data stream systems
- analyze mining data streams
- design Hadoop concept
- understanding the Framwwork applications

REFERENCES

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2012.
2. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012
4. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 1 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | 2 |
| CO2 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 2 | 1 | 2 | 2 | - | - | - | 2 | - | - | - | - | 3 | 2 |
| CO5 | 1 | 2 | 1 | 2 | - | - | - | 2 | - | - | - | 2 | 2 | 2 |



COURSE OBJECTIVES

To enable the students to

- know of how to do project for the open source software process
 - learn the cost estimation techniques during the analysis of the project
1. Basic Linux Commands
 2. Students Details using Shell Program
 3. Develop PHP program using Arrays, control structures, looping structures and Form Handling Develop a web application for Airline Reservation System using PHP.
 4. Running Python: some simple exercise – e.g. Connecting with MySql database
 5. Text processing with Perl: simple programs, connecting with database e.g., MYSQL

TOTALPERIODS 60

COURSE OUTCOMES

At the end of the course the students would be able to

- prepare and do project for the open source software process
- understand the cost estimation techniques during the analysis of the project

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO2 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 2 | 1 | 1 | 3 |



COURSE OBJECTIVES

To enable the students to

- learn the cost estimation techniques during the analysis of the project
 - understand the quality concepts for ensuring the functionality of the software
1. Programs using Branching, Looping.
 2. Programs using Methods, Arrays, Strings.
 3. Programs using Structures, Enumerations.
 4. Programs using Inheritance.
 5. Programs using Polymorphism.
 6. Programs using Interfaces.
 7. Programs using Operator overloading.
 8. Programs using Delegates, Events, Errors and Exceptions.
 9. Program to Build an Calculator widget
 10. Programs Using Multi Module Assembly
 11. Programs using application development on .net.
 12. Programs using Web applications.

TOTAL PERIOD 60

COURSE OUTCOMES

At the end of the course the students would be able to

- learn the risk management activities and the resource allocation for the projects
- can apply the software estimation and recent quality standards for evaluation of the software projects

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO2 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 2 | 1 | 1 | 3 |



The goal of this course is to train the students to critically evaluate a well-defined set of research subjects and to summarize the findings concisely in a paper of scientific quality. The paper will be evaluated based on the ability to understand a topic, communicate it and identify the issues. Results from this term paper will be presented to fellow students and a committee of faculty members.

1. Every student selects a topic related to current trends and the same should be approved by the respective committee. This selection should have at least 5 distinct primary sources.
2. Every student must write a short review of the topic and present it to fellow students and faculty (discuss the topic – expose the flaws – analyze the issues) every week.
3. The faculty should evaluate the short review and award marks with respect to the following.
 - a. Has the student analyzed – not merely quoted – the most significant portions of the primary sources
 - b. Employed?
 - c. Has the student offered original and convincing insights?
 - d. Plagiarism to be checked.
4. Every student should re-submit and present the review article including issues/ comments/ conclusions which had arisen during the previous discussion.
5. Every student should submit a final paper as per project specifications along with all short review reports (at least 4 internal reviews) and corresponding evaluation comments.
6. Every student should appear for a final external review exam to defend themselves.

TOTALPERIODS

60

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO2 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



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|---|-------------------------------------|-----------|
| UNIT I | CORPORATE READINESS | 6 |
| Business Communication–Inter& Intra Personal Skills–Business Etiquettes – Corporate Ethics – Communication Media Etiquette | | |
| UNIT II | INTERVIEW SKILLS | 6 |
| Resume Building – Group Discussions – Presentation Skills – Entrepreneur Skills – Psychometric Assessment – Mock Interview | | |
| UNIT III | QUANTITATIVE APTITUDE (QA) 2 | 6 |
| Profit & Loss–Clock–Power & Square Roots – Train – Boats & Streams – Probability – Calendars – Permutations& Combinations - Partnership – Simplification – Pipes & Cisterns – Puzzles | | |
| UNIT IV | LOGICAL REASONING (LR) 2 | 6 |
| Statements & Assumptions – Matching Definitions – Logical Games – Making Judgments – Statements &Conclusions – Verbal Classifications | | |
| UNIT V | VERBAL REASONING (VR) 2 | 6 |
| Syllogisms – Data Sufficiency – Dice – Series Completion – Character Puzzles – Cube & Cuboid – Arithmetic Reasoning | | |
| TOTAL PERIODS | | 30 |

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| COs | Programme Outcomes (POs) | | | | | | | | | | | | | |
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| CO2 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



ELECTIVE I

CAE15401

ENERGY AWARE COMPUTING

3 0 0 3

COURSE OBJECTIVES

To enable the students to

- examine the design of power efficient architecture, power and performance tradeoffs,
- restructuring of software and applications and standards for energy aware Hardware and software
- know the fundamental principles energy efficient devices
- study the concepts of Energy efficient storage
- know energy efficient techniques involved to support real-time systems

| | | |
|---------------|---------------------|----------|
| UNIT I | INTRODUCTION | 9 |
|---------------|---------------------|----------|

Energy efficient network on chip architecture for multi core system-Energy efficient MIPS CPU core with fine grained run time power gating – Low power design of Emerging memory technologies.

| | | |
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| UNIT II | ENERGY EFFICIENT STORAGE | 9 |
|----------------|---------------------------------|----------|

Disk Energy Management-Power efficient strategies for storage system-Dynamic thermal management for high performance storage systems-Energy saving technique for Disk storage systems.

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| UNIT III | ENERGY EFFICIENT ALGORITHMS | 9 |
|-----------------|------------------------------------|----------|

Scheduling of Parallel Tasks – Task level Dynamic voltage scaling – Speed Scaling – Processor optimization-Memetic Algorithms – Online job scheduling Algorithms.

| | | |
|----------------|--------------------------|----------|
| UNIT IV | REAL TIME SYSTEMS | 9 |
|----------------|--------------------------|----------|

Multi processor system – Real Time tasks- Energy Minimization – Energy aware scheduling-Dynamic Reconfiguration-Adaptive power management-Energy Harvesting Embedded system.

| | | |
|---------------|----------------------------------|----------|
| UNIT V | ENERGY AWARE APPLICATIONS | 9 |
|---------------|----------------------------------|----------|

On chip network – Video codec Design – Surveillance camera- Low power mobile storage

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- design Power efficient architecture Hardware and Software
- analyze power and performance tradeoff between various energy aware storage devices
- implement various energy aware algorithms
- restructure the software and Hardware for Energy aware applications
- design Power efficient architecture Hardware and Software

REFERENCES

1. Handbook of Energy Aware and Green computing, Ishfaq Ah mad, Sanjay Ranka, Chapman and Hall/ CRC,2012
2. Energy Aware system design Algorithms and Architecture, Chong-Min Kyung, Sungiooyoo, Springer,2011.
3. Energy Aware computing, Bob steigerwald ,Chris:Luro,Intel Press,2012.

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
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| CO1 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |
| CO2 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | - | - | 1 | - | - | - | - | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable students to

- understand the basics of cryptography
- learn to find the vulnerabilities in programs and to overcome them,
- know the different kinds of security threats in networks and its solution
- know the different kinds of security threats in databases and solutions available
- learn about the models and standards for security.

UNIT I ELEMENTARY CRYPTOGRAPHY 9

Terminology and Background – Substitution Ciphers – Transpositions – Making Good Encryption Algorithms- Data Encryption Standard- AES Encryption Algorithm – Public Key Encryption – Cryptographic Hash Functions– Key Exchange – Digital Signatures – Certificates .

UNIT II PROGRAM SECURITY 9

Secure programs – Non-malicious Program Errors – Viruses – Targeted Malicious code – Controls Against Program Threat – Control of Access to General Objects – User Authentication – Good Coding Practices – Open Web Application Security Project Flaws – Common Weakness Enumeration Most Dangerous Software Errors

UNIT III SECURITY IN NETWORKS 9

Threats in networks – Encryption – Virtual Private Networks – PKI – SSH – SSL – IPSec – Content Integrity – Access Controls – Wireless Security – Honeypots – Traffic Flow Security – Firewalls – Intrusion Detection Systems – Secure e-mail.

UNIT IV SECURITY IN DATABASES 9

Security requirements of database systems – Reliability and Integrity in databases –Redundancy – Recovery – Concurrency/ Consistency – Monitors – Sensitive Data – Types of disclosures – Inference-finding and confirming QL injection

UNIT V SECURITY MODELS AND STANDARDS 9

Secure SDLC – Secure Application Testing – Security architecture models – Trusted Computing Base – Bell-LaPadula Confidentiality Model – Biba Integrity Model – Graham-Denning Access Control Model – Harrison-Ruzzo-Ulman Model – Secure Frameworks – COSO – CobiT – Compliances – PCI DSS – Security Standards - ISO 27000 family of standards – NIST.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- apply cryptographic algorithms for encrypting and decryption for secure data transmission
- understand the importance of Digital signature for secure e-documents exchange
- understand the program threats and apply good programming practice
- get the knowledge about the security services available for internet and web applications
- understand data vulnerability and sql injection

REFERENCES

1. Charles P. Pfleeger, Shari Lawrence Pfleeger, “Security in Computing”, Fourth Edition, Pearson Education, 2007.
2. Michael Whitman, Herbert J. Mattord, “Management of Information Security”, Third Edition, Course Technology, 2010.
3. William Stallings, “Cryptography and Network Security : Principles and Practices”, Fifth Edition, Prentice Hall, 2010.
4. Michael Howard, David LeBlanc, John Viega, “24 Deadly Sins of Software Security: Programming Flaws and How to Fix Them”, First Edition, McGrawHill Osborne Media, 2009.
Matt Bishop, “Computer Security: Art and Science”, First Edition, Addison-wesley

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|--|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
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| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 1 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 | 1 | 2 |
| CO2 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 2 | 1 | 2 | 2 | - | - | - | 2 | - | - | - | - | 3 | 2 |
| CO5 | 1 | 2 | 1 | 2 | - | - | - | 2 | - | - | - | 2 | 2 | 2 |



COURSE OBJECTIVES

To enable the students to

- understand the phases of distributed computing
- be aware of the synchronization
- build concepts communication protocols
- learn about shared memory
- learn the design issues and distributed system concepts

UNIT I INTRODUCTION 9

Characterization of distributed systems - Examples - Resource sharing and the web - Challenges – System models -Architectural and fundamental models-Networking and internetworking–Types of networks-Network principles-Internet protocols.

UNIT II MESSAGE PASSING AND SYNCHRONIZATION 9

Interprocess communication - The API for the internet protocols - External data representation and marshalling-Client-Server communication - Group communication - Desirable features message passing system- Issues in message passing- Synchronization- Clock synchronization- Event ordering- Mutual exclusion- Deadlock-Election Algorithm - Buffering.

UNIT III REMOTE PROCEDURE CALL 9

RPC model - Transparency of RPC- Implementing RPC mechanism- Stub generation- Marshaling arguments and results- Server management- Parameter passing semantics - Call semantics-Communication protocols for RPCs- Complicated RPC client server binding- Exception handling-Security- Special types of RPCs-RPCs in heterogeneous environments- Lightweight RPC.

UNIT IV DISTRIBUTED SHARED MEMORY 9

General architecture of DSM systems- Design and implementation of DSM- Granularity- Structure of shared memory space- Consistency models- Replacement strategy- Thrashing- Other approaches to DSM- Heterogeneous DSM and advantages of DSM.

UNIT V DISTRIBUTED NAMING 9

Introduction- Desirable features of naming system- Fundamental concepts- System oriented names- Object locating mechanisms-Human oriented names- Name caches - Naming and security.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- apply basic principles and practices of Computer Science and Engineering to productively
- engage in the research
- design and conduct experiments, as well as to analyzed
- design the interpret data on experiments relevant to Computer Science practice
- identify, analyze, formulate and solve engineering problems

REFERENCES

1. George Coulouris, Jean Dollimore and Tim Kindberg, Distributed Systems Concepts and Design, Pearson Education, 2009.
2. Pradeep K Sinha . Distributed Operating Systems: Concepts and design,. IEEE computerpress, 2007.
3. Andrew S Tanenbaum, Maartenvan Steen, Distibuted Systems –Principles and Pardigms, Pearson Education, 2002.
4. Mullender, Distributed Systems, Addison Wesley, 1993.
5. M.L.Liu, Distributed Computing Principles and Applications, Pearson Education, 2004.

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Week | | | | | | | | | | | | | | |
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| CO1 | 1 | 2 | 2 | 2 | - | - | - | - | - | - | - | 1 | 1 | 2 |
| CO2 | 2 | 3 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 2 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 1 | 2 | 2 | 2 |
| CO4 | 1 | 2 | 2 | 1 | - | - | - | 2 | - | - | - | - | 3 | 2 |
| CO5 | 1 | 3 | 2 | 2 | - | - | - | 2 | - | - | - | 2 | 2 | 2 |



COURSE OBJECTIVES

To enable the students to

- describe approaches to enterprise application integration
- understand the integration middleware
- evaluate the integration approaches suitable for a given problem
- understand the integration
- evaluate the integration approaches against specified requirements

UNIT I INTRODUCTION 9

Requirements for EAI - Challenges in EAI – Integration with legacy systems – Integration with partners - Heterogeneous environment–Implementation approaches – Web services, messaging ETL, direct data integration – Middleware requirements – Approaches to integration – services oriented and messaging.

UNIT II INTEGRATION PATTERNS 9

Introduction to integration patterns – Architecture for application integration – Integration patterns – Point to point, broker, message bus, publish/subscribe, Challenges in performance, security, reliability - Case studies

UNIT III SERVICE ORIENTED INTEGRATION 9

Business process integration - Composite applications-services – Web services – Service choreography and orchestration-Business process modeling-BPMN, Business process execution–BPEL–Middleware infrastructure-Case studies

UNIT IV MESSAGING BASED INTEGRATION 9

Messaging – Synchronous and asynchronous – Message structure – Message oriented middleware – Reliability mechanisms – Challenges – Messaging infrastructure – Java Messaging Services – Case studies.

UNIT V ENTERPRISE SERVICE BUS 9

Enterprise Service Bus – routing, scalable connectivity, protocol and message transformations, data enrichment, distribution, correlation, monitoring – Deployment configurations – Global ESB, Directly connected, Federated ,brokered ESBs–Application server based – Messaging system based– Hardware based ESBs – Support to SOA, message based and event based integrations – Case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- describe different approaches to integration enterprise applications
- analyze specifications and identify appropriate integration approaches
- analyze service oriented integration
- develop a suitable integration design for a given problem
- identify appropriate integration middleware for a given problem

REFERENCES

1. George Mentzas and Andreas Frezen (Eds), "Semantic Enterprise Application Integration for Business Processes: Service-oriented Frameworks", Business Science Reference, 2009
2. Waseem Roshen, "SOA Based Enterprise Integration", Tata McGrawHill, 2009.
3. G Hohpe and B Woolf, "Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions", Addison-Wesley Professional, 2003
4. D Linthicum, "Next Generation Application Integration: From Simple Information to Web Services", Addison-Wesley, 2003
5. Martin Fowler, "Patterns of Enterprise Application Architecture", Addison- Wesley, 2003

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
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| CO1 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 |
| CO2 | 2 | 1 | 1 | 2 | 2 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 2 | 1 | 2 | 2 |
| CO4 | 1 | 2 | 2 | 1 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 2 | 3 | 2 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable the students to

- understand of game design and development
- understand the processes, mechanics, issues in game design, game engine development
- understand modelling, techniques, handling situations, and logic
- understand the game platforms and frameworks
- design and develop interactive games

UNIT I 3D GRAPHICS FOR GAME PROGRAMMING 9

Coordinate Systems, Ray Tracing, Modeling in Game Production, Vertex Processing, Rasterization, Fragment Processing and Output Merging, Illumination and Shaders, Parametric Curves and Fragment Processing and Output Merging, Illumination and Shaders, Parametric Curves and Animation, Physics-based Simulation

UNIT II GAME DESIGN PRINCIPLES 9

Character development, Story Telling, Narration, Game Balancing, Core mechanics, Principles of level design, Genres of Games, Collision Detection, Game Logic, Game AI, Path Finding

UNIT III GAMING ENGINE DESIGN 9

Renderers, Software Rendering, Hardware Rendering, and Controller based animation, Spatial Sorting, Level of detail, collision detection, standard objects, and physics

UNIT IV GAMING PLATFORMS AND FRAMEWORKS 9

Flash, DirectX, OpenGL, Java, Python, XNA with Visual Studio, Mobile Gaming for the Android, iOS, Game engines - Adventure Game Studio, DXStudio, Unity

UNIT V GAME DEVELOPMENT 9

Developing 2D and 3D interactive games using OpenGL, DirectX – Isometric and Tile Based Games, Puzzle games, Single Player games, Multi Player games.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- understand and apply 3 D concepts in Game programming
- gain knowledge about principles and levels of design in various game development
- gain knowledge about gaming engine design for controlling
- analyze various gaming platforms
- explore into various platforms and frameworks available for game development

REFERENCES

1. David H. Eberly, "3D Game Engine Design, Second Edition: A Practical Approach to Real- Time Computer Graphics" Morgan Kaufmann, 2 Edition, 2006.
2. JungHyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 1st edition, 2011
3. Mike McShaffirfy, "Game Coding Complete", Third Edition, Charles River Media, 2009.
4. Jonathan S. Harbour, "Beginning Game Programming", Course Technology PTR, 3 edition, 2009
5. Ernest Adams and Andrew Rollings, "Fundamentals of Game Design", Prentice Hall 1st edition, 2006

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
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| CO2 | 1 | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 1 | 2 | 3 | 1 | - | - | - | 1 | - | - | - | 3 | 2 | 3 |



COURSE OBJECTIVES

To enable the students to

- learn the key aspects of Soft computing
- know about the components and building block hypothesis of Genetic algorithm
- understand the features of neural network and its applications
- study the fuzzy logic components
- gain insight onto Neuro Fuzzy modeling and control

UNIT I INTRODUCTION TO SOFT COMPUTING 9

Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence- Machine Learning Basics

UNIT II GENETIC ALGORITHMS 9

Introduction, Building block hypothesis, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling: Significance of Genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems, JSPP (Job Shop Scheduling Problem), TSP (Travelling Salesman Problem), Differences & similarities between GA & other traditional methods, Applications of GA.

UNIT III NEURAL NETWORKS 9

Machine Learning using Neural Network, Adaptive Networks – Feed Forward Networks –Supervised Learning Neural Networks – Radial Basis Function Networks - Reinforcement Learning– Unsupervised Learning Neural Networks – Adaptive Resonance Architectures – Advances in neural networks.

UNIT IV FUZZY LOGIC 9

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

UNIT V NEURO-FUZZY MODELING 9

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule base Structure Identification – Neuro-Fuzzy Control – Case Studies.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course the students would be able to

- implement machine learning through neural networks
- gain Knowledge to develop Genetic Algorithm and Support vector machine based machine learning system
- write Genetic Algorithm to solve the optimization problem
- understand fuzzy concepts and develop a Fuzzy expert system to derive decisions
- model Neuro Fuzzy system for data clustering and classification

REFERENCES

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing”, Prentice-Hall of India, 2003
2. Kwang H. Lee, “First course on Fuzzy Theory and Applications”, Springer-Verlag Berlin Heidelberg, 2005.
3. George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic-Theory and Applications”, Prentice Hall, 1995.
4. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson Edn., 2003.
5. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Addison Wesley

| Mapping of Courses Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
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| CO1 | 2 | 2 | 3 | 2 | - | - | - | - | - | - | - | 1 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 3 | 3 | - | - | - | - | - | - | 2 | 1 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | | 2 | 1 | 1 | 3 |
| CO4 | 1 | 2 | 3 | 2 | - | - | - | 2 | - | - | - | - | 2 | 2 |
| CO5 | 2 | 2 | 1 | 2 | - | - | - | 2 | - | - | - | 3 | 2 | 3 |

