A.D.M COLLEGEFOR WOMEN (AUTONOMOUS),

(Accredited With 'A' Grade by NAAC 4th Cycle)

(Affiliated to Bharathidasan University, Tiruchirappalli)

NAGAPATTINAM-611001

PG DEPARTMENT OF COMPUTER SCIENCE

(for the candidates admitted from the academic year 2024-2025)

SYLLABUS

M.Sc., COMPUTER SCIENCE

(2024-2026)

PG DEPARTMENT OF COMPUTER SCIENCE
M.Sc., COMPUTER SCIENCE COURSE STRUCTURE UNDER CBCS
(2024-2026 Batch)

OBE ELEMENTS

Programme Educational Objectives (PEO):

PEO 1	To provide advanced and in-depth knowledge of computer science and its applications
PEO 2	To prepare Post Graduates who will achieve peer-recognition; as an individual or in a through demonstration of good analytical, design and implementation skills.
PEO 3	To enable students pursue a professional career in Information and Communication Technology related industry, business and research
PEO 4	To impact professional knowledge and practical skills to the students.
PEO 5	To enable students to take up challenging jobs.

Programme Outcomes (PO):

On completion of the course the learner will be able

PO-1	Attain a sound understanding of the general principles of Computer Science.
PO-2	Obtain exposure to innovative, research-based topics within computing
PO-3	Acquire leadership qualities, and good communication, teamwork, social, and professional skills.
PO-4	Understand the impact of computer science solutions in a global and societal context
PO-5	Apply knowledge of computing to produce effective designs and solutions for specific problems

Programme Specific Outcomes (PSO):

On completion of the course the learner will be able

PSO - 1	Acquire academic excellence with an aptitude for higher studies and research.
PSO – 2	Attain knowledge to develop and apply new computer technologies.
PSO – 3	Contribute to the local society and the global community related to Computer Science.
PSO – 4	Identify, formulate, and solve computer science problems.
PSO – 5	Practice high standard of professional ethics.

A.D.M COLLEGE FOR WOMEN (AUTONOMOUS), NAGAPATTINAM-611001
PG DEPARTMENT OF COMPUTER SCIENCE

CURRICULUM STRUCTURE – M.Sc., Computer Science (2024-2026)
(For I Year 2024 Batch onwards)

Category of Courses	No. of Courses	Hrs	Total Credits
Core Courses (CC)	**12**	**72**	**52**
Core Choice Courses(CCC)	**3**	**18**	**12**
Elective Courses(EC)	**3**	**16**	**11**
Entrepreneurship/ Industry Based Course	**1**	**4**	**3**
Internship	**0**	**0**	**2**
Skill Enhancement Courses (SEC)	**2**	**4**	**4**
Project	**1**	**6**	**4**
Value Added Courses (Extra Credit)*	**2**	**0**	**4**
TOTAL	**22+2**	**120**	**90+4**

SCHEME OF EXAMINATIONS – 2024 Batch
M.Sc., Computer Science (2024-2026)

SEMESTER I						
COURSE TYPE	**COURSES**	**HRS**	**CREDITS**	**EXAM DURATION**	**MAX. MARKS**	
Core Course I	CC I - Design and Analysis of Algorithms	6	4	3	25	75
Core Course II	CC II - Web Development Tools	6	5	3	25	75
Core Course III	CC III – Advanced Java Programming Lab	6	5	3	40	60
Core Choice Course I	CCC I – 1. **Advanced Java Programming** 2. XML	6	4	3	25	75
Elective Course I	EC I – **1. Web Development Tools Lab** 2. Software Testing Tools Lab	6	4	3	40	60
	No. of Courses	**30**	**22**			

SEMESTER II						
COURSE TYPE	**COURSES**	**HRS**	**CREDITS**	**EXAM DURATION**	**MAX. MARKS**	
Core Course IV	CC IV - Database & NOSQL	6	4	3	25	75
Core Course V	CC V - Modern Operating Systems	6	5	3	25	75
Core Course VI	CC VI - Big Data Analytics	6	5	3	25	75
Core Choice Course II	CCC II - **1. Artificial Intelligence & Machine Learning** 2. Human Computer Interaction	6	4	3	25	75
Elective Course II	EC II - **1. R –Programming Lab** 2. Computer Vision – Lab	4	3	3	40	60
Skill Enhancement Course I	SEC I - MongoDB Lab	2	2	3	40	60
Value Added Course I	VAC I - Full Stack Management	-	2	3	0	100
	No. of Courses	**30**	**23+2**			
Internship/Industrial Activity during the Summer Vacation after I Year						

SEMESTER III						
COURSE TYPE	**COURSES**	**HRS**	**CREDITS**	**EXAM DURATION**	**MAX. MARKS**	
Core Course VII	CC VII - Data Mining & Data Warehousing	6	4	3	25	75
Core Course VIII	CC VIII - Data Mining Lab	6	4	3	40	60
Core Course IX	CC IX - Distributed Technologies	6	5	3	25	75
Core Choice Course III	CCC III - **1. Compiler Design** 2. Metaverse	6	4	3	25	75
Industry Based Course I	IBC I - Internet of Things	4	3	3	25	75
Skill Enhancement Course II	SEC II - Distributed Technologies Lab	2	2	3	40	60
Internship/ Industrial Activity	Internship/Industrial Activity	-	2	-	-	-
Value Added Course II	VAC II - Information Security	-	2	3	0	100
	No. of Courses	**30**	**24+2**			

SEMESTER IV						
COURSE TYPE	**COURSES**	**HRS**	**CREDITS**	**EXAM DURATION**	**MAX. MARKS**	
Core Course X	CC X - Research Methodology	6	5	3	25	75
Core Course XI	CC XI - Data Science Using Python	6	4	3	25	75
Core Course XII	CC XII - Advanced Python Programming Lab	6	4	3	40	60
Core Course XIII	CC XIII - Project work and Viva-voce	6	4	3	25	75
Elective Course III	EC III - 1. **Ethical Hacking** 2. Cyber Security	6	4	3	25	75
	No. of Courses	**30**	**21**			
	Grand Total	**120**	**90+4**			

Semester-I / Core Course- I (CC- I)	**DESIGN AND ANALYSIS OF ALGORITHMS**	**Course Code :**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- Define the basic concepts of algorithms and analyze the performance of algorithms.
- Discuss various algorithm design techniques for developing algorithms.
- Discuss various searching, sorting and graph traversal algorithms.
- Understand NP completeness and identify different NP complete problems.
- Discuss various advanced topics on algorithms

UNIT	CONTENT	HOURS
UNIT I	Algorithm Definition – Algorithm Specification – Performance Analysis. Elementary Data Structures: Stacks and Queues – Trees – Dictionaries – Priority Queues – Sets and Disjoint Set Union – Graphs.	18
UNIT II	The General Method – Defective Chessboard – Binary Search – Finding The Maximum And Minimum – Merge Sort – Quick Sort – Selection - Strassen's Matrix Multiplication.	18
UNIT III	General Method - Container Loading - Knapsack Problem - Tree Vertex Splitting – Job Sequencing With Deadlines - Minimum Cost Spanning Trees - Optimal Storage On Tapes – Optimal Merge Patterns - Single Source Shortest Paths.	18
UNIT IV	The General Method – Multistage Graphs – All-Pairs Shortest Paths – Single-Source Shortest Paths - Optimal Binary Search Trees - String Editing - 0/1 Knapsack - Reliability Design - The Traveling Salesperson Problem - Flow Shop Scheduling. Basic Traversal and Search Techniques: Techniques for Binary Trees – Techniques for Graphs – Connected Components and Spanning Trees – Biconnected Components and DFS.	18

UNIT V	The General Method – The 8-Queens Problem – Sum of Subsets –Graph Coloring – Hamiltonian Cycles – Knapsack Problem Branch and Bound: The Method - 0/1 Knapsack Problems.	18

Text Books:

1. Ellis Horowitz, Satraj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Universities Press, Second Edition, Reprint 2009.

Reference Books:

1. Data Structures Using C - Langsam, Augenstien, Tenenbaum, PHI
2. Data structures and Algorithms, V.Aho, Hopcropft, Ullman , LPE
3. Introduction to design and Analysis of Algorithms - S.E. Goodman, ST. Hedetniem- TMH

Web-Resources:

https://www.iare.ac.in/sites/default/files/lecture_notes/DAA_LECTURE_NOTES_0.pdf

http://dmice.ac.in/wp-content/uploads/2017/05/DAA.pdf

Course Outcomes:

On completion of the Course, Students should be able to do

CO1: Define, compare and use the four types of NoSQL Databases (Document-oriented, KeyValue Pairs, Column-oriented and Graph).

CO2: Distinguish the different types of NoSQL databases.

CO3 : Explain the detailed architecture, define objects, load data, query data and Performance tune Document-oriented NoSQL databases.

CO4: Demonstrate an understanding of the detailed architecture, define objects, load data, querydata and performance tune Column-oriented NoSQL databases.

CO5: Evaluate NoSQL database development tools and programming languages.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	M	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	S	S	M	S	M	S
CO4	S	S	S	M	S	S	S	S	S	S
CO5	S	M	S	S	S	M	S	M	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-I / Core Course- II (CC- II)	**WEB DEVELOPMENT TOOLS**	**Course Code :**
Instruction Hours: 6	**Credits: 5**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To introduce the fundamentals of Internet, and the principles of web design
- To construct basic websites using HTML and Cascading Style Sheets.
- To build dynamic web pages with validation using Java Script objects and by applying different event handling mechanisms.
- To develop modern interactive web applications using PHP, XML and MySQL
- To Apply basic design principles to present ideas, information, products, and services on websites

UNIT	CONTENT	HOURS
UNIT I	Introduction to CSS: Importing a style sheet – CSS rules – Style Types –Selectors – Fonts and Typography – Managing Text Styles – CSS Colors -Positioning Elements. The HTML5 Canvas: Creating and Accessing a Canvas –Writing Text to the Canvas – Drawing Lines – Working with Curves –Manipulating Images. HTML5 Audio and Video: The <audio> and <video>Element. Other HTML5 Features: Geolocation and the GPS Service.	18
UNIT II	Exploring JavaScript: JavaScript and HTML Text – Using Comments – Semicolons – Variables – Operators – The Document Object Model – About document write. Expressions and Control Flow in JavaScript: Expressions –Literals and Variables – Operators – with Statement – Using try….catch –Conditionals – Looping – Explicit Casting – JavaScript Functions – JavaScript Objects – JavaScript Arrays.	18
UNIT III	Exploring PHP: PHP Functions and Objects: PHP Functions- Including and requiring Files-PHP Objects. PHP Arrays: Basic Access-Multidimensional Arrays- Using Array Functions. Accessing MYSQL using PHP: Querying a MYSQL Database with PHP-A Practical Example. Cookies, Sessions And Authentication: Using Cookies in PHP-HTTP Authentication-Using Sessions.	18

UNIT IV	Introduction to jQuery: What jQuery can do for you -Installing jQuery. Selecting and Filtering: Using Selector API- Filtering a Selection-Slicing and Adding. Events. Manipulating Content.	18
UNIT V	Introduction to JSON: JSON Grammar -JSON Tokens. Creating JSON: The Serialization Process-Demystified- JSON Object. Parsing JSON: JSON.parse. Data Interchange: Hyper Text Transfer Protocol-*Ajax-XML HTTP request Interface.	18

Text Books:

1. Robin Nixon , Learning PHP, MySQL &JavaScript with JQuery, CSS &HTML 5, O'Reilly, 5th Edition, 2018.
2. Richard York, Web Development with jQuery , John Wiley & Sons, Inc.2015
3. Ben Smith, Beginning JSON , A press Publisher, 2015

Reference Books:

1. Laura Lemay, Rafe Colburn and Jennifer Kyrnin, Mastering HTML, CSS & Java Script Web Publishing, BPB Publications, 2016
2. John Pollock, JQAuery: A Beginner's Guide, McGraw Hill Publisher, 2014
3. Ben Smith, Beginning JSON, Apress Publisher, 2015

Web-Resources:

1. https://www.w3schools.com/js/js_json_intro.asp
2. https://www.javatpoint.com/json-tutorial
3. https://www.geeksforgeeks.org/json-introduction/

Course Outcomes:

On completion of the Course, Students should be able to do

CO1: Understand the concepts of CSS, JavaScript, PHP, jQuery, AJAX and JSON

CO2: Utilize JavaScript with HTML and CSS to create interactive webapplications.

CO3 : Inspect JavaScript frameworks and light weight format which facilitate thedevelopers to focus on core features.

CO4: Explain the importance of PHP, jQuery and JSON for web applicationdevelopment .

CO5: Develop object oriented Server-Side Scripts using PHP to generate and display the contents dynamically.

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	M	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	S	S	M	S	M	S
CO4	S	S	S	M	S	S	S	S	S	S
CO5	S	M	S	S	S	M	S	M	S	S

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Semester-I / Core Course-III (CC-III)	**ADVANCED JAVA PROGRAMMING LAB**	**Course Code:**
Instruction Hours: 6	**Credits: 5**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To understand how to design, implement, test, debug, and document programs that use basicdata types and computation, simple I/O, conditional and control structures, string handling and functions.
- Using Graphics, Animations and Multithreading for designing Simulation and Game based applications.
- Design and develop Web applications
- Designing Enterprise based applications by encapsulating an application's business logic.
- Designing applications using pre-built frameworks.

List of Practical's:

1. Remote Method Invocation
2. Servlet
3. Servlet with JDBC
4. JSP
5. JSP Cookies
6. JSP with JDBC
7. EJB: Session Bean
8. Simple Spring application
9. Spring based forms
10. JSP Web Views

Course Outcomes:

On completion of the Course, Students should be able to do

CO1 : Demonstrate programming language concepts RMI, Servlet

CO2 : Write, debug, and document well-structured J2EE applications

CO3 : Demonstrate the behavior of JSP and Cookies

CO4 : Implement JSP connection with JDBC

CO5: Develop programming aspect with spring based forms and apply the concept of JSP using web views

Semester-I / Core Choice Course-I (CCC-I)	**1. ADVANCED JAVA PROGRAMMING**	**Course Code :**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To learn why Java is useful for the design of desktop and web applications.
- To learn how to implement object-oriented designs with Java.
- To identify Java language components and how they work together in applications.
- To design and program stand-alone Java applications.
- To understand how to use Java APIs for program development

UNIT	CONTENT	HOURS
UNIT I	**J2EE OVERVIEW:** J2EE and J2SE- The Birth of J2EE - J2EE. **J2EE Multitier Architecture:** The Tier - J2EE Multi-Tier Architecture - Client Tier Implementation- Classification of Clients -Web Tier Implementation. **J2EE Best Practices:** The Enterprise Application-Session Management- Presentation and Processing- Model View Controller.	18
UNIT II	JAVA REMOTE METHOD INVOCATION: RMI Concept-Remote Interface- Passing Objects - The RMI Process - Sever side - Client side. **JAVA Servlets:** Java Servlets and Common Gateway Interface Programming- Benefits of using a Java Servlet – A simple Java Servlet – Anatomy of Java Servlet – Deployment Descriptor – Reading Data from a Client – Working with Cookies – Tracking Sessions.	18
UNIT III	JSP - JSP Tags- Variables and Objects- Methods -Control Statements-Loops -Tomcat- Request String -User Session - Cookies - Session Objects. **EJB:** Enterprise Java Beans-The EJB container- EJB Classes-EJB Interfaces- Referencing EJB- Relationship Elements -Session Java Bean –Stateless vs. Stateful - Creating a Session Java Bean-Entity Java Bean -The JAR file.	18

UNIT IV	INTRODUCTION TO SPRING Simplifying Java Development – Containing Beans – Surveying Bean Landscape. **Spring Configuration:** Wiring Beans – With Java – With XML.	18
UNIT V	SPRING ON THE WEB Spring MVC – Simple Controller – Request Input – Processing Forms. WEB VIEWS: Creating JSP Web Views – Defining Layout– JSP Libraries	18

Text Books:

1. Jim Keogh," The Complete Reference J2EE ", Tata McGraw Hill, New Delhi, 2012.Units: I, II, III
2. Craig Walls, "Spring in Action" 4 Ed, Manning Publication, New York, 2015

Reference Books:

1. McGovern," J2EE 1.4 Bible", Wiley, Chennai, India, 2007.
2. Nicholas S. Williams, "Professional Java for Web Applications: Featuring Web Sockets, Spring Framework, JPA Hibernate and Spring Security

Web-Resources:

https://web.iiit.ac.in/~nagarjuna.psug08/J2ME%20-%20The%20Complete%20Reference.pdf
https://doc.lagout.org/programmation/Spring%20Boot%20in%20Action.pdf
https://livebook.manning.com/#!/book/spring-in-action-fifth-edition/chapter-2/23

Course Outcomes:

On completion of the Course, Students should be able to do

CO1 : Understand the fundamental concepts of the J2EE Technologies
CO2 : Comprehend the principles of J2EE programming.
CO3 : Learn the communication of client and server in the programming paradigm.
CO4 : Understand the concept of JSP and EJB
CO5 : Ability to connect Spring with XML and develop programming skills in Spring using web views.

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	M	S	S
CO2	S	M	S	S	S	S	S	S	S	S
CO3	M	S	S	M	S	S	M	S	M	S
CO4	M	S	M	M	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	M	M	S

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Semester-I / Core Choice Course-I (CCC-I)	**2. XML**	**Course Code :**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To understand the basic concepts of XML.
- Expose the students to the XML family of technologies, and the latest W3C and WS-I XML standards.
- Demonstrate the application of XML in distributed communications enabling, enterprise systems assurance,
- Demonstrate the application of XML in web enabling, application enabling, and enterprise data enabling.
- Understanding of the current industry support for XML technologies.

UNIT	CONTENT	HOURS
UNIT I	Introducing XML: What is XML – An introduction to XML applications: XML for XML - Your first XML document – Structuring data: preparing a style sheet for document display attributes, empty tags and XSL – Well formed XML documents .	18
UNIT II	Foreign Languages and Non Roman Text: Legacy character sets – Document type definitions: Document type definitions and validity – Entities and external DTD subsets – Attribute declarations in DTDs: Attribute – Attribute types – Embedding Non-XML data.	18
UNIT III	Cascading Style Sheets level 1: CSS – Attaching style sheets to documents – inheritance – comments in CSS – Font, color, background, text and box properties.	18
UNIT IV	XSL transformations – Overview of XSL transformations – Computing the value of a node with XSL: value of – Processing multiple elements with XSL: for each – Copying the current node with XSL: copy – Merging multiple style sheets .	18

UNIT V	Namespaces - XML applications: The importance of reading DTDs – Designing a new XML application: Organization of the data.	18

Text Books:

1. Elliote Rusty Harold, XML Bible, IDG Books India (P) Ltd., First Edition, 2000.
   UNIT I : Chapters 1 to 6 UNIT II : Chapter 6 & Chapters 8 to11 UNIT III : Chapter 12
   UNIT IV : Chapter 14 UNIT V : Chapters 20 & 23

Reference Books:

Heather Williamson, XML The Complete Reference, Tata McGraw Hill, 2001.

Course Outcomes:

On completion of the Course, Students should be able to do

CO1: How to create and manipulate XML documents

CO2: Understanding how DTDs and Schemas define XML document structures and languages

CO3: Understanding how to use XML electronic text markup languages and XML metadata markup schemas

CO4: Understanding how XML markup schemas and standards are currently being used in the library community

CO5: Evaluate XML and understand its applications.

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	M	S	S
CO2	S	M	S	S	S	S	S	S	S	S
CO3	M	S	S	M	S	S	M	S	M	S
CO4	M	S	M	M	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	M	M	S

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M - Moderately Correlated
W-Weakly Correlated
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Semester-I / Elective Course -I (EC-I)	**1. WEB DEVELOPMENT TOOLS LAB**	**Course Code :**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- Design and develop static and dynamic web pages.
- Familiarize with Client-Side Programming, Server-Side Programming, Active server Pages.
- Understand, analyze and build web applications using PHP.
- Display web pages on a web server.
- Manage normal and abnormal interactions with databases using PHP

List of Practicals:

1. Create a HTML form for building your resume. Apply inline, internal, and external CSS in theform.
2. Design a web site using HTML and DHTML. Use Basic text Formatting & Images.
3. Write a JavaScript program to list the properties of a JavaScript object.
4. Write a JavaScript program to create a registration form and validate the username and passwordfields.
5. Write a HTML program to draw graphics on webpage using <canvas> element.
6. Write a simple PHP program for database connectivity.
7. Write a program to display session id, creation time and last access time of the web page using PHP.
8. Write a jQuery program to get a single element from a selection of elements of a HTML page.
9. Write a jQuery program to attach a click and double-click events to all elements.
10. Write a jQuery program to get the value of a textbox.
11. Write a program to convert PHP object in to JSON.

Course Outcomes:

On completion of the Course, Students should be able to do

CO1 : Demonstrate the concepts of CSS, JavaScript, PHP, jQuery, AJAX and JSON

CO2: Utilize JavaScript with HTML and CSS to create interactive webapplications.

CO3: Inspect JavaScript frameworks and light weight format which facilitate the developers to focus on core features.

CO4 : Prove the importance of PHP, jQuery and JSON

CO5: Develop Server-Side Scripts using PHP to generate and display the contents dynamically.

Semester-I / Elective Course - I (EC-I)	**2. SOFTWARE TESTING TOOLS LAB**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks :40	**External Marks:60**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To improve understanding of software testing skills- it's purpose, nature, issues and constraints.
- To learn various software testing techniques through case studies.
- To understand the essential characteristics of various automation tools used for testing.
- To gaining confidence in and providing information about the level of quality.
- To make sure that the end result meets the business and user requirements.

List of Practicals:

1. Write a test case based on controls.
2. Test data in a flat file.
3. Manual test case to verify student grade
4. Write and test a program to select the number of students who have scored more than 60 inany one subject(or all Subjects)
5. Write and test a program to login a specific web page.
6. Write and test a program to get the number of list items in a list / combo box.
7. Test a HTML file.
8. Test a program in MS Excel for Data Driven Wizard.
9. Test the addition of two values in C++ Program.
10. Write a test suite containing minimum 4 test cases.

Course Outcomes:

CO1 : Apply modern software testing processes in relation to software development andmanagement.

CO2: Create test strategies and plans, design test cases

CO3: Prioritize and Execute

CO4: Manage incidents and risks within a project.

CO5 :Understands the Automation Testing Approach.

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	S	S	S	S	S
CO2	S	S	S	S	S	M	S	S	S	M
CO3	S	S	M	S	M	S	M	S	S	S
CO4	M	S	S	S	S	S	S	S	S	S
CO5	S	M	S	M	S	S	S	S	M	M

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-II / Core Course-IV (CC-IV)	**DATABASE & NoSQL**	**Course Code :**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks: 75**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- Understand the concept of database and data warehouses.
- Knowledge on MongoDB query language.
- Ability to comprehend the principles of NoSQL.
- Understand the difference of NoSQL key value database and Document database, data modeling techniques
- Know the concept of Column database.

UNIT	CONTENT	HOURS
UNIT I	**Database** Revolutions- System Architecture- Relational Database- Database Design Data Storage- Transaction Management- Data warehouse and Data Mining- Information Retrieval.	**18**
UNIT II	**Introduction to MongoDB** key features- Core Server tools- MongoDB through the JavaScript's Shell- Creating and Querying through Indexes- Document-Oriented, principles of schema design- Constructing queries on Databases- collections and Documents- MongoDBQuery Language.	**18**
UNIT III	**NOSQL DATABASE**: RDBMS VS NOSQL - Data Management with Distributed Databases- ACID and BASE- Four types of NOSQL Databases. KEY VALUE DATABASES: Introduction to key value databases- Essential Features of Key value Databases- Key-Value Database Data Modeling Terms- Key-Value Architecture Terms- Key-Value Implementation Terms.	**18**
UNIT IV	**DOCUMENT DATABASE**: Introduction to Document Database: Document- managing Multiple Document in collection-Basic Operations on document Database- Types of Partitions- Data modeling and Query processing- Normalization, Denormalization, and the Search for proper Balance.	**18**

UNIT V	**COLUMN DATABASE**: Introduction to Column Family Database: Utilizing Dynamic Control over Column- Indexing by row, column name and Time Stamp- Controlling Location of data- Reading and Writing Atomic Rows- Maintaining rows in Sorted Order- Column Family Database Features- Column family Database Versus Relational Database- Basic Components of Column Family database.	**18**

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, SixthEdition, McGrawHill.
2. Dan Sullivan, NoSQL for Mere Mortals, Addison-Wesley, 2015.

Reference Books:

Kyle Banker, Piter Bakkum, Shaun Verch, MongoDB in Action, Dream tech Press.

Web-Resources:

1. https://www.guru99.com/what-is mongodb.html#:~:text=MongoDB%20is%20a%20document%2Doriented,unit%20of%20dat a%20in%20MongoDB.
2. https://www.geeksforgeeks.org/mongodb-an-introduction/
3. https://intellipaat.com/blog/what-is-mongodb/
4. https://www.tutorialspoint.com/mongodb/index.html

Course Outcomes:

On completion of the Course, Students should be able to do

- Define, compare and use the four types of NoSQL Databases (Document-oriented,KeyValue Pairs, Column-oriented and Graph).
- Distinguish the different types of NoSQL databases.
- Explain the detailed architecture, define objects, load data, query data and performance tuneDocument-oriented NoSQL databases.
- Demonstrate an understanding of the detailed architecture, define objects, load data, querydata and performance tune Column-oriented NoSQL databases.
- Evaluate NoSQL database development tools and programming languages.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	S	S
CO4	S	S	M	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

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N – No Correlation

Semester-II / Core Course- V (CC- V)	**MODERN OPERATING SYSTEMS**	**Course Code :**
Instruction Hours: 6	**Credits: 5**	**Exam Hours: 3**
Internal Marks :25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To acquire knowledge in Distributed operating.
- To know the components of distributed resource management.
- To know the components and management aspects of Real time, Mobile operating systems.
- Use disk management and disk scheduling algorithms for better utilization of external memory.
- Recognize file system interface, protection and security mechanisms.

UNIT	CONTENT	HOURS
UNIT I	Definition of operating system - The Operating System as a Extended Machine- The Operating System as a Resource Manager-History of Operating systems-The Operating system Zoo-Mainframe Operating systems-Server Operating System-Personal Computer Operating systems-Computer Hardware Review-Processor-I/O Devices-System calls-Operating System Structure-Client And Server Model-Process-Threads-Scheduling.	18
UNIT II	Basic Memory Management-Mono programming Without Swapping Or Paging-Modeling Multiprogramming-Swapping-Memory Management with Bitmaps-Linked Lists-Virtual Memory-Paging-Page Table-Translation Look side Buffers-Design Issues for Paging System- Local Versus Global Allocation Policies-Load Control- Segmentation-The Intel Pentium.	18
UNIT III	Files-File Types-File Attributes-File Operation-Memory Mapped Files-Directories-Single Level Directory Systems-Two Level Directory Systems-Hierarchical Directory Systems-File System Implementation. **Input/output**: Principles of I/O Hardware-Device Controllers-Memory Mapped I/O-Principles of I/O Software-Goals Of The Software -Programmed I/O-Interrupt I/O-I/O Using DMA.	18

UNIT IV	Introduction to Multimedia – Multimedia Files- Multimedia Process Scheduling- Scheduling Homogeneous Processes-General Real Time Scheduling-Earliest Deadline First Scheduling. **Dead Lock**: Introduction to Dead Locks-Conditions For Deadlock- Deadlock Modeling-The Ostrich Algorithm-Dead Lock Detection And Recovery-Dead Lock Avoidance-Resource Trajectories-Safe And Unsafe States- The Banker's Algorithm for Single Resource- The Banker's Algorithm for Multiple Resource-Deadlock Prevention.	18
UNIT V	Distributed System-Network Hardware-Network Services and Protocols-File System Based Middleware-Shared Object Based Middleware. **Security:** The Security Environment-Threads-Intruders-Accidental Data Loss- Basics of Cryptography-Secret key. Cryptography-Digital Structure-User Authentication-Countermeasures- Attacks From Inside The System-Trojan Horses-Login Spoofing-Generic Security Attacks- Attacks From Outside The System-Virus Damage Scenarios-Mobile Code-Java Security.	18

Text Book:

Andrew S. Tannenbaum and Herbert Bos, "Modern Operating Systems", Fourth Edition, Prentice Hall, 2014.

Reference Books:

1. Jonathan Levin, "Mac OS X and iOS Internals: To the Apple‟s Core", John Wiley & Sons, 2012.
2. Mike Ebbers, John Kettner, Wayne O‟Brien, Bill Ogden, "Introduction to the New Mainframe: z/OS Basics", Third Edition, International Business Machines Corporation, 2011.
3. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts", Wiley, Eighth edition, 2008.

Web-Resources:

http://materias.fi.uba.ar/7508/MOS4/Operating.Systems.4th.Edi.pdf
https://acadndtechy.files.wordpress.com/2015/01/real-time-systems-rajib-mall-pearson-education-india-2007.pdf

Course Outcomes:

On completion of the Course, Students should be able to do

CO1: To understand the main components of an OS & their functions.

CO2: To study the process management and scheduling.

CO3: To understand various issues in Inter Process Communication (IPC) and the role of OS in IPC.

CO4: To understand the concepts and implementation Memory management policies and Virtual memory.

CO5: To study the need for special purpose operating system with the advent of new emerging technologies.

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	M	S	S	S	M	S	S	S
CO2	S	M	M	S	S	S	S	M	S	M
CO3	M	S	S	M	S	M	S	S	M	S
CO4	S	S	M	M	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	M	S	S

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Semester-II / **Core Course –VI (CC–VI)**	**BIG DATA ANALYTICS**	**Course Code:**
Instruction Hours: 6	**Credits: 5**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- Understand the Big Data Platform and its Use cases
- Provide an overview of Apache Hadoop
- Provide HDFS Concepts and Interfacing with HDFS
- Understand Map Reduce Jobs
- Provide hands on Hodoop Eco System

UNIT	CONTENT	HOURS
UNIT I	Introduction: Concepts and Terminology – Big Data Characteristics- Different Types of Data-case study Background- Business goals and Obstacles- Business Motivations and Drivers for Big Data Adoption-Marketplace Dynamic-Business Architecture- Business process Management- Information and Communication Technology-Data Analytics and Data Science-Digitization.	18
UNIT II	Big data Adoption and Planning Considerations-:Organization Prerequisites- Data Procurement - Privacy- Security- Provenance-Limited Real time Support- Distinct Performance Challenges – Distinct Governance Requirements- Distinct Methodology Clouds- Big Data Analytics-Data Identification- Data Acquisition and Filtering-Data Extraction- Data validation and cleansing-Data Aggregation and Representation- Data Analysis-Data Visualization-Utilization of Analysis Results.	18
UNIT III	Enterprise Technologies and Big Data Business Intelligence-: Online Transaction and Processing (OLTP)-Online Analytical Processing (OLAP)- Extract Transform Load (ETL)- Data Warehouses-Data Marts-Traditional BI-Big Data BI-Big Data Storage Concepts Clusters- File System and Distributed Systems- No SQL-Shading-Replication-ACID.	18
UNIT IV	Big Data Processing Concepts: Introduction -Parallel Data Processing-Distributed Data Processing- Hadoop-Processing Workloads-Cluster- Processing in Batch Mode-MapCombine-Partition- Shuffle and Sort—Processing in Real Time Mode- Speed Consistency Volume (SCV)-Event Stream Processing-Complex Event Processing- Realtime Big data Processing and SCV-Realtime Big Data Processing and Map Reduce	18

UNIT V	Big Data Storage Technology: On-Disk Storage Devices-NoSQL Database- In-Memory Storage Device- Big Data Analytics Techniques-Quantitative Analysis-Qualitative Analysis Data Mining- Statistical Analysis-A/B Testing-Correlation-Regression- Machine Learning Semantic Analysis- Visual Analysis-Heat Maps-Time Series Plots-Network Graphs-Spatial Data Mapping	18

Text Book

1. Paul Buhler, Wajid Khattak and Thomas Erl, "Big Data Fundamentals: Concepts, Drivers & Techniques" , Prentice Hall Publications, January 2016.

Unit 1: Chapters 1 and 2
Unit 2: Chapter 3
Unit 3: Chapters 4 and 5
Unit 4: Chapter 6
Unit 5: Chapters 7 and 8

Reference Book:

1. Soumendra Mohanty, Madhu Jagadeesh, and Harsha Srivatsa, "Big Data Imperatives: Enterprise Big Data Warehouse, BI Implementations and Analytics", Published by Apress Media, 2013.
2. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'reilly Media, 2012.

Web-Resources:

https://www.ti.rwth-aachen.de/teaching/BigData/FBDA.pdf

Course Outcomes:

On completion of the Course, Students should be able to do

CO1 : To provide an overview of an exciting growing field of Big Data analytics.
CO2 : To discuss the challenges traditional data mining algorithms face when analyzing Big Data.
CO3 : To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
CO4 : To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
CO5 : To introduce to the students several types of big data like social media, web graphs and data streams.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	M	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	M	S	M	S	S	M	M	S	S	M
CO4	S	S	M	S	S	S	S	M	S	S
CO5	S	M	S	S	S	S	S	S	M	S

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Semester-II / Core Choice Course – II (CCC– II)	**1. ARTIFICIAL INTELLIGENCE & MACHINE LEARNING**	**Course Code :**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 – Creating

Course Objectives:

- Enable the students to learn the basic functions of AI, Heuristic Search Techniques.
- Provide knowledge on concepts of Representations and Mappings and Predicate Logic.
- Introduce Machine Learning with respect Data Mining, Big Data and Cloud.
- Study about Applications & Impact of ML
- Explore the current scope, potential, limitations, and implications of intelligent systems.

UNIT	CONTENT	HOURS
UNIT I	**Introduction:** AI Problems - Al techniques - Criteria for success. Problems, Problem Spaces, Search: State space search - Production Systems - Problem Characteristics - Issues in design of Search.	18
UNIT II	**Heuristic Search techniques:** Generate and Test - Hill Climbing- Best-First, Problem Reduction, Constraint Satisfaction, Means-end analysis. Knowledge representation issues: Representations and mappings - Approaches to Knowledge representations -Issues in Knowledge representations - Frame Problem.	18
UNIT III	**Using Predicate logic:** Representing simple facts in logic - Representing Instance and Isa relationships - Computable functions and predicates - Resolution - Natural deduction. Representing knowledge using rules: Procedural Vs Declarative knowledge- Logic programming – Forward Vs Backward reasoning -Matching-Control knowledge.	18
UNIT IV	**Understanding Machine Learning:** What Is Machine Learning?-Defining Big Data- Big Data in Context with Machine Learning-The Importance of the Hybrid Cloud-Leveraging the Power of Machine Learning-The Roles of Statistics and Data Mining with Machine Learning-Putting Machine Learning in Context-Approaches to Machine Learning.	18
UNIT V	Looking Inside Machine Learning: The Impact of Machine Learning on Applications-Data Preparation-The Machine Learning Cycle.	18

Text Books:

1. Elaine Richand Kevin Knight, "Artificial Intelligence", Tata McGraw Hill Publishers company Pvt Ltd, Second Edition, 1991.
2. George FLuger, "Artificial Intelligence", 4thEdition, Pearson Education Pub, 2002.

Reference Books:

Machine Learning For Dummies ®, IBM Limited Edition by Judith Hurwitz, Daniel Kirsch.

Web-Resources:

https://www.ibm.com/downloads/cas/GB8ZMQZ3
https://www.javatpoint.com/artificial-intelligence-tutorial
https://nptel.ac.in/courses/106/105/106105077/

Course Outcomes:

On completion of the Course, Students should be able to do

CO1 : Identify problems where artificial intelligence techniques are applicable
CO2: Apply selected basic AI techniques; judge applicability of more advanced techniques.
CO3 : Participate in the design of systems that act intelligently and learn from experience.
CO4 : To share in discussions of AI, its current scope and limitations, and societal implications.
CO5 : Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	M	S
CO2	S	M	M	S	S	M	S	M	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	M	M	S	M	M	S	S	S
CO5	M	S	S	S	S	S	S	S	M	M

S - Strongly Correlated
M - Moderately Correlated
W-Weakly Correlated
N – No Correlation

Semester-II /Core Choice Course- II (CCC– II)	**2.HUMAN COMPUTER INTERACTION**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- Provide an overview of the concepts relating to the design of human-computer interfacesin ways making computer-based systems comprehensive, friendly and usable.
- Understand the theoretical dimensions of human factors involved in the acceptance ofcomputer interfaces.
- Understand the important aspects of implementation of human-computer interfaces.
- Identify the various tools and techniques for interface analysis, design, and evaluation.
- Identify the impact of usable interfaces in the acceptance and performance utilization ofinformation systems.

UNIT	CONTENT	HOURS
UNIT I	**The Interaction:** Introduction – Models of interaction – Frameworks and HCI Ergonomics– Interaction styles – Elements of the WIMP interface – Interactivity – The context of the interactions. Paradigms: Introduction – Paradigms for interaction.	18 Hours
UNIT II	**Interaction, Design basics:** Introduction – What is design? – User focus – Scenarios – Navigation design – Screen design and layout – Interaction and prototyping. HCL in the Software Process: Introduction – The software lifecycle – Usability engineering – interactive design and prototyping – Design rationate.	18 Hours
UNIT III	**Design Rules:** Introduction – Principles to support usability – Standards – Guidelines – Golden rules and heuristics – HCI patterns. Implementation Support: Introduction – Elements of windowing systems – Programming the application Using toolkits – User interface management systems.	18 Hours

UNIT IV	**Evaluation Techniques:** What is evaluation – Goals of evaluation – Evaluation through expert analysis – Evaluation through user participation – Choosing an evaluation method. Universal Design: Introduction – Universal design principles – Multi-modal interaction – Designing for diversity – Summary.	18 Hours
UNIT V	**User Support:** Introduction Requirements of user support – Approaches to; user support –Adaptive help systems designing user support systems.	18 Hours

Text Books:

Human - Computer Interaction, Third Edition, "Alan Dix, Janet Finlay, Gregory D.Abowd and Russell Beale", Pearson Education, 2004.

Reference Books :

Human – Computer Interaction in the New Millennium, "John C. Carroll", Pearson Education"2002.

Web-Resources:

https://www.iare.ac.in/sites/default/files/lecture_notes/HCI%20LECTURE%20NOTES.pdf

http://www.cs.bham.ac.uk/~rxb/Teaching/SSC%20HCI%202008-9/HCIlecturenotes.pdf

Course Outcomes

- To stress the importance of good interface design
- To predict good features of interface designs.
- To evaluate designs based on theoretical frameworks and methodological approaches.
- To identify and criticize bad features of interface designs.
- To learn the techniques for prototyping and evaluating user experiences.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

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N – No Correlation

Semester-II / Elective Course-II (EC-II)	**1. R PROGRAMMING LAB**	**Course Code:**
Instruction Hours: 4	**Credits: 3**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- The basics of statistical computing and data analysis
- How to use R for analytical programming
- How to implement data structure in Rand R loop functions and debugging tools
- Object-oriented programming concepts in R
- Data visualization in R

List of Practicals:

1. Installing R and R Studio
2. Applying Simple Commands in R
3. R as a Calculator application.
4. Execution of Loops and Functions via R - Control Structures
5. Basic Descriptive Statistics using summary() – sapply() – describe() – stat.desc() – by group using aggregate()in R
6. Reading and writing different types of Datasets in R
7. Visualizations: Visualize various Plotting and Graphics in R
8. Regression: Perform Simple Regression using R Package
9. Clustering: Apply k-means by using R Package
10. Classification: Use Random Forest / Naïve Bayes / NN by using R Package.

Course Outcomes:
On completion of the Course, Students should be able to do
CO1 : Explain critical R programming concepts
CO2 : Demonstrate how to install and configure RStudio
CO3 : Explain the use of data structure and loop functions
CO4 : Analyse data and generate reports based on the data
CO5: Apply various concepts to write programs in R

Semester-II / Elective Course - II (EC-II)	**2. COMPUTER VISION LAB**	**Course Code :**
Instruction Hours: 4	**Credits: 3**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- To get an idea of how to build a computer vision application with Python language.
- To learn the basic image handling and processing
- To get familiar with various Computer Vision fundamental algorithms and how to implement and apply.
- To get an idea of how to implement the image transforms.
- To understand various image segmentation algorithms.

Implement the following problems using Python with OpenCV

1. Image Loading, Exploring, and displaying an Image.
2. Access and Manipulate of Image Pixels.
3. Image Transformations.
   i) Resizing
   ii) Rotation
4. Addition operation of Two Images.
5. Image filtering operations
   i) Mean Filtering
   ii) Gaussian Filtering
6. Image Binarization Using Simple Thresholding method.
7. Edge Detection operation using Sobel and Scharr Gradients.
8. Find Grayscale and RGB Histograms of an Image.
9. Segment an Image using K-means Clustering algorithm.
10. Write a program to classify an Image using KNN Classification algorithm.

Course Outcomes:

On completion of the Course the learner will be able to

- To develop and implement the image loading and exploring
- To Evaluate the image transforms
- To apply and analyze for image processing denoising algorithms
- To design and develop the Image Segmentation using Edge detection and Histograms
- To apply and analyze image clustering and classification algorithms

Semester-II/ Skill Enhancement Course-I(SEC - I)	**MongoDB Lab**	**Course Code:**
Instruction Hours: 2	**Credits: 2**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- Create a simple Structured query program
- Design database using MongoDB, Design and Manipulate forms to provide user authentication
- Apply distributed techniques for querying documents and modification
- Ability to process and design forms to upload the JSON files
- Test and debug regular expression and indexing

List of Practicals:

1. Simple SQL Programs
2. MongoDB Create & Insert Database
3. MongoDB Query Document
4. MongoDB Query Modifications
5. JSON file program
6. Search Text
7. Regular Expression
8. Operation on Document
9. MongoDB Replication
10. MongoDB Indexing

Course Outcomes:
On completion of the Course, Students should be able to do

- Configure persistence with MongoDB
- Connect to MongoDB Use Query in MongoDB
- Create a Database
- Create our Collections
- Create relations between documents

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

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Semester-II / - Value Added Course I (VAC – I)	**Full Stack Management**	**Course Code :**
Instruction Hours: -	**Credits: 2**	**Exam Hours: 3**
Internal Marks : -	**External Marks:100**	**Total Marks: Grade**

Knowledge Level

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

Course Objectives:

- To become knowledge able about the most recent web development technologies.
- Idea for creating two tier and three tier architectural web applications.
- Design and Analyze real time web applications.
- Constructing suitable client and server side applications.
- To learn core concept of both front end and back end programming.

UNIT	CONTENT	HOURS
UNIT I	Web Development Basics: Web development Basics-HTML &Web servers Shell-UNIXCLI Version control - Git & Github HTML, CSS	-
UNIT II	Frontend Development: Javascript basics OOPS Aspects of JavaScript Memory usage and Functions in JS AJAX for data exchange with server jQuery Framework jQuery events, UI components etc. JSON data format.	-
UNIT III	REACTJS: Introduction to React React Router and Single Page Applications React Forms, Flow Architecture and Introduction to Redux More Redux and Client-Server Communication	-
UNIT IV	Java Web Development: JAVA PROGRAMMING BASICS, Model View Controller(MVC) Pattern MVC Architecture using Spring REST ful A PIusing Spring Framework Building an application using Maven	-
UNIT V	Data bases & Deployment: Relational schemas and normalization Structured Query Language(SQL)Data persistence using Spring JDBC Agile development principles and deploying application in Cloud	-

Text Books:

1. Web Design with HTML, CSS, JavaScript and JQuery Set Book by Jon Duckett Professional JavaScript for Web Developers Book by Nicholas C. Zakas
2. LearningPHP,MySQL,JavaScript,CSS&HTML5: A Step-by-Step Guide to Creating Dynamic Websites by Robin Nixon
3. Full Stack JavaScript: Learn Backbone.js, Node.js and MongoDB. Copyright © 2015 BYAZAT MARDAN

Reference Books:

1. Full-Stack Java Script Development by Eric Bush.
2. Mastering Full Stack React Web Development Paper back– April28,2017 by Tomasz Dyl ,Kamil Przeorski , Maciej Czarnecki

COURSEOUTCOMES:

- Develop a fully functioning web site and deploy on a web server.
- Gain Knowledge about the front end and back end Tools
- Find and use code packages based on their document to produce working results in a project.
- Create web pages that function using external data.
- Implementation of web application employing efficient data base access.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Core Course- VII (CC- VII)	**DATA MINING AND DATA WAREHOUSING**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- To understand the practical methods and techniques for building a data warehouse.
- To understand data mining concepts, tasks and their techniques.
- To understand the basic principles, concepts and applications of data warehousing and datamining.
- Ability to do Conceptual, Logical, and Physical design of Data Warehouses OLAPapplications and OLAP deployment.
- Have a good knowledge of the fundamental concepts that provide the foundation of datamining.

UNIT	CONTENT	HOURS
UNIT I	INTRODUCTION: What is Data mining, Data mining - important Data mining - various kind of data mining Functionalities – Various kinds of Patterns Pattern Interesting Classification of Data mining Systems Data mining Task Primitives Integration of Data Mining System Major issues in Data Mining.	18 Hours
UNIT II	DATA PROCESSING: Process the Data Descriptive Data Summarization – Measuring Central Tendency Dispersion of Data Graphic Displays of –Basic Descriptive Data Summaries Data Cleaning Data Integration and Transformation data Reduction Data Discrimination - Concept Hierarchy Generation.	18 Hours
UNIT III	DATA WAREHOUSE OLAP TECHNOLOGY: An overview - Data Warehouse Multidimensional Data Model Data Warehouse Architecture Data Warehouse Implementation from Data Warehouse to Data mining.	18 Hours

UNIT IV	MINING Frequent Patterns Associations Correlations - Basic Concepts Road Map Efficient Scalable Frequent Item set Mining methods Mining – Various Kinds of Association rules Analysis - Association mining to Correlation Constrain Based Association mining.	18 Hours
UNIT V	Classification – Prediction – Cluster analysis - Applications and trends in data mining.	18 Hours

Text Books:

Data Mining (Concepts and Techniques) Second Ed , Author : Jiawei Han and MichelineKamber Publishers : Morgan Kaufmann Publishers (An imprint of Elsevier)

Reference Book:

1. Data Mining (Next Generation Challenges and Future Directions) Author : Karguta, Joshi,Sivakumar & Yesha Publishers : Printice Hall of India (2007)
2. Data Mining (Practical Machine Learning Tools and Techniques (Second Edition) Author: Ian H. Witten & Eibe Frank Publishers: Morgan Kaufmann Publishers (An imprintof Elsevier).
3. Data Warehousing, Data mining & OLAP (Edition 2004) Author: Alex Benson, Stephen V. Smith Publishers: Tata McGraw – Hill

Web-Resources:

shodhganga.inflibnet.ac.in/jspui/bitstream/10603/199511/16/16_references.pdf

http://www.vssut.ac.in/lecture_notes/lecture1428550844.pdf

https://nptel.ac.in/courses/106105174/

Course Outcomes:

On completion of the Course, Students should be able to do

- To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage.
- To enable students to effectively identify sources of data and process it for data mining
- To impart knowledge of tools used for data mining
- To provide knowledge on how to gather and analyze large sets of data to gain usefulbusiness understanding.
- To make students well versed in all data mining algorithms, methods of evaluation.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Core Course- VIII (CC- VIII)	**DATA MINING LAB**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- To get hands on experience in developing applications using data mining tool.
- To evaluate the different models of OLAP and data preprocessing.
- To enlist various algorithms used in information analysis of Data Mining Techniques.
- To demonstrate the knowledge retrieved through solving problems.
- Learning performance evaluation of data mining algorithms in a supervised and anunsupervised setting.

List of Practicals:

1. Preprocessing

   a. Datatype Conversion

   b. Data Transformation

2. Filters- Practical

   a. Replace Missing Values

   b. Add Expression

3. Feature Selection

   Select Attributes- Practical

   a. Filter

   b. Wrapper

   c. Dimensionality Reduction

4. Supervised Technique

   Classifier - Function - Practical

   a. Multilayer Perceptron Tree - Practical

5. Classifier- Bay Practical

   a. Naive Bayes Rule
   Practicalb. ZeroR

6. Unsupervised Techniques
Clustering- Theory
Partitioned – Algorithm –Practical Hierarchical Algorithm – Practical Semi Supervised Algorithm – Practical

7. Association Rule Mining

A-Priori –Algorithm –PracticalPredictive A-Priori –Practical

8. Experimenter

Dataset – Test – Practical Algorithm based –Test –Practical

9. Knowledge Flow

Feature Selection – PracticalClustering –Practical

10. Knowledge Flow Classification – Practical

Course Outcomes:
On completion of the Course, Students should be able to do

- Perform exploratory analysis of the data to be used for mining.
- Implement the appropriate data mining methods like classification, clustering or FrequentPattern mining on large data sets.
- Define and apply metrics to measure the performance of various data mining algorithms.
- Develop skills and apply data mining tools for solving practical problems
- Advance relevant programming skills and gain experience and develop research skills by reading the data mining literature.

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Core Course-IX (CC-IX)	**DISTRIBUTED TECHNOLOGIES**	**Course Code:**
Instruction Hours: 6	**Credits: 5**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- This course aims to build concepts regarding the fundamental principles of distributed systems.
- The design issues and distributed operating system concepts are covered.
- To learn the principles, architectures, algorithms and programming models used in Distributed systems.
- To examine state-of-the-art distributed systems, such as Google File System.
- To design and implement sample distributed systems.

UNIT	CONTENT	HOURS
UNIT I	INTRODUCTION TO DISTRIBUTED COMPUTING: Challenges involved in establishing remote connection – Strategies involved in remote computation – Current Distributed computing practices through Dot Net and Java technologies.	18 Hours
UNIT II	ADVANCED **ADO.NET**: Disconnected Data Access – Grid view, Details View, Form View controls – Crystal Reports – Role of ADO. NET in Distributed Applications.	18 Hours
UNIT III	ADVANCED ASP.NET: AdRotator, Multiview, Wizard and Image Map Controls – Master Pages – Site Navigation – Web Parts – Uses of these controls and features in Website development.	18 Hours
UNIT IV	ADVANCED FEATURES OF ASP.NET: Security in ASP.NET – State Management in ASP, NET – Mobile Application development in ASP.NET – Critical usage of these features in Website development.	18 Hours
UNIT V	WEB SERVICES: Role of Web services in Distributed Computing – WSDL, UDDI, SOAP concepts involved in Web Services – Connected a Web Service to a Data Base – Accessing a Web Service through ASP, NET application.	18 Hours

Text Books:

Walther, ASP, NET 3.5, SAMS Publication, 2005.

Web-Resources:

http://www.sigc.edu/qb-18/cs/I%20M.Sc%20CS-%20Distributed%20Technologies.pdf

Course Outcomes:

On completion of the Course, Students should be able to do

On completion of the course the learner will be able to

- Understand the features of Dot Net Framework along with the features of C#.
- Build well-formed XML Document and implement Web Service using Java.
- Students will identify the core concepts of distributed systems: the way in which severalmachines organize to correctly solve problems in an efficient, reliable and scalable way.
- Students will examine how existing systems have applied the concepts of distributed systems in designing large systems, and will additionally apply these concepts to develop sample systems.
- Apply Web Services concept in database.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III /Core Choice Course –III (CCC –III)	**1. COMPILER DESIGN**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- To introduce the major concept areas of language translation and compiler design.
- To enrich the knowledge in various phases of compiler ant its use, code optimization techniques, machine code generation, and use of symbol table.
- To extend the knowledge of parser by parsing LL parser and LR parser.
- To provide practical programming skills necessary for constructing a compiler.
- To know various editors and debugging techniques.

UNIT	CONTENT	HOURS
UNIT I	**INTRODUCTION:** Different Phases of Compiler - Finite State Automation and Lexical analysis - A Simple Approach to the Design of Lexical Analyzers - Regular Expressions - A Language for Specifying Lexical Analyzers.	18
UNIT II	**SYNTAX SPECIFICATION:** Context Free Grammars - Parsers – Derivation and Parse trees - Shift Reduce Parsing - Operator Precedence Parsing - Top- Down Parsing - Predictive Parsers.	18
UNIT III	**CODE GENERATION:** Intermediate Code Generation - Translation - Implementation of Syntax - Directed Translators - Intermediate Code – Postfix Notation - Parse Trees and Syntax Trees - Three Address Codes, Quadruples and Triples.	18
UNIT IV	**SYMBOL TABLES**: Contents of a Symbol Table - Data Structures for Symbol Tables - Implementation of a Simple Stack Allocation Scheme - Implementation of Block Structured Languages - Storage Allocation in Block Structured Languages - Errors - Lexical Phase Error.	18
UNIT V	**CODE OPTIMIZATION AND CODE GENERATION:** Elementary Code Optimization technique - Loop Optimization - DAG Representation of Basic Blocks - Value Numbers and Algebraic Laws - Object Programs - Problems in Code Generation - A Machine Model - A Simple Code Generator.	18

Text Books:

1. Alfred V. Aho, Jeffery D.Ullman, "Principles of Compiler Design", Narosa, New Delhi, 2002. Ch:1.1-1.11,3.1-3.7,4.1,4.2,5.1-5.5,7.1-7.6,9.1,9.2,10.1, 10.2,11.1,11.2,12.1- 2.4,15.1-15.4

Reference Book:

1. Dick Grune, Henri E. Bal, CerielJ.H.Jacobs, Koen G. Langondeon, "Modern Compiler Design", Wiley, Singapore, 2003.
2. Louden K., "Compiler Construction, Principles and Practice", Thomson, New Delhi, 2003.

Web-Resources:s

https://www.geeksforgeeks.org/last-minute-notes-compiler-design-gq/
https://www.tutorialspoint.com/compiler_design/compiler_design_tutorial.pdf
https://nptel.ac.in/downloads/106108113/

Course Outcomes:

On completion of the Course, Students should be able to do

- Able to identify and understand different phases and passes of compiler and theirfunctioning.
- Able to understand the concept of syntax analysis and to solve the problems of predictiveparsing.
- Able to differentiate between top down and bottom up parsing and understand syntax directed translation techniques.
- Able to apply code optimization and code generation techniques.
- To learn & use the new tools and technologies used for designing a compiler.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Core Choice Course – III (CCC– III)	**2. METAVERSE**	**Course Code:**
Instruction Hours: 6	**Credits:4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To bring users together as in real life, as they can meet
- To interact with each other.
- To do activities that we usually do in the real world
- To make purchases or trade in this world
- To a video game world than to the real world.

UNIT	CONTENT	HOURS
UNIT I	Introduction to Metaverse: Introduction to Metaverse and immersive experience-History of Metaverse - Metaverse value chain with 7 layers Technologies Involved in the Metaverse: Metaverse as a product of Extended Reality-What is Augmented Reality (AR)-What is Virtual Reality (VR)-Benefits of AR/VR-DIfference between AR/ VR-What is Mixed Reality (MR)-Artificial Intelligence (AI) Introduction in Metaverse-Financial and Economics of Metaverse-Benefits of Metaverse	18
UNIT II	**Blockchain Adoption in Metaverse:** Blockchain Overview-History of Blockchain-Need of Decentralization in MV-Smart Contract Capabilities in Blockchain-Blockchain in Metaverse-Understanding Tokens-Understanding the NFT-NFT Token Standards-NFTs in MV-Cryptocurrency in MV	18
UNIT III	**AR, VR, and MR in Metaverse:**Everything about VR (Virtual Reality)-Everything about AR (Augmented Reality)-Everything about MR (Mixed Reality)-Blockchain Identity Management in Metaverse.	18
UNIT IV	**NFT (non-fungible token) for Metaverse:**Introduction to NFTs- History of NFTs-Benefits of NFTs-Twitter and NFT-Should you buy an NFT-How to Buy and Sell an NFT in Opensea.	18
UNIT V	**Use-cases**:Gaming in Metaverse-Meetings in Metaverse-Virtual Learning in Metaverse-Social Interactions in Metaverse-Virtual Real-estate in Metaverse-e-commerce in Metaverse-Travel in Metaverse Personalized Avatars-Digital Identity in Metaverse.	18

Text Books:

1."The Metaverse: And How It Will Revolutionize Everything" by Matthew Ball.

2.The "Navigating the Metaverse" authored by Cathy Hackl

Reference Book:

1. "Marching Toward the Metaverse" by Timothy C. Cunningham.
2."Learning in Metaverses: Co-existing in Real Virtuality," book was published in 2014.
3."The Metaverse: A Professional Guide" book, you can find a detailed overview of AR and VR technologies alongside their roles in metaverse development.

Web-Resources:

https://economictimes.indiatimes.com/markets/cryptocurrency/how-the-metaverse-future-may-look-like-in-2030

Course Outcomes:

On completion of the course, learner will be able to

CO1 : Place to immerse yourself in any digital world

CO2 : Digital economy is also growing in Metaverse

CO3 : Study various subjects and modules at their own pace

CO4 : Expand their horizons

CO5 : To interact without the need to undergo long commutes.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S
CO2	S	S	M	S	S	S	M	S	M	S
CO3	M	S	S	M	S	S	M	M	S	S
CO4	S	M	M	S	S	M	S	M	S	S
CO5	S	M	S	S	M	S	S	S	M	S

S - Strongly Correlated
M - Moderately Correlated
W-Weakly Correlated
N – No Correlation

Semester-III / Industry Based Course -I (IBC- I)	**INTERNET OF THINGS**	**Course Code:**
Instruction Hours:4	**Credits: 3**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To assess the vision and introduction of IOT.
- To Understand IOT Market perspective.
- To Implement Data and Knowledge Management and use of Devices in IOT Technology.
- To Understand State of the Art - IOT Architecture.
- To classify Real World IOT Design Constraints, Industrial Automation in IOT.

UNIT	CONTENT	HOURS
UNIT I	INTRODUCTION TO INTERNET OF THINGS Introduction - Physical design of IOT – Logical design of IOT – IOT Enabling Technologies – IOT levels & Deployment technologies. DEMYSTIFYING THE IOT PARADIGM: The Emerging IOT flavors-The Industrial Internet of Things – Consumer Internet of Things - Social Internet of things - Semantics for The Interoperable IOT - Cognitive IOT	12
UNIT II	REALIZATION OF IOT ECOSYSTEM USING WIRELESS TECHNOLOGIES: Introduction- Architecture for IOT Using Mobile Devices- Mobile Technologies for Supporting IOT Ecosystem- Mobile Use Cases for IOT – Low Power Wide Area Networking Topologies – Sigfox- Weightless – Nwave- Ingenu- Lora.	12
UNIT III	INFRASTRUCTURE AND SERVICE DISCOVERY PROTOCOLS FOR THE IOT ECOSYSTEM: Introduction- Layered Architecture for IOT T – Protocol Architecture of IOT – Infrastructure Protocols-Device or Service Discovery for IOT – Protocols for IOT service Discovery.INTEGRATION TECHNOLOGIES AND TOOLS FOR IOT ENVIRONMENTS: Sensor and actuator networks.	12
UNIT IV	IOT AND M2M: INTRODUCTION – M2M – Difference Between IOT and M2M – SDN and NFV for IOT. DEVELOPING IOT: IOT Design Methodology.	12

UNIT V	SECURITY MANAGEMENT OF AN IOT ECOSYSTEM Introduction- Security Requirements of an IOT Infrastructure-Authentication - Authorization And Audit Trail (AAA) Framework-Defense In Depth-Security Concerns of Cloud Platforms-Security Threats of Big Data –Security Threats In Smartphones-Security Solutions For Mobile Devices-Security Concerns In IOT Components-Security Measures for IOT Platforms/Devices.	12

Text Books:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things Enabling Technologies, Platforms, and Use Cases", Taylor & Francis, CRC Press, 1st Edition, 2017.
2. Arshdeep Bahga, Vijay Madisetti, "Internet of Things, A Hands-On Approach", UniversitiesPress (INDIA) Private Limited, 1st Edition, 2015.

Reference Books :

Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

Web-Resources:

https://lecturenotes.in/notes/21082-note-for-internet-of-things-iot-by-srikant-vas
https://ocw.cs.pub.ro/courses/iot/courses/01
https://nptel.ac.in/courses/106105166/
http://www.cs.ust.hk/~qianzh/FYTGS5100/spr2013/notes/Ch

Course Outcomes:

CO1 : Understand the Architectural Overview of IOT
CO2 : Realize the concepts of I IOT using Wireless Technologies.
CO3 : Understand the various IOT Protocols.
CO4 : Impart the knowledge on the devices of IOT
CO5 : Comprehend the idea of M2M and learn the IOT security in various domains

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	M	S
CO2	S	M	M	S	S	S	M	S	S	S
CO3	M	S	M	S	S	M	S	M	S	S
CO4	S	M	M	S	S	S	S	S	M	S
CO5	S	S	S	M	M	M	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Skill Enhancement Course-II(SEC-II)	**DISTRIBUTED TECHNOLOGIES LAB**	**Course Code:**
Instruction Hours: 2	**Credits: 2**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- To provide fundamental concept of Internet, JavaScript, XML, JSP, and ASP with a view todeveloping professional software development skills
- To examine state-of-the-art distributed systems, such as Google File System.
- To design and implement sample distributed systems.
- To learn the practical knowledge of using distributed application development packages.
- Programming concepts in .Net Framework

List of Practicals:

1. Create a table and insert a few records using Disconnected Access.
2. Develop a project to update and delete few records using Disconnected Access.
3. Develop a project to view the records using GridView, DetailsView, FormView Controls.
4. Develop a project to generate a crystal report from an existing database.
5. Design a web page that makes uses of Ad Rotator Control.
6. Design a web page involving Multi View or Wizard Control.
7. Make use of Image Control involving two hot spots in a web page.
8. Design a simple web site that makes use of Master Pages.
9. Establish the security features in a simple web site with five pages.
10. Use state management concepts in a mobile web application.
11. Develop a web service that has an ASP.NET client.
12. Develop a web service to fetch a data from a table and send it across to the client.

Course Outcomes

On completion of this lab course the students will be able to

- Use the features of Dot Net Framework along with the features of C#.
- Create user interactive web pages using ASP.Net.
- Build well-formed XML Document and implement Web Service using Java.
- Students will examine how existing systems have applied the concepts of distributed systems in designing large systems, and will additionally apply these concepts to develop sample systems.
- Performing Database operations for various web applications.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-III / Value Added Course –II (VAC-II)	**INFORMATION SECURITY**	**Course Code:**
Instruction Hours:-	**Credits: 2**	**Exam Hours: 3**
Internal Marks : -	**External Marks:100**	**Total Marks: Grade**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- Examine and apply the fundamental techniques of computer security
- To provide knowledge on various security problems that arises on Operating system, Database, Network& Administration.
- To be able to secure a message over insecure channel by various means.
- To learn about how to maintain the Confidentiality, Integrity and Availability of a data
- To understand various protocols for network security to protect against the threats in the networks.

UNIT	CONTENT	HOURS
UNIT I	Is there a security problem in computing: what does secure mean? – Attacks - the meaning of computer Security-Computer Criminals-Method of defense. Program security: Secure programs-Non malicious program Errors-Viruses and other malicious Code-Targeted Malicious Code-Controls against program threats	-
UNIT II	Protection in general purpose operating system: Protected objects & methods of Protection-Memory &Address Protection-Control of access to general Objects-File protection mechanisms-user authentication	-
UNIT III	Database security: Security Requirements-Reliability & Integrity-Sensitive Data-Inference-Multilevel Databases-Proposals for multilevel security	-
UNIT IV	Security in networks: Threats in Network-Network Security Controls-Firewalls	-
UNIT V	Administering security: Security Planning-Risk Analysis-Organizational Security Policies-Physical Security	-

Text Book :

C.P. PFLEEGER & S.L. FLEEGER, Security in computing, Pearson education, 4 th edition, 2011
UNIT I : Chapter 1.1, 1.2, 1.3, 1.4, 1.5 & Chapter 3.1, 3.2, 3.3, 3.4, 3.5
UNIT II : Chapter 4.1, 4.2, 4.3.4.4, 4.5
UNIT III : Chapter 6.2, 6.3, 6.4, 6.5, 6.6, 6.7 UNIT IV : Chapter 7.2, 7.3, 7.4
UNIT V : Chapter 8.1, 8.2, 8.3, 8.4

Reference Book

Mark Rhodes - Ousley, Information Security the Complete Reference, Second Edition, McGraw-Hill 2013

Course Outcomes

On completion of this lab course the students will be able to

- Formulate information security governance, and related legal and regulatory issues.
- Devices how threats to an organization are discovered, analyzed, and dealt with.
- Evaluate network security threats and countermeasures.
- Construct network security designs using available secure solutions (such as PGP, SSL, IPSec, etc)
- Acquire the knowledge of advanced security issues and technologies (such as DDoS attack detection and containment, and anonymous communications)

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-IV/ Core Course – X (CC– X)	**RESEARCH METHODOLOGY**	**Course Code:**
Instruction Hours: 6	**Credits:5**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level
K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- To understand the types of research and thesis writing and to learn to use tools related to research in Computer Science.
- To learn to calculate the computing time of algorithms and ideas related to Incompleteness.
- To learn Formal Language of Computer Science, its grammar and its applications
- To learn and use probability and applications of probability in areas such as System Reliability.
- To develop skills in qualitative and quantitative data analysis and presentation.

UNIT	CONTENT	HOURS
UNIT I	Thesis Writing: Research types – objectives and approaches – Literature collection-Web browsing – Software tools – Writing review and journal articles – manuscript publication.-Planning a thesis – general format – page and chapter format – footnotes – tables and figures – references and appendices. Research Tools in Computer Science: LaTex, R, WEKA, MATLAB, NS2.	18
UNIT II	Analysis of algorithm: The role of algorithm in computing – Insertion sort – Analyzing and designing algorithms – growth of functions – Divide and Conquer: The Maximum Subarray Problem –Strassen's algorithm for Matrix multiplication – The substitution method and recursion tree methods of solving recurrences - Introduction to NPcompleteness.	18
UNIT III	Formal Languages and Finite Automata: Context free grammars – Derivation trees –Simplification of context free Grammars – Chomsky normal form – Greiback normal form – The pumping lemma for context free languages.Finite state systems – Basic definitions – Non deterministic finite automata – Finiteautomata with epsilon moves – Regular expressions – Applications of finite Automata.	18
UNIT IV	Probability and Statistical Analysis: Probability – Fail time data analysis – Hazard models – Conditional probability – Baye's rule – System reliability – Stochastic process.	18

UNIT V	Logic – Relations and Functions: Propositions – Precedence rules for operators – Laws of equivalence – Natural deduction system – Developing natural deduction system proofs. Relation properties – Matrix and Graph – Graph Notations for relations – Partition and covering – Equivalence relation – Compatibility relations – Partial ordering – Functions– Components – Composition of function – Inverse functions – Binary and n-ary operations	18

Text Books:

1. Kothari C. R. Research Methodology – methods and techniques, 2nd Edition, Wishwa Prakashjan New Delhi 1999
2. For Research Tools in Computer Science: Official Websites of tools concerned.
3. Cormen, Leiserson, Rivest and Stein, "Introduction to Algorithms", Third Edition, PHI LEARNING PVT. LTD-NEW DELHI, ISBN: 9788120340077, 8120340078, 3rd Edition, 2009.
4. John E. Hopcroft, Jeffery D. Ullman, 'Introduction to Automata Theory Language and Computation', narosa Publishing House, 1979
5. L.S. Srinath, 'Reliability Engineering', Third Edition, Affliated East, West press Pvt.Ltd, New Delhi, 2005
6. David Gries, 'The Science of Programming' Narosa Publishing House, 1981

Reference Book:

1. Anderson, Durston and Poole, 'Thesis and Assignment writing', Wiley Eastern Ltd.ND 1970
2. Misra R.P. Research Methodology – A Hand Book, Concept publishing Company,New Delhi 1988
3. Ellis Horowitz and Sartaj Sahni, 'Fundamentals of Computer algorithms', Galgotia Publications, New Delhi 2000
4. E. Balagurusamy, 'Reliability Enginering', Tata McGraw Hill Publishing Ltd., New Delhi 2003
5. Leon S. Levy, 'Discrete structures of Computer Science', Wiley Eastern Ltd., 1980

Web-Resources:

1.https://arts.brainkart.com/subject/research-methodology-4/

2.https://www.studocu.com/row/document/purbanchal-vishwavidyalaya/research-methodology/research-methodology-lecture-notes/17676454

Course Outcomes

On completion of the Course, Students should be able to do

CO1 : Understand the concepts of research design, research process and various types of research.

CO2 : Apply the research methodologies in different research areas.

CO3 : Analyze the ethical issues in research.

CO4 : Evaluate the methods and techniques for various experimental study.

CO5 : Develop solutions for research problems in a responsible and ethical manner.

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	M	S	M	S
CO2	S	M	S	S	S	S	S	S	S	M
CO3	S	S	S	S	S	S	S	M	S	S
CO4	M	M	S	M	S	M	S	M	S	M
CO5	S	S	S	S	M	S	M	S	S	S

S - Strongly Correlated

M - Moderately Correlated

W-Weakly Correlated

N – No Correlation

Semester-IV/ Core Course-XI(CC-XI)	**DATA SCIENCE USING PYTHON**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- Explore Python language fundamentals, including basic syntax, variables, and types
- Create and manipulate regular Python lists,use functions and import packages
- Build Numpy arrays, and perform interesting calculations
- Create and customize plots on real data
- Supercharge your scripts with control flow, and get to know the Pandas DataFrame

UNIT	CONTENT	HOURS
UNIT I	WHY PYTHON FOR DATA ANALYSIS? Essential Python Libraries – Installation and setup python basics: The python Interpreter- Ipython Basics- Data Structure and Sequences: Tuple – list	18 Hours
UNIT II	NUMPY BASICS: Arrays and Vectorized Computation -The NumPy ndarray: A Multidimensional Array Object - Universal Functions: Fast Element-wise Array Functions - File Input and Output with Arrays - Linear Algebra - Random Number Generation	18 Hours
UNIT III	GETTING STARTED WITH PANDAS: Introduction to pandas Data Structures - Essential Functionality - Summarizing and Computing Descriptive Statistics - Handling Missing Data - Hierarchical Indexing - Other pandasTopics.	18 Hours
UNIT IV	DATA LOADING, STORAGE, AND FILE FORMATS:Reading and Writing Data in Text Format - Binary Data Formats - Interacting with HTML and Web APIs - Interacting with Databases - Data Wrangling: Clean, Transform, Merge, Reshape.	18 Hours

UNIT V	PLOTTING AND VISUALIZATION:A Brief matplotlib API Primer - Plotting Functions in pandas -Python Visualization Tool Ecosystem - Time Series.	18 Hours

Text Book:

1. Wes McKinney, "Python for Data Analysis", Published by O'Reilly Media, 2012, ISBN: 978-1-449-31979-3
2. Jake Vander Plas, "Python Data Science Handbook",O'Reilly Media Publishers, 2016.

Reference Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist'", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python - Revised and Updatedfor Python 3.2", Network Theory Ltd., 2011.http://www.network- theory.co.uk/docs/pytut/)

Web-Resources:

https://www.tutorialspoint.com/python/python_data_science
http://astronomi.erciyes.edu.tr/wpcontent/uploads/astronom/pdf/OReilly%20Python%20for%20Data%20Analysis.pdf
https://tanthiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf

Course Outcomes:

On completion of the Course, Students should be able to do

- Understanding the basic concepts of Python
- Preparing and pre-processing data and Visualizing the results of analytics effectively
- Basic understanding of NumPy and Pandas
- Ability to use conditional loops and list by python
- Learn the Visualization through Matplotlib

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S - Strongly Correlated

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Semester-IV / Core Course-XII (CC-XII)	**ADVANCED PYTHON PROGRAMMING LAB**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 40	**External Marks:60**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- Describe the Numbers, Math functions, Strings, List in Python.
- Describe the Tuples and Dictionaries in Python.
- Express different Decision Making statements and Functions.
- Understand and summarize different File handling operations.
- Explain how to design GUI Applications in Python and evaluate different databaseoperations.

List of Practicals:

1. Write Python applications using variables, data types
2. Write Python application using strings and functions.
3. Write Python applications using loops, arrays, sorting
4. Write Python applications using dictionaries, lists and tuples.
5. Write Python applications using matrices.
6. Create Calculator Program
7. Array Function using Numpy
8. Aggregation function using Numpy
9. Data Operation using Scipy Basics
10. Pandas Basics
11. Twitter API Integration for tweet Analysis

Course Outcomes

On completion of the course the learner will be able to

- Design forms using various functions
- Apply rich controls and conditional statement logic in Python
- Demonstrate the functionality of stack and regular expressions through Python
- Ability to Create and manipulate array functions using Numpy
- Ability to Create indexing scripts using Pandas and Build applications using Pandas

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

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Semester-IV / Core Course - XIII(CC- XIII)	**Project work and Viva voce**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

MAJOR PROJECT DISSERTATION AND VIVA-VOCE

Knowledge Level

K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Outcomes:

On completion of the Course, Students should be able to do

CO1 : Learn to plan, design and analyze the modules
CO2 : Understand various needs of the Industry
CO3: Ability to perform Critical Thinking, Reasoning, and Creative Thinking in a Workplace
CO4 : Develop Communication Skills, both for Interpersonal and Presentation Needs
CO5 : Ability to visualize the problems and provide Solution by Decision Making and work as an individual, or as a part of a team in a real-time industry environment

Semester-IV / Elective Course – III (EC– III)	**1.ETHICAL HACKING**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks : 25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

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

Course Objectives:

- Use new career opportunities available in IT profession, audits and others with special skills such as energy efficiency, ethical IT assets disposal, carbon footprint estimation, reporting and development of green products, applications and services.
- Introduces the concepts of Ethical Hacking
- Gives the students the opportunity to learn about different tools and techniques in Ethical hacking and security
- Practically apply Ethical hacking tools to perform various activities.
- To inculcate the importance of ethical hacking & cybersecurity apart from creating awareness about various types of threats that may jeopardize data integrity.

UNIT	CONTENT	HOURS
UNIT I	INTRODUCTION TO HACKING: Importance of Security – Elements of Security – Phases of an Attack – Types of Hacker Attacks – Hacktivism – Vulnerability Research – Introduction to Foot printing – Information Gathering Methodology – Foot printing Tools – WHOIS Tools – DNS Information Tools – Locating the Network Range – Meta Search Engines	18 Hours
UNIT II	INTRODUCTION TO SCANNING: Objectives – Scanning Methodology – Tools – Introduction to Enumeration – Enumeration Techniques – Enumeration Procedure – Tools	18 Hours
UNIT III	CRACKING PASSWORDS: Password Cracking Websites – Password Guessing – Password - Cracking Tools – Password Cracking – Counter measures – Escalating Privileges – Executing Applications – Keyloggers and Spyware.	18 Hours

UNIT IV	PROGRAMMING FUNDAMENTALS C Language – Html – Perl – Windows OS Vulnerabilities – Tools For Identifying Vulnerabilities – Countermeasures – Linux OS Vulnerabilities – Tools For Identifying Vulnerabilities – Countermeasures.	18 Hours
UNIT V	SECURITY ASSESSMENTS: Types of Penetration Testing-Phases of Penetration Testing – Tools – Choosing Different Types of Pen-Test Tools – Penetration Testing Tools.	18 Hours

Text Books:

Ec-Council, "Ethical Hacking and Countermeasures: Attack Phases", Delmar Cengage Learning,2009.

Reference Book:

1. Michael T. Simpson, Kent Backman, James E. Corley, "Hands-On Ethical Hacking and Network Defense", Cengage Learning, 2012.
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing – Ethical Hacking andPenetration Testing Made Easy", Syngress Media, Second Revised Edition, 2013.

Web-Resources:

https://www.tutorialspoint.com/ethical_hacking/ethical_hacking_tutorial.pdf
https://www.uio.no/studier/emner/matnat/ifi/IN5290/h18/lectures/inf5290-2018-l01- introductionhical_hacking.pdf
http://cdn.ttgtmedia.com/searchNetworking/downloads/hacking_for_dummies.pdf

Mapping of Cos with Pos & PSOs:

CO/PO	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	M	S	S	S	S	S
CO5	S	M	S	S	S	S	S	S	S	S

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Semester-IV / Elective Course – III (EC– III)	**2.CYBER SECURITY**	**Course Code:**
Instruction Hours: 6	**Credits: 4**	**Exam Hours: 3**
Internal Marks :25	**External Marks:75**	**Total Marks: 100**

Knowledge Level

K1 -Recalling
K2 -Understanding
K3 -Applying
K4 - Analyzing
K5 - Evaluating
K6 - Creating

Course Objectives:

- Understand various block cipher and stream cipher models
- Describe the principles of public key cryptosystems, hash functions and digital signature
- To get a firm knowledge on Cyber Security Essentials.
- Analyze and evaluate the cyber security needs of an organization.
- Conduct a cyber security risk assessment.

Units	Contents	Hours
I	**Introduction to Security** Data Encryption Standard-Block cipher principles-block cipher modes of operation-Advanced Encryption Standard (AES)-Triple DES-Blowfish-RC5 algorithm.	18
II	**Public Key Cryptography and Hash Algorithms** Principles of public key cryptosystems-The RSA algorithm-Key management - Diffie Hellman Key exchange- Hash functions-Hash Algorithms (MD5, Secure Hash Algorithm	18
III	**Fundamentals of Cyber Security** How Hackers Cover Their Tracks- Fraud Techniques- Threat Infrastructure-Techniques to Gain a Foothold (Shellcode, SQL Injection, Malicious PDF Files)- Misdirection, Reconnaissance, and Disruption Methods.	18
IV	**Planning for Cyber Security** Privacy Concepts -Privacy Principles and Policies -Authentication and Privacy - Data Mining - Privacy on the Web - Email Security - Privacy Impacts of Emerging Technologies.	18
V	**Cyber Security Management** Security Planning - Business Continuity Planning - Handling Incidents - Risk Analysis - Dealing with Disaster – Legal Issues – Protecting programs and Data – Information and the law – Rights of Employees and Employers - Emerging Technologies - The Internet of Things - Cyber Warfare.	18

Text Books:

1. William Stallings, "Cryptography and Network Security", Pearson Education, 6th Edition, 2013.
2. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition, Pearson Education, 2015.

Reference Book:

1. Graham, J. Howard, R., Olson, R., Cyber Security Essentials, CRC Press, 2011.
2. George K. Kostopoulous, Cyber Space and Cyber Security, CRC Press, 2013.

Web-Resources:

Web resources from NDL Library, E-content from open-source libraries

Course Outcomes:

On completion of the Course, Students should be able to do

CO1 : Implement basic security algorithms required by any computing system

CO2 : Analyze the vulnerabilities in any computing system and hence be able to design a security solution

CO3 : Analyze the possible security attacks in complex real time systems and their effective countermeasures

CO4 : Differentiate various governing bodies of cyber laws

CO5 : Impart various privacy policies for an organization

Mapping of Cos with Pos & PSOs:

CO/PO	PO					PSO				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

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