PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637018
(AUTONOMOUS)
REGULATIONS 2023
CHOICE BASED CREDIT SYSTEM
B.TECH – INFORMATION TECHNOLOGY
CURRICULUM
(Applicable to the candidates admitted during the academic year 2023-2024 onwards)

SEMESTER V

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	IT23501	Theory of Computation	3	1	0	4
2	PC	IT23502	Artificial Intelligence and Machine Learning	3	0	0	3
3	PC	IT23503	Foundations of Data Science	3	0	0	3
4	PC	IT23504	Full Stack Development	3	0	0	3
5	PC	IT23505	Software Engineering	3	0	0	3
6	PE	IT231**	Professional Elective – I	3	0	0	3
Practical							
7	PC	IT23506	Artificial Intelligence and Machine Learning Laboratory	0	0	4	2
8	PC	IT23507	Full Stack Development Laboratory	0	0	2	1
9	EE	IT23508	Industrial Training	0	0	2	1
10	EE	GE23501	Professional Development III	0	0	2	1
			Total	**18**	**1**	**10**	**24**

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Information Technology
5/7/25
AUTONOMOUS

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: DATA ANALYSIS

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	IT23151	Exploratory Data Analysis	3	0	0	3
2	PE	IT23152	Data Visualization	3	0	0	3
3	PE	IT23153	Predictive Analytics	3	0	0	3
4	PE	IT23154	Business Analytics	3	0	0	3
5	PE	IT23155	Neural Networks and Deep Learning	3	0	0	3
6	PE	IT23156	Computer Vision	3	0	0	3
7	PE	IT23157	Image and Video Analytics	3	0	0	3

VERTICAL II: SOFTWARE DEVELOPMENT

1	PE	IT23251	.NET Framework Essentials	3	0	0	3
2	PE	IT23252	Open Source Systems	3	0	0	3
3	PE	IT23253	Enterprise Linux Operating System	3	0	0	3
4	PE	IT23254	Agile Methodologies	3	0	0	3
5	PE	IT23255	Cloud Storage Services	3	0	0	3
6	PE	IT23256	Speech Processing	3	0	0	3
7	PE	IT23257	DevOps	3	0	0	3

VERTICAL III: DATA CENTER TECHNOLOGIES

1	PE	IT23351	Data Virtualization	3	0	0	3
2	PE	IT23352	Software Defined Networks	3	0	0	3
3	PE	IT23353	Cloud Services Management	3	0	0	3
4	PE	IT23354	Storage Technologies	3	0	0	3
5	PE	IT23355	Edge Computing	3	0	0	3
6	PE	IT23356	Data Warehousing and Data Mining	3	0	0	3
7	PE	IT23357	Stream Processing	3	0	0	3

VERTICAL IV: NETWORKS & SECURITY

1	PE	IT23451	Information Security	3	0	0	3
2	PE	IT23452	Cyber Security	3	0	0	3
3	PE	IT23453	Ethical Hacking	3	0	0	3
4	PE	IT23454	Web Application Security	3	0	0	3
5	PE	IT23455	Open Vulnerability Assessment System	3	0	0	3
6	PE	IT23456	Mobile Adhoc Networks	3	0	0	3
7	PE	IT23457	Wireless Sensor Networks	3	0	0	3

VERTICAL V: EMERGING TECHNOLOGIES

1	PE	IT23551	Industrial IOT	3	0	0	3
2	PE	IT23552	Game Development	3	0	0	3
3	PE	IT23553	Digital and Mobile Forensics	3	0	0	3
4	PE	IT23554	Robotic Process Automation	3	0	0	3
5	PE	IT23555	Next Generation Networks	3	0	0	3
6	PE	IT23556	Modern Compiler Design	3	0	0	3
7	PE	IT23557	Quantum Computing	3	0	0	3

VERTICAL VI: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

1	PE	IT23651	Optimization Techniques	3	0	0	3
2	PE	IT23652	Game Theory	3	0	0	3
3	PE	IT23653	Agentic AI and Prompt Engineering	3	0	0	3
4	PE	IT23654	Cognitive Science	3	0	0	3
5	PE	IT23655	Natural Language Processing	3	0	0	3
6	PE	IT23656	Knowledge Engineering	3	0	0	3
7	PE	IT23657	Text and Speech Analytics	3	0	0	3

PAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Information Technology
AUTONOMOUS

IT23501	THEORY OF COMPUTATION	3	1	0	4

COURSE OBJECTIVES

To enable the students to

1.	learn the concepts of finite automata with its types and construction.
2.	understand regular languages, finite automata, and their theoretical foundations.
3.	apply context-free grammars, derivation techniques, and normal forms in formal language theory.
4.	understand the design and operation of pushdown automata and their equivalence to context-free grammars.
5.	learn about Turing machines, decidable and undecidable problems.

UNIT I	FINITE AUTOMATA	12

Introduction Need for automata theory - Finite Automaton – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA)- Finite Automaton with ε- moves - Equivalence of NFA and DFA- Equivalence of NFA's with and without ε-moves - Conversion of NFA into DFA – Minimization of DFAs.

UNIT II	REGULAR EXPRESSIONS AND LANGUAGES	12

Regular expression – Regular Languages- Equivalence of Finite Automata and regular expressions – Proving languages to be not regular (Pumping Lemma) – Closure properties of regular languages.

UNIT III	CONTEXT FREE GRAMMAR	12

Introduction to Grammar – Types of Grammar - Chomsky's hierarchy of languages - Context-Free Grammar (CFG) and Languages – Relationship between derivations and derivation trees – Ambiguity in grammars and languages – Simplification of CFG – Elimination of useless symbols - Unit Productions – Null productions – Normal forms – Greiback Normal form(GNF) – Chomsky Normal form (CNF).

UNIT IV	PUSH DOWN AUTOMATA	12

Pushdown Automata - Definitions - Moves - Instantaneous descriptions - Deterministic and non - deterministic pushdown automata – Equivalence of Pushdown automata and CFG.

UNIT V	TURING MACHINE AND UNDECIDABILITY	12

Turing Machine - Basic model – definition and representation – Instantaneous Description – Language acceptance by TM – Non recursive Enumerable (RE) Language – Undecidable problem with RE – Undecidable problems with TM – The Class P and NP completeness.

	TOTAL PERIODS	60

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	construct finite automata for a given language with its types.	Applying (K3)
CO2	prove the equivalence of languages described by finite automata and regular expressions.	Applying (K3)
CO3	construct CFG for a given language, simplify and transform to a normal form.	Applying (K3)
CO4	design Push Down Automata, convert into CFG and vice-versa.	Applying (K3)

CO5	construct Turing machine and prove the undecidability or complexity of a variety of problems	Analyzing (K4)

TEXT BOOKS

1. Hopcroft J.E., Motwani R. and Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, 2013.
2. John C Martin , "Introduction to Languages and the Theory of Computation", 4th Edition,Tata McGraw Hill, 2011.

REFERENCES

1. Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", 2nd Edition, Prentice Hall of India, 2015.
2. Peter Linz, "An Introduction to Formal Language and Automata", 6th Edition, Jones and Bartlett, 2016. K.L.P.Mishra and N.Chandrasekaran, "Theory of Computer Science: Automata Languages and Computation", 3rd Edition, Prentice Hall of India, 2006.
3. K.L.P. Mishra and N. Chandrasekaran, "Theory of Computer Science: Automata Languages and Computation", 3rd Edition, Prentice Hall of India, 2006.
4. Laurel Brodkorb, The Entscheidungs problem and Alan Turing, 2019. 5. Deepak D' Souza – Modern Applications of Automata Theory, 2021.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	3	2	-	-	-	-	-	-	2	3	3
CO2	2	2	2	2	2	-	-	-	-	-	-	2	3	2
CO3	3	2	3	3	3	-	-	-	-	-	-	2	2	3
CO4	2	3	2	2	2	-	-	-	-	-	-	1	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	2	2

IT23502	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	study about uninformed and Heuristic search techniques.
2.	learn techniques for reasoning under uncertainty
3.	introduce Machine Learning and supervised learning algorithms
4.	study about ensembling and unsupervised learning algorithms
5.	learn the basics of deep learning using neural networks

UNIT I	PROBLEM SOLVING	9

Introduction to AI – AI Applications – Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP).

UNIT II	PROBABILISTIC REASONING	9

Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

UNIT III	SUPERVISED LEARNING	9

Introduction to machine learning – Linear Regression Models: Least squares, single and multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model – Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests.

UNIT IV	ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING	9

Combining multiple learners: Model combination schemes, Voting, Ensemble Learning – bagging, boosting, stacking, Unsupervised learning: K-means, Instance-Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT V	NEURAL NETWORKS	9

Perceptron – Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	demonstrate awareness of intelligent agents and problem solving using search methods	Applying (K3)
CO2	use probabilistic models and Bayesian networks to reason and make decisions under uncertainty.	Analyzing (K4)

CO3	apply supervised learning techniques like regression, classification, SVM, decision trees, and random forests.	Analyzing (K4)
CO4	implement ensemble methods and unsupervised learning algorithms such as K-means and KNN.	Applying (K3)
CO5	build and train neural networks using perceptron, multilayer perceptron, activation functions, and optimization techniques.	Applying (K3)

TEXT BOOKS

1. Stuart Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition. Pearson Education, 2021.
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.

REFERENCES

1. Lavika Goel, "Artificial Intelligence Concepts and Applications", Wiley Publications, 2021.
2. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education Publications, 2013.
3. Tom M. Mitchell, "Machine learning", Tata McGraw Hill Education Publications, 2017.
4. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	2	-	-	-	-	-	-	3	3	3

IT23503	FOUNDATIONS OF DATA SCIENCE	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the data science fundamentals and its process.
2.	describe the data for building the model along and statistical basis for AI.
3.	analyses the relationship between data using predictive model evaluation.
4.	utilize the Python libraries for Data Wrangling.
5.	present and interpret data using visualization libraries in Python.

UNIT I	INTRODUCTION	9

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model– presenting findings and building applications.

UNIT II	DESCRIBING DATA	9

Types of Data - Types of Variables - Basic Statistical descriptions of Data - Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores.

UNIT III	DESCRIBING RELATIONSHIPS	9

Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean.

UNIT IV	PYTHON LIBRARIES FOR DATA WRANGLING	9

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables.

UNIT V	DATA VISUALIZATION	9

Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	define the data science process	Understanding (K2)
CO2	understand different types of data description for data science process	Analyzing (K4)
CO3	gain knowledge on relationships between data	Applying (K3)
CO4	use the Python Libraries for Data Wrangling	Applying (K3)
CO5	apply visualization Libraries in Python to interpret and explore data	Analyzing (K4)

TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications 2016.
2. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.

REFERENCES

1. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.
2. Auerlien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd or 3rd Edition. O'Reilly Media. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.
3. Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science",Cambridge Press, 2020.
4. Brennan Davis, Hunter Glanz, "Data Science for all", 1st Edition,Pearson Publication, 2024.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO2	2	2	2	1	1	-	-	-	-	-	-	2	2	3
CO3	2	3	2	3	3	-	-	-	-	-	-	3	2	2
CO4	3	2	2	2	1	-	-	-	-	-	-	2	3	3
CO5	2	2	3	3	3	-	-	-	-	-	-	2	2	2

IT23504	FULL STACK DEVELOPMENT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand HTML and CSS concepts to build responsive and visually appealing web pages.
2.	understand core JavaScript concepts including ES6+ features for efficient web development.
3.	implement dynamic data binding and expressions to create interactive user interfaces.
4.	develop dynamic user interfaces by creating and managing React components with JSX.
5.	develop backend web application using Node JS and MongoDB

UNIT I	HTML AND CSS	9

Introduction to www, HTML: Tags, Lists, Images, Forms, Links, Tables, frames, videos, anchors, HTML Divs – CSS : Inline, Internal, External, CSS Display, CSS Backgrounds, Borders, Margins, Padding, CSS Font Styling, Stylings Lists, Tables, Forms, Gradients, Font, Tool tips, Buttons, Transitions, Transformation, Animations Box sizing, Flex, Grid. Responsive web page building using bootstrap.

UNIT II	JAVA SCRIPT AND JQUERY	9

Introduction to JavaScript, Variables, scoping, Data type, Strings, Numbers, Operators, Loops, Functions, Objects, Events, Working with DOM, AJAX, ES5 vs ES6 Vs ES7; jQuery – Introduction, to jQuery, Syntax, Selectors, Events, Effects, Traversing, and jQuery AJAX.

UNIT III	ANGULAR JS	9

Introduction - MVC Architecture - Modules - Controllers - Data Binding - Directives - Filters – ng model - ng-repeat- Expressions - Dependency Injection - Services - Routing - Forms and Validation - Custom Directive. Introduction to Git and GitHub, Deployment web applications on cloud. Deployment process on Heroku, Vercel, and Netlify.

UNIT IV	REACT JS	9

React JS: ReactDOM - JSX - Components - Properties – Fetch API - State and Lifecycle – JS Local storage - Events - Lifting State Up - Composition and Inheritance.

UNIT V	NODE JS AND MONGO DB	9

Introduction to No SQL databases – MongoDB system overview - Basic querying with MongoDB shell – Request body parsing in Express – NodeJS Mongo DB connection – Adding and retrieving data to MongoDB from NodeJS – Handling SQL databases from NodeJS – Handling Cookies in NodeJS – Handling User Authentication with NodeJS. Introduction to Docker for Web Applications.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	design front end of web application using HTML and CSS.	Applying (K3)
CO2	create a Javascript code to validate user date and asynchronously invoke background application.	Applying (K3)

CO3	validate user input effectively using AngularJS forms and built-in validation techniques.	Applying (K3)
CO4	develop front end applications using React JS library and make a call to server side programming.	Applying (K3)
CO5	implement basic and advanced queries using the MongoDB shell and Node.js	Applying (K3)

TEXT BOOKS

1. Jeffrey C. Jackson ,"Web Technologies : A Computer Science Perspective", Pearson, 1st edition, 2007.
2. Brad Dayley, Brendan Dayley, Caleb Dayley, "Node.js, MongoDB and Angular Web Development", Addison-Wesley, Second Edition, 2018.

REFERENCES

1. Martin Krause, "The Complete Developer Master Full Stack, No Scratch Press", Google Books, 2024.
2. Chris Northwood, 'The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer', Apress; 1st edition, 2018.
3. Jon Duckett, "JavaScript and jQuery: Interactive Front-End Web Development", Wiley , 1st Edition, 2014.
4. Anthony, Accomazzo, Murray Nathaniel, Lerner Ari, "Fullstack React: The Complete Guide to React JS and Friends", Fullstack.io, 2017.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	3	3	-	-	-	-	-	-	3	3	3
CO2	2	2	3	3	3	-	-	-	-	-	-	3	3	3
CO3	3	3	3	2	3	-	-	-	-	-	-	3	3	3
CO4	2	2	3	3	3	-	-	-	-	-	-	3	3	3
CO5	3	3	2	2	3	-	-	-	-	-	-	3	3	3

IT23505	SOFTWARE ENGINEERING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. analyze software life cycle models and system engineering processes.
2. understand fundamental concepts of requirement engineering and analysis modeling.
3. acquire knowledge about various software design methodolgies.
4. learn various software testing techniques.
5. study the software project management concepts.

UNIT I	SOFTWARE PROCESS	9

The Nature of Software - Defining Software, Software Application Domains, Legacy Software - The Software Process - A Process Framework ,Umbrella Activities -Process Adaption; Process Models - A Generic Process Model-Process Assessment and Improvement-Perspective Process Models -The Waterfall Model ,Incremental Model , Prototyping Process Models, The RAD Model, Evolutionary Process Models , The Spiral Model, the Unified Process Model- Product and Process; Agility and Process-Agile Process ,Scrum, Other Agile Frameworks; DevOps.

UNIT II	SOFTWARE REQUIREMENTS AND ANALYSIS	9

Requirements Engineering- Requirements Engineering tasks – Requirements Gathering - Developing Use cases-Building the Analysis Models - Elements of the Analysis Model, Analysis pattern - Negotiating Requirements – Requirements Monitoring-Validating Requirements; Requirements Modeling - Requirements Analysis - Scenario Based Modeling - Flow Oriented Modeling - Class Based Modeling - Functional Modeling-Behavioral Modeling.

UNIT III	SOFTWARE DESIGN	9

Design Engineering - Design process - Design Concepts - Design model - Agile Methods - Extreme Programming - Software Reuse; Pattern Based Design- Design Pattern-Pattern Based Software Design-Architectural patterns-Component Level Design Patterns-User Interface Design Patterns; Quality and Securtiy-Software Quality-The Software Quality Dilemma-Achieving Software Quality.

UNIT IV	SOFTWARE TESTING AND IMPLEMENTATION	9

A Strategic Approach to Software Testing-Planning and Recordkeeping-Test Case Design- white box testing -black box testing- Object Oriented Testing; Software Testing - Software Testing Fundamentals-Integration Testing- Artificial Intelligence and Regression Testing-Validation Testing-Testing Patterns-Security Testing-Performance Testing-Real Time Testing.

UNIT V	SOFTWARE PROJECT MANAGEMENT	9

Software Configuration Management – The SCM Repository-Version Control Systems-Continuous Integration-The Change Management Process-Mobility and Agile Change Management: Software Metrics-Software Measurement-Software Analytics-Product Metrics-Metrics for Testing-Metrics for Maintenance-Process and Product Metrics-Software Measurement-Metrics for Software Quality.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	compare different software process models.	Analyzing (K4)
CO2	apply the Requirement engineering process with emphasis on elicitation analysis and modelling for any given software requirement.	Analyzing (K4)
CO3	apply systematic procedure for software design and development .	Applying (K3)
CO4	understand different software testing methods.	Understanding (K2)
CO5	understand the principles of planning, execution, monitoring, and closure of a software project	Understanding (K2)

TEXT BOOKS

1. Rogers. Pressman. "Software Engineering: A Practitioner's Approach", Mc-Graw Hill International, Ninth Edition, 2020.
2. Ian Somerville, Software Engineering, 10th Edition, Pearson Education, 2016.

REFERENCES

1. Richard E. Fairley, "Principles of Software Engineering", IEEE computer society press, 2010.
2. PankajJalote, "Software Engineering, A Precise Approach", Wiley India, 2010.
3. Kelkar S.A., "Software Engineering", Prentice Hall of India Pvt Ltd, 2007.
4. Shari P fleeger, Joanne Atlee, "Software Engineering: Theory and Practice", Fourth Edition, Pearson Education, 2010.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	2	2	-	-	-	-	-	-	2	3	3
CO2	3	2	3	2	2	-	-	-	-	-	-	3	3	3
CO3	2	3	3	2	3	-	-	-	-	-	-	3	3	3
CO4	2	3	3	2	3	-	-	-	-	-	-	3	2	3
CO5	3	3	2	2	2	-	-	-	-	-	-	3	3	3

IT23506	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LABORATORY	0	0	4	2

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of Artificial Intelligence and classical problem-solving techniques such as search algorithms.
2.	apply AI techniques for solving constraint satisfaction and optimization problems.
3.	implement and evaluate supervised and unsupervised machine learning models.
4.	explore and apply neural networks and ensemble methods for intelligent decision making.

LIST OF EXPERIMENTS

1. Write a Program to Implement Breadth First Search(BFS).
2. Write a Program to Implement Depth First Search(DFS).
3. Write a Program to implement Hill Climbing Algorithm
4. Write a Program to implement A* Algorithm
5. Implement a CSP solver that can find solutions to problems defined by Variables, Domains, and Constraints.
6. Write a Program to Implement Simple Linear Regression and Plot the Graph.
7. Write a Program to Implement Decision Tree Classifier.
8. Write a Program to Implement Random Forest Classifier.
9. Write a Program to Implement K-Means Clustering Algorithm to Group Similar Data Points into Clusters.
10. Write a Python Program to Implement KNN Classifier on a Sample Dataset.
11. Write a Python program to combine Logistic Regression, Decision Tree, and SVM classifiers using voting method.
12. Write a Python Program to Implement a Single-layer Perceptron for Binary Classification of Linearly Separable Data.

TOTAL PERIODS	60

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	implement classical AI search algorithms to solve graph traversal and pathfinding problems.	Analyzing (K4)
CO2	solve constraint satisfaction and optimization problems using appropriate AI techniques.	Analyzing (K4)
CO3	apply supervised and unsupervised learning algorithms for classification.	Analyzing (K4)
CO4	Build neural and ensemble models for robust learning and accurate decision making	Analyzing (K4)

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3

IT23507	FULL STACK DEVELOPMENT LABORATORY	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1.	develop responsive, user-friendly forms and navigation using HTML, CSS, and AngularJS.
2.	implement dynamic, real-time interactivity with JavaScript, jQuery, and AngularJS.
3.	build React components managing state, API integration, and UI feedback.
4.	create secure backend authentication and full-stack apps using Node.js and MongoDB.

LIST OF EXPERIMENTS

1. Create an HTML form with inputs for name, email, and a submit button, styled using CSS flexbox for a responsive layout.
2. Build a webpage with a navigation menu using anchors and styled hover effects with CSS transitions and transformations.
3. Create a JavaScript program that takes user input for weight and height, calculates the BMI, and displays the category (underweight, normal, overweight, obese) dynamically on the webpage.
4. Create a webpage with a list of items and a text input box. Using jQuery, implement a real-time search filter that hides list items which do not match the text entered in the input box.
5. Create a simple AngularJS app that binds user input to a variable and displays it in real-time.
6. Using Angular JS, build a form with email and password fields and show validation messages for invalid input.
7. Create a React component that fetches a list of users from an API and displays their names in a styled list with loading and error states.
8. Implement a todo list in React where users can add and remove items, with state lifted to a parent component managing the list.
9. Create a sign up and login form with authentication in node js. Store the user data into mongodb database.
10. Create a simple e-commerce app using react.js with features such as filtering products and placing order Note: fetch the product data from mongodb through node.js.

	TOTAL PERIODS	30

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	enhance UI/UX with CSS transitions, transformations, and responsive layouts.	Applying (K3)
CO2	practice data binding and form validation in AngularJS applications.	Applying (K3)
CO3	implement real-time search and filtering using jQuery.	Applying (K3)
CO4	build scalable full-stack applications connecting React frontend with Node.js backend.	Applying (K3)

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	2	2	-	-	-	-	-	-	3	3	3
CO2	3	3	3	2	2	-	-	-	-	-	-	3	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	3	3	3
CO4	3	3	3	2	2	-	-	-	-	-	-	3	3	3

IT23508	INDUSTRIAL TRAINING	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1	expose students to industrial environments and provide hands-on experience relevant to their field of specialization.
2	bridge theoretical knowledge with industrial applications by engaging students in real-time practices and problem-solving.
3	develop professional skills, workplace discipline, and interpersonal abilities essential for prospective employment.
4	enhance analytical and reporting skills through observation, analysis, and preparation of a structured industrial training report.

DESCRIPTION

Industrial Training provides work experience relevant to their field of specialization, before graduation, and it is an essential component for the development of practical and professional skills required for an engineering graduate and supports for prospective employment.

At the end of the industrial training, students should be able to improve their knowledge and skills relevant to their areas of specialization where they have been trained. The students should also be able to relate, apply, and adapt the relevant knowledge, concepts, and theories within an industrial organization, and also to practice the general workplace behavior and interpersonal skills.

The student (either in group or single) should undergo industrial training for a minimum period of two weeks during the summer vacation after the completion of fourth semester as specified in the curriculum in any research organization/university/industry of State/National and International level industry relevant to their branch of specialization, after getting proper approval from the Head of the Institution.

On the completion of the industrial training for the specified period, the student has to submit the industrial training report (at least 25-30 pages) containing the following details, along with the certificate obtained from the industry for the period of training undergone.

1. Introduction of the industry.
2. Industry layout and its various operations with its infrastructure facilities.
3. Formulation of practical problems, data required to formulate the problems and its analysis.
4. Suggestions and recommendations for the above problems

During the period of training, the student has to abide the rules and regulations enforced by the organization and to ensure FULL attendance during the period of industrial training and uphold the discipline and decorum of the institution.

- On the completion of the industrial training, the End Semester Examinations shall be conducted by the Office of the Controller of Examinations at the end of the fifth semester. A three-member committee constituted by the Head of the Institution, consisting of (1) a senior faculty member at the Professor level, (2) senior faculty member at the Associate Professor and (3) faculty member from outside the department, will evaluate the industrial training undergone by the student. The evaluation shall be made based on the report submitted along with the presentation and a Viva voce Examination.

		TOTAL PERIODS :30
COURSE OUTCOMES At the end of the course, the students will be able to		**BT MAPPED** (Highest level)
CO1	analyse and appreciate the organizational setup, hierarchy, and functional structure of the industry	Analyzing (K4)
CO2	practice resource optimization techniques used in industrial processes.	Understanding (K2)
CO3	apply core engineering skills to real-time industrial tasks and problem-solving.	Applying (K3)
CO4	demonstrate an understanding of sustainable practices and solutions for environmental issues in the industry.	Understanding (K2)

CO - PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

PSO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	-	-	-	-	-	-	-	-	-	-	2	1	3
CO2	1	-	-	-	-	-	-	-	-	-	-	2	1	3
CO3	2	2	-	-	-	-	-	-	-	-	-	3	2	3
CO4	3	2	2	2	2	-	-	-	-	-	-	3	3	3

PAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Information Technology
5/7/25
AUTONOMOUS

GE23501	PROFESSIONAL DEVELOPMENT III	0	0	2	1

COURSE OBJECTIVES

To enable students to

1.	enhance their Resume writing skills and improving corporate vocabularies to survive in the corporate world.
2.	evaluate their interview skills and improve their interview presentation.
3.	solve the quantitative aptitude problems and improve their mental ability.
4.	improve critical thinking and reasoning skills.

UNIT I	RESUME WRITING SKILLS	6

Updated Resume Building III – Self Introduction III – Dressing Etiquette – JAM V – Corporate Vocabulary.

UNIT II	INTERVIEW SKILLS	6

Interview skills – General guidelines - Work Ethics – Group Discussion III – JAM VI – Presentation Competence – Mock Interview.

UNIT III	QUANTITATIVE APTITUDE	9

Cube Root and Square Root - Time and Work - Ages - Permutation and Combination - Probability – Calendar.

UNIT IV	LOGICAL REASONING	9

Series Completion - Blood Relations - Coding and Decoding - Data Sufficiency - Statements and Assumptions.

TOTAL PERIODS:	30

COURSE OUTCOMES Upon completion of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	excel in drafting Resumes and speaking.	Applying (K3)
CO2	demonstrate the participative skills in group discussions and Interviews.	Applying (K3)
CO3	solve problems based on quantitative aptitude.	Applying (K3)
CO4	enhance their logical and verbal reasoning.	Analyzing (K4)

TEXTBOOKS

1. Aggarwal, R. S. A Modern Approach to Verbal & Non-Verbal Reasoning. Revised ed., 2024–25, S. Chand & Company Ltd., 2024.
2. Aggarwal, R. S. Objective General English: Fully Revised Video Edition. S. Chand & Company Ltd., 2022.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hil1.2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.
3. Johnson, D.W. Reaching out — Interpersonal Effectiveness and self- actualisation. Boston: Allyn and Bacon.2019.
4. Infosys Campus Connect Program — students' guide for soft skills.2015.

CO/PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3

IT23151	EXPLORATORY DATA ANALYSIS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	outline an overview of exploratory data analysis.
2.	implement data visualization using Matplotlib.
3.	perform univariate data exploration and analysis.
4.	apply bivariate data exploration and analysis.
5.	use Data exploration and visualization techniques for multivariate and time series data.

UNIT I	EXPLORATORY DATA ANALYSIS	9

EDA fundamentals – Understanding data science – Significance of EDA – Making sense of data – Comparing EDA with classical and Bayesian analysis – Software tools for EDA - Getting started with EDA - Visual Aids for EDA - EDA with Personal Email - Data transformation techniques-merging database, reshaping and pivoting, Transformation techniques.

UNIT II	EDA USING PYTHON	9

Data Manipulation using Pandas – Pandas Objects – Data Indexing and Selection – Operating on Data – Handling Missing Data – Hierarchical Indexing – Combining datasets – Concat, Append, Merge and Join – Aggregation and grouping – Pivot Tables – Vectorized String Operations - Working with Time series - High performance Pandas:eval and query.

UNIT III	UNIVARIATE ANALYSIS	9

Introduction to Single variable: Distribution and Variables - Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality - Smoothing Time Series.

UNIT IV	BIVARIATE ANALYSIS	9

Relationships between Two Variables - Percentage Tables - Analysing Contingency Tables - Handling Several Batches - Scatterplots and Resistant Lines - Transformations.

UNIT V	MULTIVARIATE AND TIME SERIES ANALYSIS	9

Introducing a Third Variable - Causal Explanations - Three-Variable Contingency Tables and Beyond – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time- based indexing – Visualizing – Grouping – Resampling.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the fundamentals of exploratory data analysis.	Understanding (K2)
CO2	implement the data visualization using Matplotlib.	Analyzing (K4)
CO3	perform univariate data exploration and analysis.	Applying (K3)
CO4	apply bivariate data exploration and analysis.	Applying (K3)

CO5	use Data exploration and visualization techniques for multivariate and time series data.	Analyzing (K4)

TEXT BOOKS

1. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python", Packt Publishing, 2020.
2. Catherine Marsh, Jane Elliott, "Exploring Data: An Introduction to Data Analysis for Social Scientists", Wiley Publications, 2nd Edition, 2008.

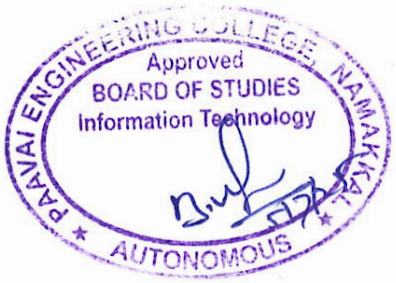
REFERENCES

1. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", First Edition, O Reilly, 2017.
2. Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017.
3. Claus O. Wilke, "Fundamentals of Data Visualization", O'reilly publications, 2019.
4. Matthew O. Ward, Georges Grinstein, Daniel Keim, "Interactive Data Visualization: Foundations, Techniques, and Applications", 2nd Edition, CRC press, 2015.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	2	3	-	-	-	-	-	-	3	1	2
CO2	3	3	3	3	3	-	-	-	-	-	-	3	1	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	1	2
CO4	2	2	2	2	3	-	-	-	-	-	-	2	1	2
CO5	2	2	2	2	3	-	-	-	-	-	-	3	1	2



IT23152	DATA VISUALIZATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the principles of visual perception and perform preprocessing on real-time data.
2.	identify appropriate visualization techniques for different data types.
3.	apply suitable visualization methods to various application domains.
4.	develop customized visualization solutions for given problems.
5.	learn best practices for designing effective information dashboards.

UNIT I	INTRODUCTION	9

Visualization – visualization process – role of cognition – Pseudocode conventions – Scatter plot - Data foundation: Types of data - Structure within and between records - Data preprocessing –perception in visualization – Visualization foundations – The visualization process in detail – semiology of graphical symbols - The eight visual variables.

UNIT II	SPATIAL AND GEOSPATIAL, TIME ORIENTED DATA AND MULTIVARIATE DATA	9

One, two, three dimensional data – Dynamic data – Combining techniques - Visualization of spatial data - Visualization of point data - Visualization of line data - Visualization of area data - Issues in Geospatial data Visualization – Characterizing and visualizing Time oriented data- Point, Line ad region based techniques for multivariate data.

UNIT III	TREE, GRAPH, NETWORKS, TEXT AND DOCUMENT	9

Displaying hierarchical structure – Displaying Arbitrary Graphs/Networks – Other issues. Visualization techniques for Tree- Graph and Networks - Levels of text representation – Vector space model – Single Document Visualization – Document collection visualization- Extended text visualization.

UNIT IV	DESIGNING EFFECTIVE VISUALIZATION	9

Steps in Designing Visualization – problems in Designing Effective Visualization – Comparing and evaluating visualization techniques – Visualization Systems.

UNIT V	INFORMATION DASHBOARD DESIGN	9

Characteristics of dashboards – Key goals in visual design process – Dashboard display media – Designing dashboards for usability – Meaningful organization – Maintaining consistency – Aesthetics of dashboards – Testing for usability – Case Studies: Sales dashboard. Marketing analysis dashboard.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the principles of visual perception and perform data preprocessing for real-time data.	Applying (K3))
CO2	apply visualization techniques to support data analysis across different domains.	Applying (K3)

CO3	use appropriate visualization approaches for unstructured and multivariate data.	Analyzing (K4)
CO4	apply suitable visualizations for hierarchical, network, or temporal datasets	Applying (K3)
CO5	design and develop interactive dashboards for real-world business scenarios like sales and marketing.	Analyzing (K4)

TEXT BOOKS

1. Matthew O. Ward. , Georges Grinstein and Daniel Keim., "Interactive Data Visualization: Foundations, Techniques, and Applications", 2nd Edition, CRC Press, 2015 for Units I, II, III and IV.
2. Stephen Few, "Information Dashboard Design: The Effective Visual Communication of Data", 2nd Edition, O'Reilly, 2013 for Unit V.

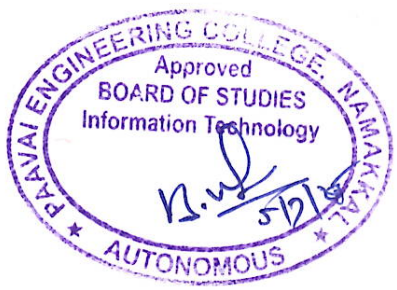
REFERENCES

1. Stephen Few., "Now you see it: Simple Visualization Techniques for Quantitative Analysis", Analytics Press, 2013.
2. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2012.
3. Gert H.N.Laursen and Jesper Thorlund, "Business Analytics for Managers: Taking business intelligence beyond reporting", Wiley 2012.
4. Edward R.Tufte,"The Visual display of quantitative information", Second Edition, Graphics Press, 2010.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	1	3	-	-	-	-	-	-	2	3	3
CO2	3	3	3	2	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2
CO4	3	2	3	2	3	-	-	-	-	-	-	3	2	2
CO5	3	3	3	2	3	-	-	-	-	-	-	2	3	3



IT23153	PREDICTIVE ANALYTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of predictive analytics, the CRISP-DM process, data roles, and statistical tools.
2.	learn how to prepare and preprocess data, handle missing values, and select features for predictive modeling.
3.	study and use various models like decision trees, logistic regression and neural networks.
4.	understand time series analysis, including trend and seasonality, and apply forecasting methods
5.	study deep learning, unsupervised learning, ensemble methods and consider ethical issues in predictive analysis.

UNIT I	INTRODUCTION TO PREDICTIVE ANALYTICS	9

Overview of Predictive Analytics - The CRISP-DM Process Model for Predictive Analysis - The role of data in Predictive Analysis - Data Understanding - Data Visualization - The Value of Statistical Significance - Statistical concepts and tools for Predictive Analysis.

UNIT II	DATA PREPARATION AND FEATURE SELECTION	9

Understanding the importance of data quality for Predictive Analysis - Data Preparation - Data preprocessing - Dealing with missing data and outliers - Feature selection/creation techniques - Exploratory data analysis for predictive modelling.

UNIT III	PREDICTIVE MODELING TECHNIQUES	9

Introduction to Modeling - Descriptive Modeling- Data Preparation Issues with Descriptive Modeling - Predictive modeling techniques - Decision Trees - Logistic Regression -Neural Network Model – K-Nearest Neighbors – Naive Bayes – Regression Models - Linear Regression - Other Regression Algorithms - Parameter tuning and hyper parameter optimization - Evaluating model performance and metrics – Model Ensembles

UNIT IV	TIME SERIES ANALYSIS AND FORECASTING	9

Introduction to Time Series Analysis and Forecasting - Components of time series - Trend and Seasonality analysis – ARIMA, LSTM modeling and forecasting - Exponential smoothing techniques – Model Evaluation - Applications.

UNIT V	ADVANCED TOPICS IN PREDICTIVE ANALYSIS	9

Deep Learning and its applications in Predictive Analysis - Unsupervised Learning techniques - Clustering and Association Rule Mining - Ensemble Learning and Model Stacking techniques - Ethical and legal considerations in Predictive Analysis – Case studies.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the pre-processing of the data and importance of feature selection.	Understanding (K2)

CO2	perform exploratory data analysis to gain insights into data patterns.	Analyzing (K4)
CO3	get hands-on practice with various predictive modeling techniques.	Applying (K3)
CO4	acquire skills in model evaluation, model selection and model validation.	Analyzing (K4)
CO5	apply predictive analytics to real-world problems using analytics software.	Applying (K3)

TEXT BOOKS

1. Dean Abbott, "Applied Predictive Analytics-Principles and Techniques for the Professional Data Analyst", 2nd Edition John Wiley and Sons, 2021.
2. Conrad Carlberg, "Predictive Analytics: Microsoft Excel", 1st Edition, Que Publishing, 2012.

REFERENCES

1. Anasse Bari, Mohammad Chaouchi, Tommy Jung, Predictive Analytics for Dummies, 2nd Edition, 2017.
2. Daniel T. Larose, Chantal D. Larose, "Data Mining and Predictive Analytics", Wiley, 2015.
3. Alberto Cordoba, "Understanding the Predictive Analytics Lifecycle", Wiley, 2014.
4. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Third Edition, Elsevier, 2012.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO3	3	2	2	3	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	2	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	2	3

IT23154	BUSINESS ANALYTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the Analytical Life Cycle
2.	comprehend the process of acquiring Business Intelligence
3.	understand various types analytics for Business Forecasting
4.	model the Supply chain management for Analytics
5.	apply analytics for different functions of a business

UNIT I	INTRODUCTION TO BUSINESS ANALYTICS	7

Analytics and Data Science – Analytics Life Cycle – Types of Analytics – Business Problem Definition – Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration.

UNIT II	BUSINESS INTELLIGENCE AND BUSINESS FORECASTING	11

Data Warehouses and Data Mart – Knowledge Management – Types of Decisions – Decision Making Process – Decision Support Systems – Business Intelligence – OLAP – Analytic functions.- Introduction to Business Forecasting and Predictive analytics - Logic and Data Driven Models – Data Mining Predictive Analysis Modelling – Machine Learning for Predictive analytics.

UNIT III	HR AND SUPPLY CHAIN ANALYTICS	9

Human Resources- Planning and Recruitment – Training and Development – Supply chain network – Planning Demand, Inventory and Supply – Logistics – Analytics applications in HR and Supply Chain – Applying HR Analytics to make a prediction of the demand for hourly employees for a year.

UNIT IV	MARKETING AND SALES ANALYTICS	9

Marketing Mix, Customer Behaviour - selling Process – Sales Planning – Analytics applications in Marketing and Sales – predictive analytics for customers' behavior in marketing and sales.

UNIT V	CASE STUDIES	9

Business Analytics Case Studies : Customer Churn Prediction - Optimizing E-Commerce Sales - Sentiment Analysis for Product Reviews – Fraud Detection in Online Transactions - Predictive Maintenance for IT Systems - Market Basket Analysis

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the real world business problems and model with analytical solutions.	Understanding (K2)
CO2	identify the business processes for extracting Business Intelligence	Analyzing (K4)
CO3	apply predictive analytics for business fore-casting	Applying (K3)
CO4	apply analytics for supply chain and logistics management.	Applying (K3)
CO5	use Analytics for Marketing and Sales	Analyzing (K4)

TEXT BOOKS

1. R.Evans James, Business Analytics, 2nd Edition, Pearson 2017
2. R N Prasad , Seema Acharya, Fundamentals of Business Analytics, 2nd Edition, Wiley,2016.

REFERENCES

1. Philip Kotler and Kevin Keller , Marketing Management , 15th edition , PHI ,2016.
2. VSP RAO, Human Resource Management, 3rd Edition , Excel Books,2010
3. Mahadevan B, "Operations Management -Theory and Practice",3rd Edition, Pearson Education,2015.
4. Philip Kotler and Kevin Keller , Marketing Management , 15th edition , PHI ,2016.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO3	3	2	3	3	3	-	-	-	-	-	-	3	3	3
CO4	2	3	2	3	3	-	-	-	-	-	-	2	3	3
CO5	2	3	3	3	3	-	-	-	-	-	-	3	3	3

IT23155	NEURAL NETWORKS AND DEEP LEARNING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	apply the key concepts behind neural networks and deep learning, including the structure of neural networks, layers, and models.
2.	build generalized models for real time applications by training deep neural networks.
3.	analyze the key computations of RBF networks, Boltzman machines and use them to build models for various tasks.
4.	implement and evaluate the performance of neural networks using popular deep learning.
5.	implement and evaluate the performance of Convolutional neural networks

UNIT I	INTRODUCTION TO NEURAL NETWORKS	9

Introduction- Basic Architecture of Neural Networks- Power of Function Composition - Common Neural Architectures. Machine Learning with Shallow Neural Networks- Neural Architectures for Binary Classification Models - Neural Architectures for Multiclass Models - Backpropagated Saliency for Feature Selection - Matrix Factorization with Autoencoders.

UNIT II	TRAINING DEEP NEURAL NETWORKS	9

Back propagation- Setup and Initialization Issues - Gradient-Descent Strategies -Batch Normalization - Acceleration and Compression - Training Deep Learners to Generalize - The Bias-Variance Trade-Off - Generalization Issues in Model Tuning and Evaluation -Penalty-Based Regularization.

UNIT III	RBF NETWORKS AND RESTRICTED BOLTZMANN MACHINES	9

Training an RBF Network -Variations and Special Cases of RBF Networks - Relationship with Kernel Methods. Restricted Boltzmann Machines - Hopfield Networks- The Boltzmann Machine - Restricted Boltzmann Machine- Applications of Restricted Boltzmann Machines.

UNIT IV	RECURRENT NEURAL NETWORK	9

The expressiveness of Recurrent Networks - Architecture of Recurrent Neural Networks- Challenges of Training Recurrent Networks - Echo-State Networks- Long Short-Term Memory (LSTM) - Gated Recurrent Units (GRUs) - Applications of Recurrent Neural Networks

UNIT V	CONVOLUTIONAL NEURAL NETWORK	9

Basic Structure of a Convolutional Network -Training a Convolutional Network - Case Studies of Convolutional Architectures - Visualization and Unsupervised Learning - Applications of Convolutional Networks.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the architecture and models in neural networks.	Understanding (K2)
CO2	solve real-time applications using neural networks	Applying (K3)

CO3	analyze the architecture and applications of RBF networks and Restricted Boltzmann machines.	Applying (K3)
CO4	demonstrate the architecture and understand the challenges of training recurrent networks	Applying (K3)
CO5	analyze the architecture, training of a convolutional network with it's applications.	Applying (K3)

TEXT BOOKS

1. Charu Aggarwal,"Neural Networks and Deep Learning: A Textbook" ,Springer International Publishing, First Edition,2018.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.

REFERENCES

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2016.
2. LazyProgrammer,"Convolutional Neural Networks in Python: Master Data Science and Machine Learning with Modern Deep Learning in Python", 2016.
3. Rajendra Prasad M,"Hands-On Generative Adversarial Networks with Keras: Your guide to implementing next-generation generative deep learning models using Keras and TensorFlow 2.x", 2019.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO4	2	3	3	2	3	-	-	-	-	-	-	2	2	2
CO5	3	3	3	2	3	-	-	-	-	-	-	2	3	3

IT23156	COMPUTER VISION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	apply the principles of Image Formation and study the algorithms applied to generate images.
2.	understand the techniques to perform feature selection, matching, tracking and detect edges with linking.
3.	analyze the alignment of images based on common features and determine the relative motion between pictures.
4.	determine the response of camera to light and study the HDR technique for image and video resolution.
5.	demonstrate object recognition focused on detecting and identifying human faces.

UNIT I	INTRODUCTION	9

Computer Vision-Image Formation: Geometric primitives and transformations – Photometric Image Formation - The digital camera.

UNIT II	FEATURE DETECTION AND MATCHING	9

Points and Patches: Feature detectors ,Feature descriptors, Feature Matching, Feature Tracking –Edges: Edge detection, Edge linking – Lines : Successive approximation – Hough Transforms- Vanishing Points.

UNIT III	FEATURE BASED ALLIGNMENT	9

2D and 3D feature – based alignment – Pose estimation – Geometric intrinsic calibration – Image Stitching: Motion models – Global alignment – Compositing.

UNIT IV	COMPUTATIONAL PHOTOGRAPHY	9

Photometric calibration – High dynamic range imaging- super-resolution and blur removal- Image matting and compositing – Texture analysis and synthesis – video –based rendering.

UNIT V	RECOGNITION	9

Object detection- Face recognition – Instance recognition –category recognition – context and scene understanding-Recognition databases and test sets.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the mathematical principles and algorithms behind computer vision.	Understanding (K2)
CO2	apply the theoretical and practical aspects of computing in image formation and transformations.	Applying (K3)
CO3	demonstrate the Image feature using detectors and descriptors.	Analyzing (K4)
CO4	illustrate the common methods for robust image matching and alignment.	Understanding (K2)
CO5	demonstrate the usage of computational photography in computer vision.	Analyzing (K4)

TEXT BOOKS

1. Richard Szeliski. "Computer Vision: Algorithms and Applications", Springer- Texts in Computer Science, Second Edition, 2022.
2. Forsyth and Ponce. "Computer Vision-A Modern Approach", Pearson Education, Second Edition. 2015.

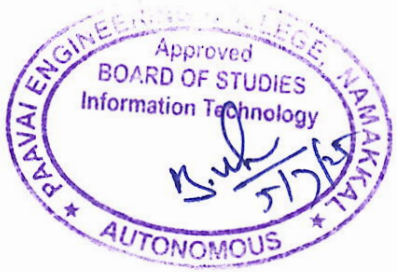
REFERENCES

1. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006.
3. Manas Kamal Bhuyan. "Computer Vision and Image Processing: Fundamentals and Applications", CRC Press, Taylor and Francis Group, USA 2020.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	2	-	-	-	-	-	-	2	2	3
CO2	2	3	3	3	3	-	-	-	-	-	-	3	3	3
CO3	3	2	2	3	2	-	-	-	-	-	-	2	2	3
CO4	3	2	3	2	3	-	-	-	-	-	-	3	3	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3



IT23157	IMAGE AND VIDEO ANALYTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the basics of image processing techniques for computer vision.
2.	learn the techniques used for image pre-processing.
3.	discuss the various object detection techniques.
4.	understand the various Object recognition mechanisms.
5.	elaborate on the video analytics techniques.

UNIT I **INTRODUCTION** **9**

Computer Vision – Image representation and image analysis tasks - Image representations – digitization – Digital image properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures.

UNIT II **IMAGE PRE-PROCESSING** **9**

Pixel brightness transformations – Geometric transformations - Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multi-speralct images - Local pre-processing in the frequency domain - Line detection by local pre-processing operators - Image restoration.

UNIT III **OBJECT DETECTION USING MACHINE LEARNING** **9**

Object detection– Object detection methods – Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) – Non-max suppression – Anchor boxes - Deep Learning Architectures - R-CNN - Faster R-CNN-You Only Look Once(YOLO)-Salient features-Loss Functions-YOLO architectures – Single shot Multibox Detector(SSD).

UNIT IV **FACE RECOGNITION AND GESTURE RECOGNITION** **9**

Face Recognition-Introduction-Applications of Face Recognition-Process of Face Recognition- Deep Face solution by Facebook-Face Net for Face Recognition- Implementation using Face Net- Gesture Recognition.

UNIT V **VIDEO ANALYTICS** **9**

Video Processing – use cases of video analytics-Vanishing Gradient and exploding gradient problem- RestNet architecture-RestNet and skip connections-Inception Network-GoogleNet architecture- Improvement in Inception v2-Video analytics-RestNet and Inception v3.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	understand the basics of image processing techniques for computer vision and video analysis.	Understanding (K2)
CO2	explain the techniques used for image pre-processing.	Analyzing (K4)
CO3	develop various object detection techniques.	Applying (K3)

CO4	understand the various face recognition mechanisms.	Applying (K3)
CO5	elaborate on deep learning-based video analytics.	Analyzing (K4)

TEXT BOOKS

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", 4nd edition, Thomson Learning, 2013. (UNIT- I and II)
2. Vaibhav Verdhan,(2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras,Apress 2021(UNIT- III,IV and V)

REFERENCES

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag London Limited,2011.
2. Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.
3. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2003.
4. E. R. Davies, (2012), "Computer and Machine Vision", Fourth Edition, Academic Press.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	2	2	2	-	-	-	-	-	-	1	2	2
CO2	2	2	3	3	3	-	-	-	-	-	-	1	3	3
CO3	1	2	2	2	3	-	-	-	-	-	-	2	2	3
CO4	1	2	3	2	3	-	-	-	-	-	-	3	2	3
CO5	3	2	1	3	2	-	-	-	-	-	-	3	3	2

IT23251	.NET FRAMEWORK ESSENTIALS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the history and evolution of the .NET Framework.
2.	learn to implement classes and objects, constructors, and destructors.
3.	learn about Data Binding in Windows Forms applications
4.	build and deploy Web API applications in ASP.NET.
5.	learn how to deploy and manage .NET applications using various deployment strategies.

UNIT I	INTRODUCTION TO .NET FRAMEWORK	9

History of .NET - .NET Framework architecture , CLR (Common Language Runtime), Assemblies and namespaces ; Basic Components of .NET Framework - . NET Class Libraries , CTS (Common Type System) , CLS (Common Language Specification) ; .NET Language - C#, Visual Basic .NET ; Introduction to Visual Studio IDE - Overview of Visual Studio features , Creating and running basic applications.

UNIT II	OBJECT-ORIENTED PROGRAMMING WITH C#	9

Basic Concepts of OOP - Classes and objects, Constructors and destructors, Properties and fields ; Inheritance and Polymorphism - Base classes and derived classes, Method overriding , Abstract classes and interfaces ; Encapsulation and Access Modifiers - Private, public, protected, internal access modifiers ; Properties and auto-properties ; Error Handling - Try-catch-finally blocks , Custom exceptions.

UNIT III	DATA MANAGEMENT AND ADO.NET	9

Introduction to ADO.NET - Overview of ADO.NET, Components of ADO.NET (DataSet, DataTable, DataReader) , Connecting to a database (SQL Server); CRUD Operations - Insert, Update, Delete operations with ADO.NET, Using stored procedures ; Working with LINQ - Introduction to LINQ, LINQ queries on collections, LINQ to SQL; Data Binding in Windows Forms- Binding controls to data sources, Working with ComboBoxes, DataGrids

UNIT IV	ASP.NET WEB DEVELOPMENT	9

ASP.NET Web Forms, ASP.NET MVC , Web API ; Web server controls and page lifecycle; Creating Web Forms applications, Web Forms validation controls, ASP.NET MVC - MVC architecture (Model, View, Controller) , Routing in MVC , Controllers, Views, and Models ; Web API Basics – HTTP methods (GET, POST, PUT, DELETE) , Building a simple Web API.

UNIT V	ADVANCED FEATURES AND APPLICATION DEPLOYMENT	9

Multithreading and Parallel Programming - Introduction to threading in .NET , Task Parallel Library (TPL), Asynchronous programming with async/await; Security in .NET- Introduction to unit testing frameworks (NUnit, MSTest, xUnit), Writing and running unit tests, Debugging techniques in Visual Studio; Deployment and Versioning- Deployment to Azure; Introduction to .NET Core,Differences between .NET Framework and .NET Core, Migrating to .NET Core.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the components and architecture of the .NET Framework.	Understanding (K2)
CO2	design reusable and maintainable code using classes and objects.	Analysing (K4)
CO3	implement try-catch blocks to handle exceptions.	Applying (K3)
CO4	utilize common .NET libraries to perform tasks such as file I/O, collections, and string manipulation.	Applying (K3)
CO5	learn about application monitoring, troubleshooting, and maintenance.	Analysing (K4)

TEXT BOOKS

1. Thuan L.Thai, Hoang Lam".Net Framework Essentials, 2nd Edition O'Reilly Publishers,2002.
2. Andrew Troelsen, "Pro .NET Framework with C#", 7th Edition Apress, 2020.

REFERENCES

1. Andrew Troelsen, Pro C# 5.0 and the .NET 4.5 Framework , Apress publication , 2012.
2. Andy Wigley, Daniel Moth, Peter Foot, - Mobile Development Handbookll , Microsoft Press 2011.
3. Addison-Wesley, Essential .NET, Volume 1: The Common Language Runtime" by Don Box 2004.
4. Joe Duffy,"Professional .NET Framework" Wrox 2004 .

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	3	3	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	3	2	3
CO3	3	2	2	3	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	2	3
CO5	3	3	3	2	3	-	-	-	-	-	-	3	2	3

IT23252	OPEN SOURCE SYSTEMS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce students to open-source software
2.	study common open-source software licenses
3.	understand open-source project structure
4.	distributed software development
5.	current events in the open-source world

UNIT I	INTRODUCTION	9

Overview of Open Source System:Definition –The FOSS Philosophy-The Free Software Foundation-Terms and Norms in OSS Development-Open Source Software Development Models-Licensing-BSD-Linux-Apache-Mozilla.

UNIT II	OPEN SOURCE DEVELOPMENT	9

Open-Source Development: Infrastructure needed for an open-source project–Software Development Lifecycle –Building a community –Joining an Existing.

UNIT III	MANAGEMENT OF OPEN-SOURCE PROJECT	9

Open-Source Project –Ending an Open-Source Project –Open Source within a Company –Using Git and GitHub for Open-Source Development -FOSS Programming in python.

UNIT IV	ANALYSIS OSS	9

Deriving a Framework for Analyzing OSS: Zachman's Framework for IS Architecture –CATWOE and SoftSystem Method –Deriving the Analytical Framework for OSS Environment

UNIT V	OPEN-SOURCE SERVER APPLICATIONS	9

Open-Source Server Applications: Infrastructure Services –Web Servers –Database Servers –Mail Servers – Open Source Desktop Applications: Graphical Desktops –Web Browsers –The Office Suite –Mail Clients – Personal Software–Case Studies on OSS.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	define the difference between open-source software and commercial software	Understanding (K2)
CO2	exposed to the context and operation of Open-Source Communities and associated software projects.	Analyzing (K4)
CO3	get familiar with participating in an open-source project using Git and GitHub.	Applying (K3)
CO4	get insights into different development models and frameworks used in the open-source community.	Applying (K3)
CO5	implementing open-source programming using Python.	Analyzing (K4)

TEXT BOOKS

1. JosephFeller, BrianFitzgerald and Eric S.Raymond,— Understanding Open Source Software Development, AddisonWesleyProfessional,2000

REFERENCES

1. E-Book Producing Open Source Software which is available at: https://producingoss.com/
2. "Code Reading: The Open-Source Perspective" by Diomidis Spinellis.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	1	3	-	-	-	-	-	-	1	3	3
CO2	3	3	3	2	2	-	-	-	-	-	-	1	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO4	3	2	3	2	3	-	-	-	-	-	-	1	2	2
CO5	3	3	3	2	3	-	-	-	-	-	-	2	3	3

IT23253	ENTERPRISE LINUX OPERATING SYSTEM	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the history, development and significance of Linux in modern computing
2.	comprehend the importance of Host Administration.
3.	explore the Network and Security Tools.
4.	overview of various internet services work, such as DNS,, SMTP, and POP3.
5.	understand the Role of Intranet Services.

UNIT I	INTRODUCTION TO LINUX AND INSTALLATION	9

Introduction to Linux, Linux Distributions and FOSS; Open source software and GNU overview; Advantage of open source Software; Understanding the Difference between Windows and Linux; Installing a Linus Server, Methods of Installation and Installing Fedora; Installing Ubuntu Server; Deploying Linux Server in the Cloud.

UNIT II	SINGLE – HOST ADMINISTTTRATION	9

The Command Line; Managing Software; Managing user and Groups; Booting and Shutting Down; Introduction to File systems; Core System Services; The Linux Kernel; Knobs and Dials: API File System.

UNIT III	NETWORKING AND SECURITY	9

TCP/IP for system Administration; Network Configuration- Modules and /network Interfaces, Managing Routers; Linux Firewall; Local Security-common Sources of risk, Mointoring your System; Network Security-tracking Services, Network security Tools.

UNIT IV	INTERNET SERVICES	9

Domain Name System(DNS) ; File Transfer Protocol; Apache Web Server, Simple Mail Transfer Protocol; Post Office protocol and Internet Mail Access Protocol; Voice over Internet Protocol; Secure Shell.

UNIT V	INTRANET SERVICES	9

Network File System; Samba; Distributed File Systems; Lightweight directory Access Protocol; Printing; Dynamic Host /configuration Protocol; Virtualization and Backups.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	identify the need of a Linux Operating System.	Understanding (K2)
CO2	know the process management functions of a Linux Operating System..	Analyzing(K4)
CO3	understand the need of users and group management in Linux Operating System.	Understanding (K2)
CO4	create, secure, and manage a variety of internet-based services and applications.	Applying (K3)

CO5	set up and manage key intranet services such as web servers, file sharing systems, and email servers.	Analyzing(K4)

TEXT BOOKS

1. Linux Administration A Beginner's Guide" by Wale Soyinka.Eigth Edition.
2. Linux Administration Handbook" by Evi Nemeth, Garth Snyder, Trent R. Hein, Ben Whaley, and Dan Mackin..

REFERENCES

1. Colino, Miguel Perez. " Red Hat Enterprise Linux 8 Administration: Master Linux Administration Skills", Packt Publishing, 2021.
2. Günther, Tobias, "Learn Version Control with Git: A Step-By-step Course for the Complete Beginner, Independently Published, 2017.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO2	3	3	3	2	2	-	-	-	-	-	-	1	3	2
CO3	3	3	3	3	2	-	-	-	-	-	-	2	2	3
CO4	3	2	3	2	2	-	-	-	-	-	-	3	3	2
CO5	3	2	3	3	3	-	-	-	-	-	-	2	2	3

IT23254	AGILE METHODOLOGIES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the concepts of agile methodology.
2.	learn the agile methodology.
3.	learn the agility and knowledge management .
4.	apply the knowledge in agility and requirements engineering.
5.	understand agility and quality assurance.

UNIT I	AGILE METHODOLOGY	9

Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model - Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams - Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Value

UNIT II	AGILE PROCESSES	9

Lean Production - SCRUM, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Progmming: Methodverview – Lifecycle – Work Products, Roles and Practices.

UNIT III	AGILITY AND KNOWLEDGE MANAGEMENT	9

Agile Information Systems – Agile Decision Making - Earl_S Schools of KM – Institutional Knowledge Evolution Cycle – Development, quisition, Refinement, Distribution, Deployment , Leveraging – KM in Software Engineeng – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).

UNIT IV	AGILITY AND REQUIREMENTS ENGINEERING	9

Impact of Agile Processes in RE–Currt Agile Practices – Variance – Overview of RE Using Agile –Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agilenvironment, Agile Requirements Prioritization – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation

UNIT V	AGILITY AND QUALITY ASSURANCE	9

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance - Test Driven Development –Agile Approach in Global Software Development

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the existing problems with the team, development process and wider organization	Understanding (K2)
CO2	analyze through understanding of Agile principles and specific practices	Analyzing (K4)

CO3	apply the most appropriate way to improve results for a specific circumstance or need	Applying (K3)
CO4	apply and craft appropriate adaptations to existing practices or processes depending upon analysis of typical problems	Applying (K3)
CO5	analyse likely successes and formulate plans to manage likely risks or problems	Analyzing (K4)

TEXT BOOKS

1. Craig Larman, "Agile and Iterative Development: A Manager's Guide", Addison-Wesley, 2004.
2. Hazza and Dubinsky, "Agile Software Engineering, Series: Undergraduate Topics in Computer Science", Springer, 2009.

REFERENCES

1. David J. Anderson and Eli Schragenheim, "Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results", Prentice Hall, 2003.
2. Kevin C. Desouza, "Agile Information Systems: Conceptualization, Construction and Management", Butterworth-Heinemann, 2007

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	3	-	-	-	-	-	-	2	2	2
CO2	2	1	2	3	3	-	-	-	-	-	-	2	3	2
CO3	2	3	2	3	3	-	-	-	-	-	-	2	3	3
CO4	2	2	2	2	2	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	2

IT23255	CLOUD STORAGE SERVICES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the principles of cloud computing and its storage mechanisms.
2.	explore various cloud storage architectures and services.
3.	provide insights into secure, reliable, and scalable cloud storage systems.
4.	develop skills in performance optimization and cost management of cloud storage.
5.	analyze advanced applications of cloud storage in real-world scenarios.

UNIT I	FUNDAMENTALS OF CLOUD STORAGE	9

Introduction to Cloud Computing and Storage - Cloud Storage Types: Object, Block, and File Storage - Architecture and Components of Cloud Storage Systems - Benefits, Challenges, and Applications of Cloud Storage - Overview of Public, Private, and Hybrid Cloud Storage.

UNIT II	CLOUD STORAGE SERVICES AND PLATFORMS	9

Overview of Major Providers: AWS S3, Google Cloud Storage, Azure Blob Storage - Features, Pricing Models, and Service-Level Agreements (SLAs) - Cloud Storage APIs and SDKs - Use Cases: Media Streaming, Data Backup, and Archiving - Case Studies: Comparing Cloud Storage Platform

UNIT III	DATA MANAGEMENT AND SECURITY	9

Data Replication, Redundancy, and Backup Strategies - Disaster Recovery and Business Continuity Planning - Security Features: Data Encryption, Authentication, and Authorization - Compliance Standards: GDPR, HIPAA, and ISO 27001 - Hands-on Lab: Implementing Secure Cloud Storage Solution.

UNIT IV	PERFORMANCE AND OPTIMIZATION	9

Key Metrics: Latency, Throughput, and Input/Output Operations per Second (IOPS) - Role of Content Delivery Networks (CDNs) in Enhancing Performance - Cost Optimization Techniques for Cloud Storage Services - Monitoring, Troubleshooting, and Fine-Tuning Cloud Storage Systems - Performance Analysis of Real-World Cloud Storage Solutions.

UNIT V	ADVANCED APPLICATIONS AND EMERGING TRENDS	9

Integration with Big Data, IoT, and Artificial Intelligence - Hybrid and Multi-Cloud Storage Architectures - Emerging Technologies: Edge Computing and Sustainability in Cloud Storage - Designing Scalable Cloud Storage Solutions for Specific Applications - Discussion on Future Trends in Cloud Storage.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the core concepts and components of cloud storage systems	Understanding (K2)
CO2	compare and evaluate cloud storage services based on specific requirements	Applying (K3)
CO3	implement secure and efficient cloud storage solutions.	Analyzing (K4)

CO4	optimize the performance and cost-efficiency of cloud storage for various applications.	Analyzing (K4)
CO5	apply cloud storage technologies to solve problems in domains such as big data, IoT, and hybrid cloud systems.	Applying (K3)

TEXT BOOKS

1. Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Cloud Computing: Concepts, Technology and Architecture, Pearson Education.
2. Kai Hwang, Geoffrey Fox, Jack Dongarra, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Morgan Kaufmann.

REFERENCES

1. Arshdeep Bahga and Vijay Madisetti, Cloud Computing: A Hands-On Approach, Universities Press.
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing: Foundations and Applications Programming, Morgan Kaufmann
3. Rountree, Derrick, and Ileana Castrillo, The Basics of Cloud Computing: Understanding the Fundamentals of Cloud Computing in Theory and Practice, Syngress.
4. Saurabh Kumar and Pankaj Bhambri, Cloud Computing: Concepts and Deployment Models, Wiley.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	2	1	2	-	-	-	-	-	-	1	3	3
CO2	2	1	2	1	1	-	-	-	-	-	-	1	3	3
CO3	3	2	1	1	2	-	-	-	-	-	-	1	3	3
CO4	2	2	1	1	2	-	-	-	-	-	-	1	3	2
CO5	3	2	1	1	2	-	-	-	-	-	-	1	3	3

IT23256	SPEECH PROCESSING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce speech production and related parameters of speech.
2.	show the computation techniques for speech analysis.
3.	understand different speech modeling procedures.
4.	know the various speech recognition methods and its applications.
5.	gain knowledge about the speech synthesis methods.

UNIT I	SPEECH CONCEPTS	9

Articulatory Phonetics - Production and Classification of Speech Sounds; Acoustic Phonetics - acoustics of speech production; Review of Digital Signal Processing concepts - Short-Time Fourier Transform, Filter-Bank, LPC Methods.

UNIT II	SPEECH ANALYSIS	9

Speech Analysis - Speech analysis methods, the bank of filters, Linear predictive coding for speech recognition; Pattern comparison techniques - Speech distortion measures, mathematical and perceptual, Log spectral distance, Cepstral distances, Weighted cepstral distances, Likelihood distortions, Spectral distortion using a warped frequency scale; Feature extraction - PLP and MFCC coefficients

UNIT III	SPEECH MODELING	9

Hidden Markov Models - Markov Processes, HMMs-Evaluation, Optimal State Sequence, Viterbi Search, Baum - Welch Parameter Re-estimation, Implementation issues.

UNIT IV	SPEECH RECOGNITION	9

Large Vocabulary Continuous Speech Recognition - Architecture of a large vocabulary continuous speech recognition system, acoustics and language models, n-grams, context dependent sub-word units; Applications and present status.

UNIT V	ADVA SPEECH SYNTHESIS	9

Text-to-Speech Synthesis - Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness; Applications and present status.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	model speech production system and describe the fundamentals of speech.	Understanding (K2)
CO2	extract and compare different speech parameters.	Applying (K3)
CO3	choose an appropriate statistical speech model for a given application.	Analyzing (K4)
CO4	design a speech recognition system.	Analyzing (K4)
CO5	use different speech synthesis techniques.	Applying (K3)

TEXT BOOKS

1. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2009.
2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2009.

REFERENCES

1. Steven W. Smith, "The Scientist and Engineer"s Guide to Digital Signal Processing", California Technical Publishing, 1999.
2. Thomas F Quatieri, "Discrete-Time Speech Signal Processing - Principles and Practice", Pearson Education, 2004.
3. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999.
4. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1998.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	1	-	-	-	-	-	2	2	3	2
CO2	3	3	3	2	2	-	-	-	-	-	2	2	3	2
CO3	3	3	3	2	2	-	-	-	-	-	2	2	3	2
CO4	3	3	3	2	2	-	-	-	-	-	2	2	3	2
CO5	3	3	3	2	2	-	-	-	-	-	2	2	3	2

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Information Technology
AUTONOMOUS

IT23257	DEVOPS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce DevOps terminology, definition and concepts
2.	understand the different Version control tools like Git, Mercurial
3.	understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment)
4.	understand Configuration management using Ansible
5.	illustrate the benefits and drive the adoption of cloud-based DevOps tools to solve real-world problems

UNIT I	INTRODUCTION TO DEVOPS	7

Devops Essentials - Introduction to AWS, GCP, Azure - Version control systems: Git and GitHub.

UNIT II	COMPILE AND BUILD USING MAVEN AND GRADLE	10

Introduction, Installation of Maven, POM files, Maven Build lifecycle, Build phases (compile build, test, package) Maven Profiles-Maven repositories (local, central, global)- Maven plugins- Maven create and build Artifacts- Dependency Management-Installation of Gradle- understanding build using Gradle.

UNIT III	CONTINUOUS INTEGRATION USING JENKINS	12

Install and Configure Jenkins- Jenkins Architecture Overview- creating a Jenkins Job- Configuring a Jenkins job- Introduction to Plugins- Adding Plugins to Jenkins-commonly used plugins (Git Plugin, Parameter Plugin- HTML Publisher- Copy Artifact, and Extended choice parameters). Configuring Jenkins to work with Java- Git- and Maven- Creating a Jenkins Build and Jenkins workspace.

UNIT IV	CONFIGURATION MANAGEMENT USING ANSIBLE	9

Ansible Introduction- Installation-Ansible master/slave configuration- YAML basics-Ansible Modules- Ansible Inventory files- Ansible playbooks- Ansible Roles- and ad-hoc commands in Ansible

UNIT V	BUILDING DEVOPS PIPELINES USING AZURE	7

Create GitHub Account, Create Repository- Create Azure Organization- Create a new pipeline- Build a sample code- Modify azure-pipelines- yaml file

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand different actions performed through Version control tools like Git.	Understanding (K2)
CO2	perform Continuous Integration and Continuous Testing and Continuous Deployment using Jenkins bybuilding and automating test cases using Maven and Gradle.	Analyzing (K4)
CO3	ability to Perform Automated Continuous Deployment.	Applying (K3)
CO4	ability to do configuration management using Ansible.	Applying (K3)
CO5	understand to leverage Cloud-based DevOps tools using Azure DevOps.	Analyzing (K4)

TEXT BOOKS

1. Roberto Vormittag, "A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises", Second Edition, Kindle Edition, 2016.
2. Jason Cannon, "Linux for Beginners: An Introduction to the Linux Operating System and Command Line", Kindle Edition, 2014.

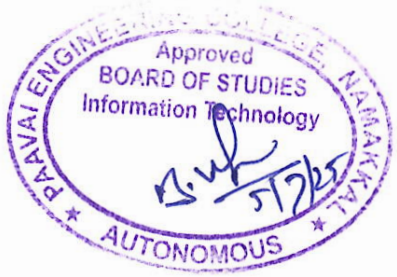
REFERENCES

1. Hands-On Azure DevOps: Cicd Implementation For Mobile, Hybrid, And Web Applications Using Azure DevOps And Microsoft Azure: CICD Implementation for. DevOps and Microsoft Azure.
2. Jeff Geerling, "Ansible for DevOps: Server and configuration management for humans", First Edition, 2015.
3. David Johnson, "Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps", Second Edition, 2016.
4. Mariot Tsitoara, "Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer", Second Edition, 2019.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	2	2	-	-	-	-	-	-	2	3	2
CO2	3	3	3	3	2	-	-	-	-	-	-	2	2	2
CO3	2	2	2	3	2	-	-	-	-	-	-	3	2	3
CO4	2	2	2	2	2	-	-	-	-	-	-	2	2	3
CO5	2	2	2	2	2	-	-	-	-	-	-	2	3	2



IT23351	DATA VIRTUALIZATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	examine how data virtualization supports data services.
2.	analyze cloud use cases involving data virtualization and gateways.
3.	compare different types of hypervisors used today.
4.	perform P2V conversions and environment loading.
5.	explore tuning techniques for VM CPU, memory, and storage.

UNIT I	INTRODUCTION	9

Data Virtualization – Introduction - Extract, Transform, and Load (ETL) processes, Enterprise Service Bus (ESB), Data Virtualization, Exploring Data Virtualization- Delivering Data Services.

UNIT II	CHALLENGES IN DATA VIRTUALIZATION	9

Big data challenges - Managing Data Lakes, streamlining with a Logical Data Warehouse, Integrating IoT Analytics; data migration challenges with data virtualization - Creating a Data Gateway, Cloud Use Cases.

UNIT III	OVERVIEW OF VIRTUALIZATION	9

Understanding Virtualization: Describing Virtualization - Understanding the Importance of Virtualization - Understanding Virtualization Software Operation. Understanding Hypervisors: Describing a Hypervisor- Understanding the Role of a Hypervisor - Comparing today's Hypervisor. Understanding Virtual Machines: Describing a Virtual Machine - Understanding How a Virtual Machine Works - Working with Virtual Machines.

UNIT IV	VIRTUAL MACHINES	9

Creating a Virtual Machine: Performing P2V Conversions - Loading Your Environment - Building a New Virtual Machine. Installing Windows on a Virtual Machine: Loading Windows into a Virtual Machine - Understanding Configuration Options - Optimizing a New Linux Virtual Machine. Installing Linux on a Virtual Machine: Loading Linux into a Virtual Machine - Understanding Configuration Options - Optimizing a New Linux Virtual Machine.

UNIT V	MANAGING VIRTUAL MACHINES	9

Managing CPUs for a Virtual Machine: Understanding CPU Virtualization - Configuring VM CPU Options - Tuning Practices for VM CPUs. Managing Memory for a Virtual Machine: Understanding Memory Virtualization - Configuring VM Memory Options - Tuning Practices for VM Memory. Managing Storage for a Virtual Machine: Understanding Storage Virtualization - Configuring VM Storage Options - Tuning Practices for VM Storage.

	TOTAL PERIODS	45

COURSE OUTCOMES		BT MAPPED
At the end of this course, the students will be able to		(Highest Level)
CO1	apply data virtualization methods to deliver data services.	Understanding (K2)

CO2	analyze cloud-based solutions using data virtualization.	Understanding (K2)
CO3	illustrate how virtual machines function in a virtualized environment	Analyzing (K4)
CO4	analyze configuration options and best practices for VMs.	Applying (K3)
CO5	analyze resource utilization and performance in virtual machines.	Analyzing (K4)

TEXT BOOKS

1. Lawrence C.Miller. Data Virtualization for dummies", John Wiley and Sons, 2019.
2. Matthew Portney, Virtualization Essentials, John Wiley and Sons, Third Edition, 2023.

REFERENCES

1. Rajkumar Buyya, Christian Vecchiola and Thamarai Selvi S, Mastering in Cloud Computing, McGraw Hill Education, (India) Private Limited, 2013.
2. Bernard Golden, Amazon Web Services for Dummies, John Wiley and Sons, First Edition, 2013.
3. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security‖, CRC Press, 2017.
4. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice) ‖, O'Reilly, 2009.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	3	-	-	-	-	-	-	2	3	2
CO4	2	2	2	2	3	-	-	-	-	-	-	2	3	2
CO5	2	3	2	3	3	-	-	-	-	-	-	2	3	2

IT23352	SOFTWARE DEFINED NETWORKS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	identify the limitations of traditional network architectures and the need for SDN.
2.	analyze the structure of SDN architecture including the data, control, and application planes.
3.	apply the concepts of the OpenFlow protocol and control mechanisms used in SDN controllers.
4.	develop understanding of SDN applications in areas such as traffic engineering, network monitoring, and data center operations.
5.	identify the components and requirements of Network Function Virtualization (NFV).

UNIT I	SDN: INTRODUCTION	9
Evolving Network Requirements–The SDN Approach–SDN architecture-SDN Data Plane, Control plane and Application Plane.		

UNIT II	SDN DATA PLANE AND CONTROL PLANE	9
Data Plane functions and protocols – Open Flow Protocol – Flow Table – Control Plane Functions-Southbound Interface, Northbound Interface–SDN Controllers - Open Day light.		

UNIT III	SDN APPLICATIONS	9
SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering – Measurement and Monitoring – Security – Data Center Networking.		

UNIT IV	NETWORK FUNCTION VIRTUALIZATION	9
Network Virtualization - Virtual LANs – Open Flow VLAN Support - NFV Concepts – Benefits and Requirements – Reference Architecture.		

UNIT V	NFV FUNCTIONALITY	9
NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV.		

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the evolving requirements of modern networks and the need for SDN.	Understanding (K2)
CO2	analyze the SDN architecture and describe the functions of the data, control, and application planes.	Analyzing (K4)
CO3	design the role of OpenFlow protocol and analyze SDN controller operations.	Analyzing (K4)
CO4	examine the architecture and applications of SDN in traffic engineering, security, and data centers.	Applying (K3)

CO5	understand the concepts and benefits of Network Function Virtualization (NFV).	Understanding (K2)

TEXT BOOKS

1. William Stallings, "Foundations of Modern Networking :SDN, NFV, QoE, IoT and Cloud", Pearson Education, 10th Edition, 2016.
2. Paul Goransson, Chuck Black Timothy Culver, "Software Defined Networks: A Comprehensive Approach", 2nd Edition, Morgan Kaufmann Press, 2016.

REFERENCES

1. KenGray, Thomas D.Nadeau, "Network Function Virtualization", Morgan Kauffman, 2016.
2. ThomasD Nadeau, KenGray," SDN: Software Defined Networks", O'Reilly Media,2013.
3. FeiHu, "Network Innovation through OpenFlow and SDN: Principles and Design", 1st Edition, CRC Press, 2014.
4. Oswald Coker, Siamak Azodolmolky, "Software – Defined Networking with OpenFlow", 2nd Edition, O'Reilly Media, 2017.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1	2	2	2	3	-	-	-	-	-	-	1	3	3
CO2	2	2	3	2	3	-	-	-	-	-	-	2	3	3
CO3	2	2	2	2	3	-	-	-	-	-	-	2	3	3
CO4	3	2	3	2	3	-	-	-	-	-	-	2	2	3
CO5	2	2	2	2	2	-	-	-	-	-	-	3	2	2

IT23353	CLOUD SERVICES MANAGEMENT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce Cloud Services Management terminology, definition and concepts.
2.	compare and contrast cloud service management with traditional IT service management.
3.	identify strategies to reduce risk and eliminate issues associated with adoption of cloud.
4.	select appropriate structures for designing, deploying and running cloud-based services .
5.	illustrate the benefits and drive the adoption of cloud-based services to solve real world issue.

UNIT I	CLOUD SERVICE MANAGEMENT FUNDAMENTALS	9

Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models.

UNIT II	CLOUD SERVICES STRATEGY	9

Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture.

UNIT III	CLOUD SERVICE MANAGEMENT	9

Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management.

UNIT IV	CLOUD SERVICE ECONOMICS	9

Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models.

UNIT V	CLOUD SERVICE GOVERNANCE AND VALUE	9

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the Service Management Fundamentals.	Understanding (K2)
CO2	understand Cloud Service Management Strategies.	Applying (K3)
CO3	identify the Services of Cloud Technologies.	Analyzing (K4)
CO4	select Appropriate Tools for Cloud Service Economics.	Applying (K3)
CO5	evaluate and optimize Cloud Governance for efficiency and effectiveness.	Analyzing (K4)

TEXT BOOKS

1. Cloud Service Management and Governance: Smart Service Management in Cloud Era by Enamul Haque, Enel Publications
2. Cloud Computing: Concepts, Technology and Architecture by Thomas Erl, Ricardo Puttini, Zaigham Mohammad 2013

REFERENCES

1. Cloud Computing Design Patterns by Thomas Erl, Robert Cope, Amin Naserpour
2. Economics of Cloud Computing by Praveen Ayyappa, LAP Lambert Academic Publishing
3. Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya, Christian Vechhiola, S.Thamarai Selvi

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	2	-	-	-	-	-	-	2	3
CO2	3	2	3	2	2	2	-	-	-	-	-	-	2	3
CO3	3	3	2	2	2	2	-	-	-	-	-	-	2	3
CO4	3	2	2	2	2	2	-	-	-	-	-	-	2	3
CO5	3	3	2	2	3	2	-	-	-	-	-	-	2	2

IT23354	STORAGE TECHNOLOGIES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	characterize the functionalities of logical and physical components of storage
2.	describe various storage networking technologiesx`
3.	identify different storage virtualization technologies
4.	discuss the different backup and recovery strategies
5.	understand common storage management activities and solutions

UNIT I	STORAGE SYSTEM	9

Information Storage and Management: Information Storage – Evolution of Storage Technology and Architecture – Data Center Infrastructure – Key Challenges in Managing Information – Information Lifecycle – Storage System Environment: Components of a Storage System Environment – Disk Drive Components – Disk Drive Performance - Fundamental Laws Governing Disk Performance - Logical Components of the Host - Application Requirements and Disk Performance - Data Protection: RAID – Intelligent Storage System: Components of an Intelligent Storage System -Intelligent Storage Array

UNIT II	DIRECT-ATTACHED STORAGE AND STORAGE AREA NETWORKS	9

Types of DAS - DAS Benefits and Limitations- Disk Drive Interfaces- Introduction to Parallel SCSI- SCSI Command Model- The SAN and Its Evolution- Components of SAN- FC Connectivity- Fibre Channel Ports- Fibre Channel Architecture- Fibre Channel Login Types- FC Topologies- IP SAN: iSCSI- FCIP.

UNIT III	NETWORK-ATTACHED STORAGE AND CONTENT-ADDRESSED STORAGE	9

General Purpose Servers vs. NAS Devices- Benefits of NAS- NAS File I/O- Components of NAS- NAS Implementations- NAS File-Sharing Protocols- NAS I/O Operations- Factors Affecting NAS Performance and Availability- Concepts in Practice: EMC Celerra- Content-Addressed Storage: Fixed Content and Archives- Types of Archives- Features and Benefits of CAS- CAS Architecture- Object Storage and Retrieval in CAS- CAS Examples- Concepts in Practice: EMC Centera. Storage Virtualization: Forms of Virtualization- Storage Virtualization Configurations- Storage Virtualization Challenges- Types of Storage Virtualization.

UNIT IV	BACKUP, ARCHIVE AND REPLICATION	9

Introduction to Business Continuity- Backup Purpose- Backup Considerations- Backup Granularity- Recovery Considerations- Backup Methods- Backup Process- Backup and Restore Operations- Backup Topologies- Backup Technologies- Source and Target- Uses of Local Replicas- Data Consistency- Restore and Restart Considerations- Creating Multiple Replicas- Management Interface- Remote Replication: Modes of Remote Replication- Remote Replication Technologies- Network Infrastructure- Concepts in Practice: EMC SRDF, EMC SAN Copy,and EMC MirrorView.

UNIT V	STORAGE SECURITY AND MANAGEMENT	9

Securing the Storage Infrastructure- Storage Security Framework- Risk Triad- Storage Security Domains- Security Implementations in Storage Networking- Managing the Storage Infrastructure:Monitoring the Storage Infrastructure- Storage Management Activities- Storage Infrastructure Management Challenges- Developing an Ideal Solution- Concepts in Practice: EMC Control Center.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	demonstrate the fundamentals of information storage management and various models of Cloud infrastructure services and deployment	Applying (K3)
CO2	illustrate the usage of advanced intelligent storage systems and RAID	Analyzing (K4)
CO3	interpret various storage networking architectures - SAN, including storage subsystems and virtualization	Applying (K3)
CO4	examine the different role in providing disaster recovery and remote replication technologies	Analyzing (K4)
CO5	infer the security needs and security measures to be employed in information storage management.	Applying (K3)

TEXT BOOKS

1. EMC Corporation, Information Storage and Management, Wiley, India Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel and Libor Miklas, Introduction to Storage Area Networks, Ninth Edition, IBM - Redbooks, December 2017.
2. Ulf Troppens, Rainer Erkens, Wolf gang Mueller-Friedt, Rainer Wolafka, Nils Haustein, Storage Networks Explained, Second Edition, Wiley,2009

REFERENCES

1. Alexander Thomasian, Storage Systems: Organization, Performance, Coding, Reliability, and Their Data Processing, 2021.
2. Gerald J. Kowalski, Mark T. Maybury , Information Storage and Retrieval Systems, 2005.
3. K.L. James, Data Storage Technologies,2019.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO3	2	3	3	3	3	-	-	-	-	-	-	2	2	3
CO4	2	2	2	3	3	-	-	-	-	-	-	3	3	3
CO5	2	2	3	3	3	-	-	-	-	-	-	3	3	3

IT23355	EDGE COMPUTING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	outline an overview of Edge Computing.
2.	implement edge routing and protocols techniques.
3.	apply various topologies of cloud and fog.
4.	perform cloud pipeline using modeling framework.
5.	apply various security schemes for manipulation and storage service.

UNIT I	INTRODUCTION TO EDGE COMPUTING	9

Edge purpose and definition; Edge use cases; Edge hardware Architectures; Operating Systems-Operating system choice points, Typical boot process, Operating system tuning; Edge platforms; Use cases for edge computing.

UNIT II	EDGE ROUTING AND PROTOCOLS	9

Edge Routing And Networking : TCP/IP network functions at the edge, Edge level network security, Software defined networking; Edge to Cloud Protocols – MQTT, MQTT-SN, Constrained application protocol; Other Protocols:STOMP, AMQP.

UNIT III	CLOUD AND FOG TOPOLOGIES	9

Topologies - Cloud service model, Public, Private and Hybrid cloud, The OpenStack cloud architecture, Constraints of cloud architectures for IoT; Fog Computing – The Hadoop philosophy for fog computing, OpenFog reference architecture, EdgeX.

UNIT IV	DATA ANALYTICS AND ML IN THE CLOUD AND EDGE	9

Basic data analytics in IOT- Top-level cloud pipeline, Rules Engines, Ingestion – streaming, processing and data lakes, Complex event processing, Lambda architecture, Sector Usecases; Machine learning in IoT – History of AI and machine learning milestones machine learning models, classification, Regression, Random Forest, Bayesian models, CNN; RNN.

UNIT V	IOT AND EDGE SECURITY	9

Cyber Security vernacular- Anatomy of IoT cyber attacks - Physical and hardware security- Shell security- Cryptography- Software defined perimeter- Blockchains and cryptocurrencies in IoT. Government regulations and intervention-IoT security best practices.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	outline an overview of Edge Computing.	Understanding (K2)
CO2	implement edge routing and protocols techniques.	Applying (K3)
CO3	apply various topologies of cloud and fog.	Applying (K3)

CO4	perform cloud pipeline using modeling framework.	Applying (K3)
CO5	apply various security schemes for manipulation and storage service.	Applying (K3)

TEXT BOOKS

1. Perry Lea"IoT and Edge Computing for Architects", Second Edition, Publisher: Pact Publishing, 2020.
2. Rajkumar Buyya, Satish Narayana Srirama "Fog and Edge Computing: Principles and Paradigms" wiley publication, 2019

REFERENCES

1. James Broberg,Andrzej M. Goscinski Rajkumar Buyya, "Cloud Computing: Principles and Paradigms", Wiley, 2011
2. Deepak Gupta (Editor), Aditya Khamparia (Editor) " Fog, Edge, and Pervasive Computing in Intelligent IoT Driven Applications", Wiley-IEEE Press,2020
3. Imad M. Abbadi "Cloud Management and Security", Wiley-IEEE Press,2014

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	3	3	-	-	-	-	-	-	2	3	3
CO2	2	2	3	3	3	-	-	-	-	-	-	2	3	3
CO3	2	3	2	2	3	-	-	-	-	-	-	2	3	3
CO4	2	2	2	2	3	-	-	-	-	-	-	2	2	3
CO5	2	2	2	2	2	-	-	-	-	-	-	2	2	3

IT23356	DATA WAREHOUSING AND DATA MINING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the design and implementation of a data store.
2.	acquire knowledge on data and various preprocessing techniques.
3.	study the various correlation besed frequent patterns mining in large datasets.
4.	learn various classifiers in data mining
5.	understand the data mining techniques and methods to be applied on large datasets.

UNIT I	DATA WAREHOUSING	9

Data warehouse - Basic Concept, Modeling, Design and usage, Implementatio –data cube compution Methods, Data Generalization by Attribute, Oriented Induction approach. Utation

UNIT II	DATA MINING	9

Introduction Kinds of Data and Patterns, Major lasues in data Mining, Statistical Description of Data, Measuring Data Similarity and Dissimilarity; Data preprocessing Data Cleasing, Data Integrition, Data Trarsformation Data Reduction; Data Discretization Concept Hierarchy Generation.

UNIT III	ASSOCIATION RULE MINING	9

Basic concepts - Frequent hem set Mining Methods, Apriori algorithm; A Pattern Growth Approach for Mining Frequent Itern sets; Mining Various Kinds of Association Rules, Correlation Analysis; Constraint Based Association Mining.

UNIT IV	CLASSIFICATION	9

Basic Concepts Decision Tree Induction, Bayes Classification Methods, Rule Based Classification, Classification by Back propagation, Support vector machines, Associative Classification, Lazy Leamers, Other Classification Methods, Prodiction.

UNIT V	CLUSTERING AND DATA MINING APPLICATIONS	9

Cluster analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dinersional Data, Constraint Based Clustering Analysis-Outlier Analysis; Data Mining Applications - Financial Duty Analysis, Science and Engineering, Intrusion Detection and Prevention.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the design of a data warehouse.	Understanding (K2)
CO2	apply preprocessing techniques.	Applying (K3)
CO3	analyze the various correlation based frequent patterns mining in large datasets.	Analyzing (K4)
CO4	compare and contrast the various classifiers.	Applying (K3)

CO5	apply clustering techniques and methods	Applying (K3)

TEXT BOOKS

1. Jiawei Han and Micheline Kamber, -Data Mining Concepts and Techniques, Third Edition, Elsevier, 2012

REFERENCES

1. Alex Berson and Stephen J.Smith, Data Warehousing, Data Mining and OLAPI, Tata MeGraw-Hill Edition, 35th Reprint 2016.
2. K.P. Soman, Shyam Diwakar and V. Ajay, -Insight into Data Mining Theory and Practice, Eastern Economy Edition, Prentice Hall of India, 2006.
3. Ian H.Witten and Eibe Frank, -Data Mining: Practical Machine Learning Tools and Techniques,Elsevier. Second Edition.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	3
CO2	3	3	2	2	2	-	-	-	-	-	-	3	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	3	3	3
CO4	3	3	2	2	2	-	-	-	-	-	-	3	3	3
CO5	3	2	2	2	2	-	-	-	-	-	-	3	3	2

IT23357	STREAM PROCESSING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the Data Stream Processing
2.	apply DSMS Challenges and Scheduling Strategies for CQs
3.	analyze Modeling Continuous Queries over Data Streams
4.	determine Load shedding in DSMS and Network Fault Management Problem
5.	demonstrate Integrating Stream and Complex Event Processing

UNIT I	INTRODUCTION TO DATA STREAM PROCESSING	9

Paradigm Shift - Data Stream Characteristics - Data Stream Application Characteristics - Continuous Queries: Window Specification - Examples of Continuous Queries - QoS Metrics - Data Stream Management System Architecture - Data Stream Applications.

UNIT II	DSMS CHALLENGES	9

QoS-Related Challenges: Capacity Planning and QoS Verification - Scheduling Strategies for CQs - Load Shedding and Run-Time Optimization - Complex Event and Rule Processing - Continuous Query Modeling - Data Stream Management Systems - QoS-Related Issues- Complex Event Processing- Commercial and Open-Source Stream and CEP Systems

UNIT III	MODELING CONTINUOUS QUERIES OVER DATA STREAMS	9

Continuous Query Processing - Problem Definition - Modeling Relational Operators - Modeling Continuous Queries - Intuitive Observations - Experimental Validation - Scheduling Model and Terminology - Impact of Scheduling Strategies on QoS - Novel Scheduling Strategies for CQs - Experimental Validation.

UNIT IV	LOAD SHEDDING IN DSMS AND NFM	9

The Load Shedding Problem - Integrating Load Shedders - Load Shedding Framework - Experimental Validation - Network Fault Management Problem - Data Processing Challenges for Fault Management - Stream and Event- Based NFM Architecture - Three-Phase Processing Model for NFM - Transactional Needs of Network Management Applications.

UNIT V	INTEGRATING STREAM AND CEP	9

Event Processing Model - Complex Event Vs. Stream Processing - MavEStream: An Integrated Architecture - Stream-Side Extensions - Event-Side Extensions - MavStream Architecture - Window Types - Stream Operators and CQs - Buffers and Archiving - Run-time Optimizer - QoS-Delivery Mechanisms.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the Data Stream Processing	Understanding (K2)
CO2	apply DSMS Challenges and Scheduling Strategies for CQs	Applying (K3)

CO3	analyze Modeling Continuous Queries over Data Streams	Analyzing (K4)
CO4	determine Load shedding in DSMS and Network Fault Management Problem	Understanding (K2)
CO5	demonstrate Integrating Stream and Complex Event Processing	Analyzing (K4)

TEXT BOOKS

1. Qingchun Jiang, Sharma Chakravarthy, "Stream Data Processing: A Quality of Service Perspective - Modeling, Scheduling, Load Shedding and Complex Event Processing", Springer
2. Martin Kleppmann, "Designing Data-Intensive Applications", O'Reilly Media, 2017

REFERENCES

1. Tyler Akidau, Slava Chemyak, Reuven Lax, "Streaming Systems: The What, Where, When and How of Large-Scale Data Processing", O'Reilly Publication, 2018
2. Slava Chernyak and Reuven Lax. "Large-Scale Data Processing", O'Reilly Publications, 2023

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	2	3	2	-	-	-	-	-	-	2	3	3
CO2	2	2	2	3	2	-	-	-	-	-	-	2	3	3
CO3	2	3	3	2	2	-	-	-	-	-	-	2	3	3
CO4	2	2	3	3	2	-	-	-	-	-	-	3	2	3
CO5	2	2	3	2	2	-	-	-	-	-	-	2	2	3

IT23451	INFORMATION SECURITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the basic concepts of information security, its model and development life cycle
2.	assess the need for information security and its legal, ethical and its professional issues
3.	identify the information security needs
4.	enable planning of security solutions
5.	implement and practice security policies

UNIT I	INFORMATION SECURITY	9

Introduction – History – Security – Critical Characteristics of Information – National Security Telecommunications and Information System Security Committee (NSTISSC) – Security Model – Components of an Information System – Securing the Components – Balancing Information Security and Access – The Systems Development Life Cycle – Security Professionals and the Organization.

UNIT II	SECURITY INVESTIGATION	9

Need for Security – Business Needs – Threats – Attacks – Legal, Ethical and Professional Issues in Information Security – Selecting Risk Control Strategy – Risk Management – Recommended Risk Control Practices.

UNIT III	SECURITY PLANNING	9

Information Security Policy, Standards and Practices – Information Security Blueprint – Design of Security Architecture – Security Education – Training and Awareness Program – Continuity Strategies.

UNIT IV	AI IN SECURITY	9

Physical Design – Firewalls – Protecting Remote Connections – Intrusion Detection ,Anomaly Detection and Prevention Systems – Honey Pots, Honey Nets, Padded Cell Systems – Scanning and Analysis Tools ,SIEM, Penetration Testing with Kali Linux– Access Control Devices.

UNIT V	IMPLEMENTATION AND MAINTENANCE	9

Implementing IS – IS Project Management – Technical and Non-Technical Aspects of Implementation - Security and Personnel – Introduction – Positioning and Staffing the Security Function – Credentials of IS Professionals – Employment Policies and Practices – Internal Control Strategies – Privacy and the Security of Personal Data. Information Security Maintenance – Security Management Models – Maintenance Model – Digital Forensics, Cyber Forensics.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	analyze the Information Security Model and its relevance in modern IT infrastructures.	Analyzing (K4)
CO2	analyze risk management practices and recommend suitable risk control measures for business security.	Analyzing (K4)

CO3	apply knowledge to develop continuity strategies that ensure organizational resilience during disruptions.	Applying (K3)
CO4	apply scanning and analysis tools to identify vulnerabilities and threats within networks.	Applying (K3)
CO5	analyze various security management and maintenance models, including digital forensics practices, for ongoing protection of assets.	Analyzing (K4)

TEXT BOOKS

1. Michael E Whitman and Herbert J Mattord, "Principles and Practices of Information Security", Cengage Learning, Seventh Edition 2022.
2. Charles P. Pfleeger and Shari Lawrence Pfleeger, "Security in Computing" Pearson Education Pvt. Ltd., 2015.

REFERENCES

1. Matt Bishop, "Computer Security Art and Science", Pearson/PHI, 2018.
2. Harold F. Tipton, Micki Krause Nozaki, "Information Security Management Handbook, Volume 6, 6th Edition, 2016

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	2	3	-	-	-	-	-	-	2	2	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	2
CO3	3	2	2	2	2	-	-	-	-	-	-	2	2	3
CO4	3	3	3	2	3	-	-	-	-	-	-	3	3	2
CO5	3	3	3	2	2	-	-	-	-	-	-	3	3	3

IT23452	CYBER SECURITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	classify various types of cybercrimes and examine their effects on individuals, organizations, and governments
2.	analyze different forms of malware and how they exploit system weaknesses
3.	demonstrate the use of tools such as Harvester, Whois, Netcraft, and Host for extracting publicly available information
4.	understand the fundamentals of Intrusion Detection Systems (IDS) and their role in identifying and mitigating security threats
5.	prepare students to configure and manage modern firewall and IPS solutions in real-world environments.

UNIT I	INTRODUCTION	9

Cyber Security – History of Internet – Impact of Internet – CIA Triad; Reason for Cyber Crime – Need for Cyber Security – History of Cyber Crime; Cybercriminals – Classification of Cybercrimes – A Global Perspective on Cyber Crimes; Cyber Laws – The Indian IT Act – Cybercrime and Punishment.

UNIT II	ATTACKS AND COUNTERMEASURES	9

OWASP; Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Countermeasures.

UNIT III	RECONNAISSANCE	9

Harvester – Whois – Netcraft – Host – Extracting Information from DNS – Extracting Information from E-mail Servers – Social Engineering Reconnaissance; Scanning – Port Scanning – Network Scanning and Vulnerability Scanning – Scanning Methodology – Ping Sweer Techniques – Nmap Command Switches – SYN – Stealth – XMAS – NULL – IDLE – FIN Scans – Banner Grabbing and OS Finger printing Techniques.

UNIT IV	INTRUSION DETECTION SYSTEM	9

Host -Based Intrusion Detection – Network -Based Intrusion Detection – Distributed or Hybrid Intrusion Detection – Intrusion Detection Exchange Format – Honeypots – Example System Snort.

UNIT V	INTRUSION PREVENTION SYSTEM	9

Firewalls and Intrusion Prevention Systems: Need for Firewalls – Firewall Characteristics and Access Policy – Types of Firewalls – Firewall Basing – Firewall Location and Configurations – Intrusion Prevention Systems – Example Unified Threat Management Products.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the basics of cyber security, cyber crime and cyber law	Understanding (K2)

CO2	classify various types of attacks and learn the tools to launch the attacks	Understanding (K2)
CO3	apply various tools to perform information gathering	Applying (K3)
CO4	apply intrusion techniques to detect intrusion	Applying (K3)
CO5	apply intrusion prevention techniques to prevent intrusion	Applying (K3)

TEXT BOOKS

1. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publishers, 2024
2. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones and Bartlett Learning Publishers, 2021

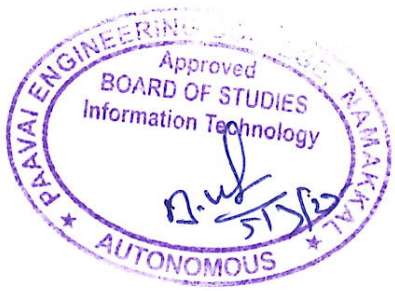
REFERENCES

1. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made easy", Elsevier, 2022
2. William Stallings, Lawrie Brown, "Computer Security Principles and Practice", Third Edition, Pearson Education, 2020

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	2	2	2	-	-	-	-	-	-	3	2	3
CO2	2	3	2	3	2	-	-	-	-	-	-	3	2	3
CO3	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO4	3	3	2	2	2	-	-	-	-	-	-	3	2	3
CO5	3	2	2	1	3	-	-	-	-	-	-	3	2	3



IT23453	ETHICAL HACKING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the purpose and importance of ethical hacking in cyber security.
2.	learn to interpret website responses and headers to gather useful data.
3.	recognize tools used for vulnerability scanning in Linux environments.
4.	become familiar with popular tools used for web application testing.
5.	explore automated tools that assist in firewall and router security analysis.

UNIT I	INTRODUCTION	9

Ethical Hacking Overview – Role of Security and Penetration Testers, Penetration-Testing Methodologies, Laws of the Land; TCP/IP Concepts - Overview of TCP/IP, The Application Layer, The Transport Layer,The Internet Layer, IP Addressing; Network and Computer Attacks – Malware, Protecting Against Malware Attacks, Intruder Attacks, Addressing Physical Security.

UNIT II	FOOTPRINTING AND PORT SCANNING	9

Web tools for Foot printing, Conductive Competitive Intelligence, Analyzing a Company's website, Using E-Mail Addresses, Using HTTP Basics; Introduction to Social Engineering – The Art of Shoulder Surfing, The Art of Dumpster Diving, The Art of Piggybacking; Port Scanning – Tools, Ping Sweeps, Understanding Scripting..

UNIT III	ENUMERATION AND VULNERABILITY ANALYSIS	9

Enumeration Concepts – NetBIOS Enumeration – SNMP, LDAP, NTP, SMTP and DNS Enumeration, Vulnerability; Desktop and Server OS Vulnerabilities -Windows OS Vulnerabilities, Tools for Identifying Vulnerabilities in Windows, Linux OS Vulnerabilities, Vulnerabilities of Embedded Oss.

UNIT IV	HACKING WEBSERVERS	9

Understanding Web Applications, Vulnerabilities, Tools for Web Attackers and Security Testers; Hacking Wireless Networks – Understanding Wireless Technology, Standards, Authentication, Wardriving, Wireless Hacking.

UNIT V	NETWORK PROTECTION SYSTEMS	9

Introduction - Access Control Lists, Cisco Adaptive Security Appliance Firewall, Configuration and Risk Analysis Tools for Firewalls and Routers. Intrusion Detection and Prevention Systems, Network-Based and Host-Based IDSs and IPSs, Web Filtering, Security Incident Response Teams, Honeypots.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand and explain the TCP/IP protocol suite, including the application, transport, and internet layers, as well as IP addressing.	Understanding (K2)

CO2	analyze company websites and gather information using email addresses and HTTP protocols.	Analyzing (K4)
CO3	identify common vulnerabilities in desktop and server operating systems, including Windows, Linux, and embedded OSs.	Applying (K3)
CO4	use tools to analyze and exploit web applications ethically.	Applying (K3)
CO5	describe the deployment and purpose of honeypots in network defense.	Analyzing (K4)

TEXT BOOKS

1. Michael T. Simpson, Kent Backman, and James E. Corley, Hands-On Ethical Hacking and Network Defense, Course Technology, Delmar Cengage Learning, 2010.
2. The Basics of Hacking and Penetration Testing – Patrick Engebretson, SYNGRESS, Elsevier, 2013.

REFERENCES

1. The Web Application Hackers Handbook: Finding and Exploiting Security Flaws, Dafydd Stuttard and Marcus Pinto, 2011.
2. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing Company, 2007.
3. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press,Cambridge, 2020.
4. Jack D. Hidary, Quantum Computing: An Applied Approach, Firstedition, Springer International Publishing, 2019.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	2	2	3	-	-	-	-	-	-	2	2	3
CO2	2	3	3	3	2	-	-	-	-	-	-	3	3	3
CO3	2	3	3	3	2	-	-	-	-	-	-	2	3	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2	3	3
CO5	2	3	3	2	2	-	-	-	-	-	-	3	2	3

IT23454	WEB APPLICATION SECURITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of web application architecture and how to identify potential vulnerabilities.
2.	learn the phases of web attacks and tools commonly used by attackers.
3.	analyze different types of web attacks and defense mechanisms to enhance security.
4.	examine user-targeted attacks like XSS and client-side exploitation techniques.
5.	understand secure coding practices and techniques to protect data exchange using XML and APIs in web applications.

UNIT I	WEB APPLICATION ARCHITECTURE	9

Overview of Web Applications - Importance of Web Application Security - Modern Web Application Architecture - Web Application Technologies - Security Principles and Core Defense Mechanisms - Web Application Insecurity - Mapping - Enumerating Content and Functionality, Web Spidering, User-Directed Spidering.

UNIT II	HACKING TECHNIQUES AND TOOLS	9

Hacker's Goals - The Five Phases of Hacking - Creating an Attack Map, Building an Execution Plan ,Establishing a Point of Entry , Continued and Further Access; Tools and **Techniques** – Burp Suite, OWASP ZAP,NIKTO,Wfuzz; Introduction to Vulnerability Scanners – Nessus, Acunetix.

UNIT III	DEFENSEMECHANISMS AND ATTACKING MECHANISMS	9

Input Validation and Output Encoding - Authentication and Authorization Controls- Session Management Security- Access Control Mechanisms-Bypassing Client Side Controls, Attacking Authentication, Attacking Session Management, Attacking Access Controls -Attacking Data Stores, Attacking Back-End Components, Attacking Application Logic

UNIT IV	ATTACKING USERS	9

Attacking Users: Cross Site Scripting- Reflected XSS Vulnerabilities , Stored XSS Vulnerabilities , DOM-Based XSS Vulnerabilities ; Real-World XSS Attacks , Payloads for XSS Attacks , Delivery Mechanisms for XSS Attacks - Other Techniques - Inducing User Actions, Capturing Data Cross-Domain, Other Client-Side Injection Attacks, Local Privacy Attacks, Attacking Browser Extensions- Clickjacking – CSRF.

UNIT V	SECURE WEB APPLICATION DEVELOPMENT AND DATA EXCHANGE	9

Securing XML - Introduction to XML , XML Elements and Structure , Risks of Using XML in Web Applications , XML Security Techniques, XML Encryption and XML Digital Signatures; Securing APIs - Building Safe API , Internet Controls , Common API Vulnerabilities, API Security Techniques, Authentication, Access Control, Rate Limiting ; Developing Security-Enabled Applications- Secure Coding Practices.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the architecture of web applications and identify their security weaknesses.	Understanding (K2)
CO2	analyze and demonstrate core defense mechanisms for securing web applications.	Analyzing (K4)
CO3	apply techniques to detect and mitigate authentication and session-related attacks.	Applying (K3)
CO4	identify and evaluate user-targeted attacks including Cross-Site Scripting and client-side vulnerabilities.	Applying (K3)
CO5	develop and implement secure coding practices to protect web applications and ensure safe data exchange using XML and API security techniques.	Analyzing (K4)

TEXT BOOKS

1. Dafydd Stuttard and Marcus Pinto, " The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws" , 2nd edition, Wiley, 2011
2. Michael Cross , "Developer's Guide to Web Application Security" 1st Editiosyngress,2007

REFERENCES

1. Rob Botwright, OWASP Top 10 Vulnerabilities: Beginner's Guide To Web Application Security Risks, Pastor Publishing Ltd, January 2024.
2. Malcolm McDonald, "Application Security Program Handbook", Manning Publications, May 2024
3. Andrew Hoffman, Web Application Security: Exploitation and Countermeasures for Modern Web Applications, O'Reilly Media, Inc., February 2024
4. Ankit Fadia, "Ultimate Pentesting for Web Applications", Notion Press, May 2024

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	-	-	-	-	-	-	1	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	2	3	-	-	-	-	-	-	2	3	3
CO4	3	3	3	2	3	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	3

IT23455	OPEN VULNERABILITY ASSESSMENT SYSTEM	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand fundamental concepts of computer security, threats, and protection mechanisms.
2.	apply cryptographic principles for securing systems and communications.
3.	analyze user authentication methods and access control techniques.
4.	identify and mitigate common attacks such as denial-of-service and unauthorized intrusions.
5.	evaluate and configure firewalls, intrusion detection, and prevention systems effectively.

UNIT I	INTRODUCTION	9

Computer Security- Key objectives and Challenges of Computer security , A model for computer security ; Threats, Attacks, and Assets – assets of computer; Security functional requirements – Attack Surfaces and Attack Trees – Computer Security Strategy.

UNIT II	CRYPTOGRAPHIC TOOLS	9

Confidentiality with Symmetric Encryption - Symmetric Encryption , Symmetric Block Encryption Algorithms , Stream Ciphers; Message Authentication and Hash Functions- Authentication Using Symmetric Encryption, Message Authentication without Message Encryption , Secure Hash Functions; Public-Key Encryption- Public-Key Encryption Structure, Applications for Public-Key Cryptosystems ,Requirements for Public-Key Cryptography ,Asymmetric Encryption Algorithms; Digital Signatures and Key Management.

UNIT III	AUTHENTICATION AND ACCESS CONTROL	9

User Authentication - Password-Based Authentication, Token-Based Authentication, Biometric Authentication, Remote User Authentication; Access Control Principles- Discretionary Access Control, Role-Based Access Control, Attribute-Based Access Control.

UNIT IV	DOS AND INTRUSION DETECTION	9

Denial-of-Service Attacks- The Nature of Denial-of-Service Attacks , Classic Denial-of-Service Attacks, Distributed Denial-of-Service Attacks; HTTP-Based Attacks; Defenses Against Denial-of-Service Attacks; Intrusion Detection -Basic Principles , The Base-Rate Fallacy, Requirements; Host-Based Intrusion Detection-Data Sources and Sensors , Anomaly HIDS, Signature or Heuristic HIDS, Distributed HIDS.

UNIT V	FIREWALLS AND INTRUSION PREVENTION SYSTEMS	9

The Need for Firewalls -Firewall Characteristics and Access Policy-Types of Firewalls-Packet Filtering Firewall , Stateful Inspection Firewalls; Firewall Basing-Bastion Host , Host-Based Firewalls , Personal Firewall; Firewall Location and Configurations-DMZ Networks , Virtual Private Networks, Distributed Firewalls , Summary of Firewall Locations and Topologies; Intrusion Prevention Systems-Host-Based IPS , Network-Based IPS , Distributed or Hybrid IPS.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the foundational concepts of computer security, including attack surfaces, attack trees, and threat models.	Understanding (K2)
CO2	apply cryptographic tools such as encryption, hashing, digital signatures, and key management for securing systems.	Applying (K3)
CO3	evaluate user authentication techniques and access control models to secure sensitive systems.	Applying (K3)
CO4	analyze and classify denial-of-service attacks and employ intrusion detection techniques effectively.	Analyzing (K4)
CO5	configure and assess firewall architectures and intrusion prevention systems for protecting network infrastructure.	Analyzing (K4)

TEXT BOOKS

1. William Stallings Lawrie Brown Computer Security Principles and Practice , Third Edition,pearson ,2015.
2. Charles Pfleeger, Shari Lawrence Pfleeger, and Lizzie Coles-Kemp, "Security in Computing",6th edition, Addison-Wesley Professional,2023.

REFERENCES

1. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson, 8th Edition,2024
2. William Chuck Easttom ,computer security fundamantals, 5th edition,Pearson publication,2023
3. Mark Stamp, "Information Security: Principles and Practice", Wiley, 3rd Edition (2021).
4. OWASP.org.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	-	-	-	-	-	-	2	3	2
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	3

IT23456	MOBILE ADHOC NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamental concepts, characteristics, and challenges of ad-hoc wireless networks, including the design and classification of MAC protocols.
2.	explore the design considerations and classifications of routing protocols tailored for ad-hoc wireless networks.
3.	principles and challenges of multicast routing within ad-hoc wireless networks, including architectural models and protocol classifications.
4.	comprehend the transport layer challenges and security issues specific to ad-hoc networks, along with the strategies to address them.
5.	understand the Quality of Service (QoS) requirements and energy management strategies essential for the efficient functioning of ad-hoc wireless networks.

UNIT I	AD-HOC WIRELESS NETWORKS	9

Introduction, Issues in Ad-hoc Wireless Networks, Ad-hoc Wireless Internet; MAC Protocols for Ad-hoc Wireless Networks - Introduction, Issues in Designing a MAC Protocol, Design Goals of MAC Protocols, Classification of MAC protocols, Contention-Based Protocols, Contention-Based Protocols with Reservation Mechanisms, Contention-Based Protocols with Scheduling Mechanisms, MAC Protocols that Use Directional Antennas.

UNIT II	ROUTING PROTOCOLS	9

Introduction, Issues in Designing a Routing Protocol for Ad-hoc Wireless Networks, Classification of Routing Protocols, Table Driven Routing Protocols, On-Demand Routing Protocols, Hybrid Routing Protocols, Hierarchical Routing Protocols and Power-Aware Routing Protocols.

UNIT III	MULTICAST ROUTING	9

Introduction, Issues in Designing a Multicast Routing Protocol, Operation of Multicast Routing Protocols, An Architecture Reference Model for Multicast Routing Protocols, Classifications of Multicast Routing Protocols, Tree-Based Multicast Routing Protocols and Mesh-Based Multicast Routing Protocols.

UNIT IV	TRANSPORT LAYER AND SECURITY PROTOCOLS FOR AD-HOC NETWORKS	9

Introduction, Issues in Designing a Transport Layer Protocol, Design Goals of a Transport Layer Protocol, Classification of Transport Layer Solutions, TCP over Ad Hoc Wireless Networks, Other Transport Layer Protocols for Ad-hoc Networks, Security in Ad-hoc Wireless Networks, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management and Secure routing in Ad-hoc Wireless Networks.

UNIT V	QUALITY OF SERVICE	9

Introduction, Issues and Challenges in Providing QoS in Ad-hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, Network Layer Solutions, QoS Frameworks for Ad hoc Wireless Networks.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the fundamentals of ad hoc wireless networks and evaluate various MAC protocols.	Understanding (K2)
CO2	classify and compare different routing protocols suitable for various network scenarios.	Analyzing (K4)
CO3	apply multicast routing protocols and differentiate between tree-based and mesh-based approaches.	Applying (K3)
CO4	analyze transport layer solutions and understand security challenges in ad hoc networks.	Analyzing (K4)
CO5	assess Quality of Service (QoS) solutions and implement energy management techniques to enhance network performance.	Applying (K3)

TEXT BOOKS

1. C. Siva Ram Murthy and B. S. Manoj: Ad-hoc Wireless Networks, Pearson Education, 2018.
2. Charles E. Perkins Ad Hoc Networking Addison-Wesley, 2001.

REFERENCES

1. Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovic Mobile Ad Hoc Networking, Wiley-IEEE Press, 2013.
2. Mohammad Ilyas The Handbook of Ad Hoc Wireless Networks, CRC Press, 2002.
3. Chai Keong Toh Ad Hoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall, 2001.
4. T. Camp, J. Boleng, V. Davies A Survey of Mobility Models for Ad Hoc Network Research, Wireless Communications and Mobile Computing, Vol. 2, No. 5, 2002, pp. 483–502.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	3
CO2	3	3	2	3	3	-	-	-	-	-	-	2	3	3
CO3	3	2	2	2	2	-	-	-	-	-	-	2	3	3
CO4	3	2	2	3	2	-	-	-	-	-	-	2	3	2
CO5	3	3	2	3	3	-	-	-	-	-	-	2	2	3

IT23457	WIRELESS SENSOR NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the foundational concepts of Wireless Sensor Networks, including their applications, challenges, and enabling technologies.
2.	explore the sensor node and network architectures including commercially available sensor platforms.
3.	analyze MAC and routing protocols suitable for WSNs under different traffic and network conditions.
4.	analyze the transport mechanisms, coverage models, and QoS in wireless sensor deployments.
5.	apply OS concepts in WSNs with a focus on performance and design trade-offs.

UNIT I	WIRELESS SENSOR NETWORKS	9

Introduction - Application examples, Types of applications, Challenges for WSNs, Mobile ad hoc networks and wireless sensor networks, Enabling technologies for wireless sensor networks; Applications of Wireless Sensor Networks - Home Control, Building Automation, Industrial Automation, Medical Applications, Highway Monitoring, Military Applications, Habitat Monitoring.

UNIT II	ARCHITECTURES	9

Single-node Architecture - Hardware components, Energy consumption of sensor nodes, commercially available sensor nodes – Mica Mote, EYES nodes, BTnodes, Scatterweb; Network Architecture - Sensor network scenarios, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.

UNIT III	COMMUNICATION PROTOCOLS	9

Fundamentals of MAC protocols - Requirements and design constraints for wireless MAC protocols, Important classes of MAC protocols, MAC protocols for wireless sensor networks; Low duty cycle protocols and wakeup concepts; Contention-based protocols - CSMA, PAMAS; Schedule-based protocols – LEACH, SMACS, Traffic-adaptive medium access protocol (TRAMA); The IEEE 802.15.4 MAC protocol; Routing protocols - Gossiping and agent-based unicast forwarding, Broadcast and multicast, Geographic routing.

UNIT IV	TRANSPORT LAYER AND QUALITY OF SERVICE	9

The transport layer and QoS in wireless sensor networks, Coverage and deployment-Sensing models, Coverage measures, Uniform random deployments: Poisson point processes, Uniform random deployments: Poisson point processes, Coverage of random deployments: general sensing model, Coverage determination, Coverage of grid deployments; Reliable data transport; Single packet delivery; Block delivery; Congestion control and rate control.

UNIT V	EMBEDDED OPERATING SYSTEMS	9

Introduction, Operating System Design Issues; Examples of Operating Systems - TinyOS, Mate, MagnetOS, MANTIS, OSPM, EYES OS, SenOS, EMERALDS, PicOS, WSN Design Issues, Performance Modeling of WSNs; Case Study - Simple Computation of the System Life Span.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the types of applications, challenges, and enabling technologies for WSNs across various domains such as military, healthcare, and automation.	Understanding (K2)
CO2	illustrate the hardware components and network architecture of WSNs, and demonstrate communication between WSNs and the Internet using gateways.	Applying (K3)
CO3	compare various MAC and routing protocols and analyze their suitability for specific WSN scenarios based on network constraints and traffic patterns.	Analyzing (K4)
CO4	evaluate coverage models and deployment strategies and analyze transport and congestion control methods in WSNs.	Analyzing (K4)
CO5	apply OS design principles and use real-time embedded operating systems to support performance modeling in WSNs.	Applying (K3)

TEXT BOOKS

1. Holger Karl and Andreas Willig "Protocols and Architectures for Wireless Sensor Networks", Wiley, First Edition, 2007.
2. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "Wireless Sensor Networks-Technology, Protocols, and Applications", Second Edition, John Wiley, 2011.

REFERENCES

1. Waltenegus Dargie , Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks - Theory And Practice", John Wiley and Sons Publications, Second Edition, 2011.
2. Sabrie Soloman,Sensors Handbook by McGraw Hill publication. Second Edition, published in 2009.
3. Feng Zhao, Leonidas Guibas, Wireless Sensor Networks by Elsevier Publications, Second Edition, published in 2017.
4. Philip Levis, And David Gay TinyOS Programming by Cambridge University Press, First Edition, 2009.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	3	3
CO2	3	2	2	2	2	-	-	-	-	-	-	2	3	3
CO3	3	3	2	2	2	-	-	-	-	-	-	3	3	3
CO4	3	3	2	3	2	-	-	-	-	-	-	3	3	2
CO5	3	2	2	3	3	-	-	-	-	-	-	2	3	3

IT23551	INDUSTRIAL IOT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	learn IoT fundamental computations and evolutions of Industry 4.0.
2.	know the perspective of industrial IoT process.
3.	study about IIoT reference architectures and offsite technologies.
4.	find the available on-site reality and communication technologies.
5.	acquire the knowledge of industrial data acquisition and its applications.

UNIT I	OVERVIEW OF INDUSTRIAL IoT	9

IoT architecture, application-based IoT protocol, cloud computing, fog computing, sensor cloud, big data;Industry 4.0 – industrial revolution, evolution of Industry 4.0, environmental impacts, industrial internet,applications – IIoT – Basics of CPS, CPS and IIoT.

UNIT II	INDUSTRY 4.0 BASICS	9

Design requirements, drivers of Industry 4.0, sustainability assessment of industry, smart business perspective,cybersecurity, impacts of Industry 4.0 – Industrial IoT – Industrial internet systems, industrial sensing, industrial process.

UNIT III	IIoT REFERENCE ARCHITECTURE	9

Business models – definition, business for IoT and IIoT, reference architecture of IoT and IIoT, IIRA: Offsite technologies – cloud computing and fog computing for IIoT

UNIT IV	ON SITE TECHNOLOGIES	9

Need for Industry 4.0 – Augmented reality – Virtual reality – Big data and advanced analytics – Smart factories–Lean manufacturing systems; industrial data transmission – foundation field bus, profibus, HART, inter bus, bit bus, CC-link, mod bus, Digital STROM, CAN, Lonworks, ISA 100.11a, wireless HART, LoRa, LoRaWAN.

UNIT V	CASE STUDIES OF IIoT SYSTEMS	9

Industrial data acquisition – DCS, PLC, SCADA – IIoT analytics – Machine learning and data science in industries–Plant safety and security; case studies – manufacturing industry – automotive industry – mining industry.Introduction to Industry 5.0.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the revolution in industrial data processing techniques.	Understanding (K2)
CO2	be aware of the design requirements, security, and internet system for IIoT.	Understanding (K2)
CO3	recognize architectural and computing strategies of IIoT.	Analyzing (K4)
CO4	identify the state-of-the-art technologies for industrial data communication.	Applying (K3)
CO5	realize the industrial data acquisition methods with real-time examples.	Analyzing (K4)

TEXT BOOKS

1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0,CRC Press, Taylor and Francis Group, 2021.
2. Ismail Butun, Industrial IoT: Challenges, Design Principles, Applications, and Security, Springer Nature, 2020.

REFERENCES

1. Jiafu Wan, Iztok Humar, Daqiang Zhang, Industrial IoT Technologies and Applications, Springer, 2016.
2. R. Anandan, Suseendran Gopalakrishnan, Souvik Pal, Noor Zaman, Subhas Chandra Mukhopadhyay, Gourab Sen Gupta, Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance, John Wiley and Sons, 2022.
3. Anand Sharma, Sunil Kumar Jangir, Manish Kumar, Dilip Kumar Choubey, Tarun Shrivastava, S. Balamurugan, Industrial Internet of Things Technologies and Research Directions, CRC Press, 2020.
4. Sudan Jha, Usman Tariq, Gyanendra Prasad Joshi, Vijender Kumar Solanki, Industrial Internet of Things: Technologies, Design, and Applications, CRC Press, 2022.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	1	-	-	-	-	-	-	1	2	3
CO2	3	2	2	3	2	-	-	-	-	-	-	2	2	3
CO3	3	2	2	2	3	-	-	-	-	-	-	3	2	3
CO4	3	2	3	2	2	-	-	-	-	-	-	2	2	3
CO5	3	2	3	2	3	-	-	-	-	-	-	3	2	3

IT23552	GAME DEVELOPMENT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	identify the basics of 2D and 3D graphics for game development.
2.	know the stages of game development.
3.	understand the basics of a game engine.
4.	survey the gaming development environment and tool kits.
5.	learn and develop simple games using Pygame environment.

UNIT I	3D GRAPHICS FOR GAME DESIGN	9

Genres of Games, Basics of 2D and 3D Graphics for Game Avatar, Game Components – 2D and 3D Transformations – Projections – Color Models – Illumination and Shader Models – Animation – Controller Based Animation.

UNIT II	GAME DESIGN PRINCIPLES	9

Character Development, Storyboard Development for Gaming – Script Design – Script Narration, Game Balancing, Core Mechanics, Principles of Level Design – Proposals – Writing for Preproduction, Production and Post – Production.

UNIT III	GAME ENGINE DESIGN	9

Rendering Concept – Software Rendering – Hardware Rendering – Spatial Sorting Algorithms – Algorithms for Game Engine– Collision Detection – Game Logic – Game AI – Path finding.

UNIT IV	OVERVIEW OF GAMING PLATFORMS AND FRAMEWORKS	9

Pygame Game development – Unity – Unity Scripts –Mobile Gaming, Game Studio, Unity Single player and Multi-Player games.

UNIT V	GAME DEVELOPMENT USING PYGAME	9

Developing 2D and 3D interactive games using Pygame – Avatar Creation – 2D and 3D Graphics Programming – Incorporating music and sound – Asset Creations – Game Physics algorithms Development – Device Handling in Pygame – Overview of Isometric and Tile Based arcade Games – Puzzle Games.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the concepts of 2D and 3d Graphics	Understanding (K2)
CO2	explain the stages of game development	Analyzing (K4)
CO3	design game design documents	Applying (K3)
CO4	implementation of gaming engines	Applying (K3)
CO5	survey gaming environments and frameworks	Analyzing (K4)

TEXT BOOKS

1. Sanjay Madhav, —Game Programming Algorithms and Techniques: A Platform Agnostic Approach‖, Addison Wesley,2013.
2. David H. Eberly, —3D Game Engine Design: A Practical Approach to Real- Time Computer Graphics‖, Second Edition, CRC Press,2006.

REFERENCES

1. Will McGugan, —Beginning Game Development with Python and Pygame: From Novice to Professional‖, Apress,2007.
2. Paul Craven, Python Arcade game, Apress Publishers,2016.
3. Jung Hyun Han, 3D Graphics for Game Programming, Chapman and Hall/CRC, 2011.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3	3	3	-	-	-	-	-	-	2	3	3
CO2	3	3	3	2	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO4	3	2	3	2	3	-	-	-	-	-	-	2	2	2
CO5	3	3	3	2	3	-	-	-	-	-	-	2	3	3

IT23553	DIGITAL AND MOBILE FORENSICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamental concepts of digital forensics, including the investigation process, professional conduct, and workstation setup.
2.	learn the methods and techniques of data acquisition, including contingency planning and acquisition tools.
3.	know the procedures for processing digital crime and incident scenes, ensuring evidence is correctly identified, collected, and preserved.
4.	use the current tools and techniques used in digital forensics, including handling graphics files and understanding data compression.
5.	discuss the principles of digital forensic validation, including email and social media investigations, focusing on data integrity and validation techniques.

UNIT I	DIGITAL FORENSICS INVESTIGATIONS AND WORKSTATIONS MODELLING	9

An overview of Digital forensics- Preparing for Digital investigations- Maintaining Professional Conduct-Preparing a Digital Forensics Investigation-Procedures for Private Sector High Tech Investigations-Understanding Data Recovery Workstations and Software-Conducting an Investigation- Understanding Forensics Lab Accreditation Requirements-Determining the Physical Requirements for a Digital Forensics Lab-Selecting a Basic Forensic Workstation.

UNIT II	DATA ACQUISITION	9

Understanding Storage Formats for Digital Evidence-Determining the Best Acquisition Method-Contingency Planning for Image Acquisitions-Using Acquisition Tools-Validating Data Acquisitions-Performing RAID Data Acquisitions-Using Remote Network Acquisition Tools-Using Other Forensics Acquisition Tools.

UNIT III	PROCESSING CRIME AND INCIDENT SCENES	9

Identifying Digital Evidence – Collecting Evidence in Private Sector Incident Scenes –Processing Law Enforcement Crime Scenes – Preparing for a Search –Securing a Computer Incident or Crime Scene –Seizing Digital Evidence at the Scene –Storing Digital Evidence –Obtaining a Digital Hash –Reviewing a Case.

UNIT IV	CURRENT TOOLS AND GRAPHIC FILES	9

Evaluating Digital Forensics Tool Needs-Digital Forensics Software Tools-Digital Forensics Hardware Tools-Validating and Testing Forensics Software-Recognizing a Graphics File-Understanding Data Compression-Identifying Unknown File Formats.

UNIT V	DIGITAL FORENSIC VALIDATION AND E-MAIL INVESTIGATIONS	9

Determining What Data to Collect and Analyze-Validating Forensic Data-Addressing Data Hiding Techniques-Exploring the Role of E-mail in Investigations-Exploring the Roles of the Client and Server in E-mail-Investigating E-mail Crimes and Violations - Understanding E-mail Servers-Using Specialized E-mail Forensics Tools-Applying Digital Forensics Methods to Social Media Communications.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the principles of digital forensics and professional conduct during the investigation process	Understanding (K2)
CO2	discuss the most effective data acquisition methods, tools, and techniques for different types of digital evidence	Understanding (K2)
CO3	identify, collect, and preserve digital evidence in line with legal and forensic standards.	Applying (K3)
CO4	classify digital forensic tools, especially in relation to graphics files and data compression, to identify and examine digital evidence.	Applying (K3)
CO5	justify forensic data in email and social media investigations, applying appropriate tools and techniques	Analyzing(K4)

TEXT BOOKS

1. Nelson Bill, Phillips Amelia and Steuart Christopher, "Guide to Computer Forensics and Investigations", 6th Edition, Cengage Learning, 2018.
2. Nhien-An Le-Khac, Kim-Kwang Raymond Choo, "Cyber and Digital Forensic Investigations", Springer, 2020.

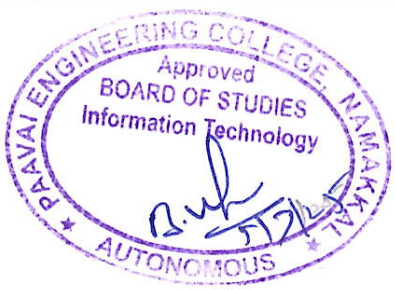
REFERENCES

1. Oettinger, W, "Learn Computer Forensics", Packt Publishing, 2020.
2. Marjie BritzMarjie Britz, "Computer Forensics and Cyber Crime: An Introduction", Pearson Education India; third edition, 2013.
3. Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations: Processing Digital Evidence", Fifth Edition, Cengage Learning, 2015.
4. Linda Volonino, Reynaldo Anzaldua, "Computer Forensics for Dummies", Wiley Publishing, Inc., 2008.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	3	2	2	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	2
CO3	3	3	2	3	2	-	-	-	-	-	-	2	3	3
CO4	3	2	2	2	3	-	-	-	-	-	-	2	2	3
CO5	2	3	2	3	2	-	-	-	-	-	-	3	3	3



IT23554	ROBOTIC PROCESS AUTOMATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the basic concepts of Robotic Process Automation.
2.	apply the key RPA design and development strategies and methodologies.
3.	apply learn the fundamental RPA logic and structure.
4.	analyze the Exception Handling, Debugging and Logging operations in RPA.
5.	analyse deploy and Maintain the software bot.

UNIT I	INTRODUCTION TO ROBOTIC PROCESS AUTOMATION	9

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.

UNIT II	AUTOMATION PROCESS ACTIVITIES	9

Types of Sequence, Flowchart and Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events.

UNIT III	APP INTEGRATION, RECORDING AND SCRAPING	9

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

UNIT IV	EXCEPTION HANDLING AND CODE MANAGEMENT	9

Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.

UNIT V	DEPLOYMENT AND MAINTENANCE	9

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA-Real-world Enterprise Automation.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the key distinctions between RPA and existing automation techniques and platforms.	Understanding (K2)
CO2	analyse to design control flows and work flows for the target process	Analyzing (K4)
CO3	apply recording, web scraping and process mining by automation	Applying (K3)

CO4	apply by using UIPath Studio to detect, and handle exceptions in automation processes	Applying (K3)
CO5	analyse to implement and use Orchestrator for creation, monitoring, scheduling, and controlling of automated bots and processes.	Analyzing (K4)

TEXT BOOKS

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018.
2. Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.

REFERENCES

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018
2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks and Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018
3. A Gerardus Blokdyk, "Robotic Process Automation Rpa A Complete Guide ", 2020

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	3	-	-	-	-	-	-	2	2	2
CO2	2	2	2	3	3	-	-	-	-	-	-	3	3	2
CO3	2	3	2	3	3	-	-	-	-	-	-	3	3	3
CO4	2	2	1	2	2	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	2

IT23555	NEXT GENERATION NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the evolution, architecture, and key characteristics of Next Generation Networks (NGNs).
2.	learn the fundamental transport, signaling, and multimedia protocols in NGNs.
3.	examine access technologies and network integration techniques for NGNs.
4.	analyze service provisioning, network management, QoS, and security in NGNs.
5.	explore emerging trends such as SDN, NFV, IoT, and real-world NGN deployments.

UNIT I	INTRODUCTION TO NEXT GENERATION NETWORKS	9

Evolution of Telecommunication Networks- Legacy systems (PSTN, ISDN), Need for convergence; Fundamentals of NGN- Key characteristics of NGN, NGN architecture (transport, service, control layers); NGN Standards and Regulatory Framework- ITU-T NGN framework, Role of ETSI, IETF, 3GPP; Convergence of Networks- Triple play: voice, data, video, Fixed-mobile convergence (FMC).

UNIT II	TRANSPORT TECHNOLOGIES AND PROTOCOLS	9

Packet-Switched Networks- IP transport: IPv4 and IPv6, MPLS fundamentals; Multimedia and Signaling Protocols- SIP, H.323, RTP/RTCP, MGCP and MEGACO for media gateways; IP Multimedia Subsystem (IMS)- IMS architecture and components, Role in NGN service delivery; Quality of Service (QoS)- IntServ and DiffServ models, QoS parameters and traffic shaping.

UNIT III	ACCESS NETWORKS AND INTEGRATION	9

Broadband Access Technologies- DSL (ADSL/VDSL), Cable, FTTx, Passive Optical Networks (PONs); Wireless and Mobile Access- Wi-Fi, WiMAX, 4G LTE and 5G overview; Integration of Access and Core Networks- Multi-service access nodes (MSANs), Access gateway functions; Mobility Management in NGN- Mobile IP, handover techniques, Seamless session continuity.

UNIT IV	NGN SERVICES, MANAGEMENT AND SECURITY	9

Service Creation and Provisioning- Service Delivery Platform (SDP), Application servers and middleware; Network and Service Management- Network management protocols (SNMP, TMN), Fault, Configuration, Accounting, Performance, Security (FCAPS); Security in NGN- Security threats in NGNs, Encryption, firewalls, and AAA (Authentication, Authorization, Accounting).

UNIT V	EMERGING TRENDS AND CASE STUDIES IN NGN	9

Software-Defined Networking (SDN)- SDN architecture and controllers, Benefits for NGN; Network Function Virtualization (NFV)- NFV concepts and architecture, Virtual network functions (VNFs); Case Studies and Real-World Applications- NGN deployments in telecoms (e.g., ATandT, BT), Regulatory and economic considerations.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the evolution and architecture of NGNs.	Understanding (K2)
CO2	describe transport, signaling, and multimedia protocols in NGNs.	Applying (K3)
CO3	analyze broadband, wireless, and integrated access technologies.	Analyzing (K4)
CO4	evaluate NGN service platforms, QoS, security, and management.	Applying (K3)
CO5	interpret emerging technologies and their impact on NGNs.	Analyzing (K4)

TEXT BOOKS

1. Neill Wilkinson, Next Generation Network Services, Technologies and Strategies, WileyOlivier Hersent, Next Generation Networks Next Generation Telecommunications Network, Parliament office of Science and Technology (Post note). Dec 2007

REFERENCES

1. Mobile Next Generation Networks Huber, JF IEEE Multimedia Vol. 11, Issue I Jan- March 2004.
2. Next Generation Network (NGN) Service, J.C. Crimi, A Telecoolia Technologies

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	3	3	-	-	-	-	-	-	1	2	3
CO2	3	3	2	2	3	-	-	-	-	-	-	2	2	3
CO3	3	3	2	2	2	-	-	-	-	-	-	3	3	3
CO4	2	3	2	3	2	-	-	-	-	-	-	2	3	3
CO5	2	2	3	2	3	-	-	-	-	-	-	3	2	2

IT23556	MODERN COMPILER DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the Structure and Function of a Compiler
2.	learn the Techniques for Lexical and Syntax Analysis
3.	explore Semantic Analysis and Intermediate Code Generation
4.	develop Skills in Code Optimization and Generation
5.	understand the Role of Runtime Systems and Advanced Compiler Features

UNIT I **INTRODUCTION TO COMPILERS AND LEXICAL ANALYSIS** **9**

Overview of Compiler Design- Compilation vs. Interpretation, Phases of a Compiler ;Lexical Analysis- Role of Lexical Analyzer, Tokens, Patterns, and Lexemes, Regular Expressions, Finite Automata: NFA and DFA, Conversion from Regular Expression to Automata, LEX tool.

UNIT II **SYNTAX ANALYSIS (PARSING)** **9**

Context-Free Grammars (CFG)- Derivations, Parse Trees, Ambiguity and Grammar Simplification; Top-Down Parsing- Recursive Descent, Predictive Parsing , FIRST and FOLLOW sets; Bottom-Up Parsing- Shift-Reduce Parsing, LR Parsing: SLR, LALR; Error Recovery in Parsing.

UNIT III **SEMANTIC ANALYSIS AND INTERMEDIATE CODE GENERATION** **9**

Syntax-Directed Translation- Syntax-Directed Definitions, Attribute Grammars; Symbol Tables- Scopes and Bindings, Implementation Techniques; Type Checking- Type Systems, Type Compatibility and Conversion; Intermediate Representations- Abstract Syntax Trees (AST), Three-Address Code (TAC), Translation of Expressions and Control Statements.

UNIT IV **CODE OPTIMIZATION AND CODE GENERATION** **9**

Introduction to Code Optimization- Basic Blocks and Control Flow Graphs, Dominators and Loops; Optimization Techniques- Constant Folding, Dead Code Elimination, Loop Invariant , Code Motion, Peephole Optimization; Code Generation- Target Code Generation Strategies, Instruction Selection, Register Allocation , Simple Code Generator Algorithm.

UNIT V **RUNTIME ENVIRONMENT AND ADVANCED TOPICS** **9**

Runtime Environment- Memory Layout: Stack, Heap, Dynamic; Activation Records and Calling Conventions; Storage Management- Manual and Automatic (Garbage Collection); Exception Handling; Object-Oriented Language Support- Method Dispatch, Inheritance, Virtual Tables; Just-in-Time Compilation (JIT); Introduction to Modern Tools (LLVM, JVM internals).

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	understand the phases, working of a compiler and differentiate it from interpreters and regular expressions to design a lexer.	Understanding (K2)

CO2	construct syntax analysers using parsing techniques like LL, LR, SLR, and LALR parsers.	Applying (K3)
CO3	perform semantic analysis and generate intermediate code using syntax-directed translation.	Applying (K3)
CO4	apply optimization techniques and generate target code for a hypothetical or real machine.	Applying (K3)
CO5	analyse runtime environments and implement features such as memory management and object-oriented support.	Analyzing (K4)

TEXT BOOKS

1. Alfred V Aho, Monica S. Lam, Ravi Sethi and Jeffrey D Ullman, "Compilers - Principles, Teclmiques and Tools", 2nd Edition, Pearson Education, 2007.
2. Modern Compiler Design by David Galles, Pearson Education, 2007

REFERENCES

1. Compilers: Principles, Techniques, and Tools (The Dragon Book) by Aho, Sethi, and Ullman Engineering a Compiler by Keith D. Cooper and Linda Torczon
2. Advanced Compiler Design and Implementation by Steven S. Muchnick
3. Steven S. Muchnick, "Advanced Compiler Design and Implementation, "Mor~an Kaufmann Publishers-Elsevier Science, India, Indian Reprint 2003.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	2	2	-	-	-	-	-	-	2	2	3
CO2	3	3	2	2	2	-	-	-	-	-	-	3	2	3
CO3	3	3	2	2	2	-	-	-	-	-	-	2	2	3
CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO5	3	3	3	2	3	-	-	-	-	-	-	2	2	3

IT23557	QUANTUM COMPUTING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	provide a comprehensive foundation for understanding quantum computation from traditional computing and quantum mechanics.
2.	develop a fundamental understanding of the principles and models underlying quantum computation.
3.	explore key protocols and algorithms that demonstrate the power and uniqueness of quantum information processing.
4.	unifying framework that generalizes order finding and underpins several quantum algorithms.
5.	understanding the theoretical limits and robustness of quantum computation by covering key concepts in computational complexity, black-box models, and error correction.

UNIT I	INTRODUCTION AND DIREC NOTATION	9

Introduction - Overview of Traditional computing, Strong Church-Turing thesis, The Circuit Model of Computation, A Linear Algebra Formulation of the Circuit Model, Reversible computation, Quantum physics and computation; The Dirac Notation and Hilbert Spaces, Dual vectors, Operators, The spectral theorem, Functions of operators, Tensor products, The Schmidt Decomposition theorem.

UNIT II	QUBITS AND QUANTUM MODEL OF COMPUTATION	9

Qubits - The State of a quantum system, Time - Evolution of a closed system, Composite systems, Measurement, Mixed States and General Quantum Operations; A Quantum Model of Computation - The Quantum Circuit Model, Quantum Gates,Universal Sets of Quantum Gates, Unitary Transformations,Implementing Measurements with Quantum Circuits.

UNIT III	SUPERDENSE CODING AND QUANTUM ALGORITHMS	9

Superdense Coding, Quantum Teleportation, An Applications of Quantum Teleportation; Quantum Algorithms - Probabilistic Versus Quantum Algorithms, Phase kick-back, The Deutsch algorithm, The Deutsch- Jozsa algorithm, Simon's algorithm;Algorithms with Super polynomial Speed-up - Quantum phase estimation and The Quantum Fourier Transform, Eigenvalue Estimation.

UNIT IV	ORDER FINDING ALGORITHM	9

Finding Orders - Order-finding problem, The Eigenvalue estimation approach to order finding, Shor's Approach to order finding, Finding discrete logarithms, Hidden subgroups; Amplitude Amplification - Grover's Quantum Search Algorithm, Amplitude amplification, Quantum amplitude estimation and Quantum counting, Searching without knowing the success probability.

UNIT V	QUANTUM COMPUTATIONAL COMPLEXITY AND ERROR CORRECTION	9

Computational complexity, The Black-box model, Lower bounds for searching, General black-box lower bounds, Polynomial method, Block sensitivity, Adversary methods; Quantum Error Correction - Classical error correction, The Classical Three-bit code, Fault tolerance, Quantum error correction, Three- and nine-qubit quantum codes, Fault-tolerant quantum computation.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the foundational principles of quantum mechanics relevant to quantum computing.	Understanding (K2)
CO2	analyze quantum computational models including qubits, quantum gates, and circuits.	Analyzing (K4)
CO3	apply quantum algorithms such as Deutsch-Jozsa, Simon' s, Grover' s, and Shor' s algorithms.	Applying (K3)
CO4	evaluate the performance and complexity of quantum algorithms compared to classical counterparts.	Applying (K3)
CO5	demonstrate the ability to model, simulate, and reason about quantum systems using Dirac notation and linear algebra.	Analyzing (K4)

TEXT BOOKS

1. P. Kaye, R. Laflamme, and M. Mosca, "An introduction to Quantum Computing", Oxford University Press, 2007.
2. Chris Bernhardt, Quantum Computing for Everyone, The MIT Press,Cambridge, 2020.

REFERENCES

1. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing Company, 2007.
2. Jack D. Hidary, Quantum Computing: An Applied Approach, Firstedition, Springer International Publishing, 2019.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	2	3
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	3
CO4	3	3	2	3	2	-	-	-	-	-	-	2	3	3
CO5	3	2	2	2	3	-	-	-	-	-	-	2	2	2

IT23651	OPTIMIZATION TECHNIQUES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	acquire knowledge about optimization techniques and their importance.
2.	formulate maximization and minimization in linear programming.
3.	solve the design constraints that involve non-linear programming.
4.	apply the modern optimization techniques involving evolutionary algorithms.
5.	demonstrate appropriate optimization methods and solve real-world problems.

UNIT I	INTRODUCTION TO OPTIMIZATION TECHNIQUES	9

Introduction - Engineering Applications of Optimization - Classification of Optimization Problems - Single Variable Optimization - Multivariable Optimization with No Constraints - Multi-Variable Optimization with Equality and Inequality Constraints - Langrange Multipliers Method, Kuhn-Tucker Conditions.

UNIT II	LINEAR PROGRAMMING	9

Introduction Properties of Linear Programming - Basic Assumptions - Mathematical Formulation of Linear Programming - Limitations or Constraints - Methods for The Solution of Lp Problem - Graphical Analysis of Lp - Graphical Lp Maximization Problem - Graphical Lp Minimization Problem, Simplex Method - Basics Of Simplex Method - Formulating The Simplex Method-Simplex Method With Two Variables.

UNIT III	NON-LINEAR PROGRAMMING	9

Introduction Direct Search Methods - Univariate Method - Pattern Directions- Unimodal Function - Region Elimination Methods - Unrestricted Search- Exhaustive Search - Dichotomous Search - Fibonacci Method - Golden Section Method.

UNIT IV	BIO-INSPIRED OPTIMIZATION AND FUZZY SYSTEMS	9

Introduction - Particle Swarm Optimization - Ant Colony Optimization - Firefly Algorithm - Cuckoo Search Optimization- Genetic Algorithms - Working Principle, Genetic Operators - Simulated Annealing - Optimization of Fuzzy Systems.

UNIT V	PRACTICAL ASPECTS OF OPTIMIZATION	9

Parallel Processing - Multi-Objective Optimization - Lexicographic Method - Goal Programming Method - Introduction to Game Theory

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	comprehend the need, characteristics and applications of the Optimization Methods.	Understanding (K2)
CO2	understanding the concepts of Linear programming and its methods.	Applying (K3)
CO3	recognize and solve the nonlinear Optimization Methods.	Applying (K3)
CO4	explore the various Bio-Inspired and fuzzy-based Optimization Methods.	Applying (K3)

CO5	learn the practical aspects of Optimization.	Analyzing (K4)

TEXT BOOKS

1. Singiresu S. Rao, "Engineering Optimization - Theory and Practice", 2022, 4thEdition, John Wiley and Sons, Inc
2. Sukanta Nayak , Fundamentals of Optimization Techniques with algorithms,2020 , Academic Press.

REFERENCES

1. Michel Bierlaire , Optimization: Principles and Algorithms , 2018, Second Edition, EPFL Press Sherali, H.D., Shetty, C.M., "Optimization with Disjunctive Constraints",2016, Springer.
2. Shubham Agarwal, "Computer Based Optimization Techniques", Alpha Science International Ltd, 2015.
3. Godfrey C. Onwubolu. B.V. Babu, "New Optimization techniques in Engineering", 2004

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	2	-	-	-	-	-	-	2	2	3
CO2	3	2	3	2	2	-	-	-	-	-	-	2	3	2
CO3	3	2	3	2	2	-	-	-	-	-	-	2	3	3
CO4	3	2	3	2	3	-	-	-	-	-	-	2	2	2
CO5	3	2	2	3	3	-	-	-	-	-	-	3	2	2

IT23652	GAME THEORY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the introductory concept of mathematics in game theory with example
2.	learn about the perfection in game strategy equilibrium and its areas neatly
3.	apply the non cooperative game theory in give contrast over the strategy.
4.	apply strategy to to know about the behavioural aspects of games.
5.	acquire thorough knowledge over the game strategy and change overs

UNIT I **INTRODUCTION** **9**

Introduction – Making rational choices: basics of Games – strategy – preferences – payoffs – Mathematical basics –Game theory –Rational Choice – Basic solution concepts-non-cooperative versus cooperative games – Basic computational issues – finding equilibria and learning in games- Typical application areas for game theory (e.g. Google's sponsored search, eBay auctions, electricity trading markets).

UNIT II **GAMES WITH PERFECT INFORMATION** **9**

Games with Perfect Information – Strategic games – prisoner's dilemma, matching pennies- Nash equilibria-theory and illustrations – Cournot and Bertrand models of oligopoly- auctions- mixed strategy equilibrium-zero-sum games- Extensive Games with Perfect Information-repeated games (prisoner's dilemma)- subgame perfect Nash equilibrium; computational issues.

UNIT III **GAMES WITH IMPERFECT INFORMATION** **9**

Games with Imperfect Information – Bayesian Games – Motivational Examples – General Definitions – Information aspects – Illustrations – Extensive Games with Imperfect –Information – Strategies- Nash Equilibrium – Beliefs and sequential equilibrium – Illustrations – Repeated Games – The Prisoner`s Dilemma – Bargaining

UNIT IV **NON-COOPERATIVE GAME THEORY** **9**

Non-cooperative Game Theory – Self-interested agents- Games in normal form – Analyzing games: from optimality to equilibrium – Computing Solution Concepts of Normal-Form Games – Computing Nash equilibria of two-player, zero-sum games –Computing Nash equilibria of two- player, general- sum games – Identifying dominated strategies.

UNIT V **MECHANISM DESIGN** **9**

Aggregating Preferences-Social Choice – Formal Model- Voting – Existence of social functions – Ranking systems – Protocols for Strategic Agents: Mechanism Design – Mechanism design with unrestricted preferences- Efficient mechanisms – Vickrey and VCG mechanisms (shortest paths) – Combinatorial auctions – profit maximization Computational applications of mechanism design – applications in Computer Science – Google's sponsored search – eBay auctions – K-armed bandits..

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the various skills to assess the games	Understanding (K2)
CO2	analyze the game strategy in perfect sense to develop it	Analyzing (K4)
CO3	apply all the imperfection in games to make it perfect	Applying (K3)
CO4	apply the perfection to know the non cooperative designs	Applying (K3)
CO5	analyze the mechanism of the final strategy of the game	Analyzing (K4)

TEXT BOOKS

1. Thomas S Ferguson - A Course in Game Theory-World Scientific Publishing Company (2020)
2. M. Machler, E. Solan, S. Zamir, Game Theory, Cambridge University Press, 2013.

REFERENCES

1. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani, Algorithmic Game Theory. Cambridge University Press, 2007.
2. A.Dixit and S. Skeath, Games of Strategy, Second Edition. W W Norton and Co Inc, 2004.
3. YoavShoham, Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press 2008.
4. Zhu Han, DusitNiyato, WalidSaad, TamerBasar and Are Hjorungnes, "Game Theory in Wireless and Communication Networks", Cambridge University Press, 2012.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	3	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	2	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	2	2	-	-	-	-	-	-	3	3	3

IT23653	AGENTIC AI AND PROMPT ENGINEERING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of agentic AI, including agency, autonomy, and types of intelligent agents.
2.	explore the basics of prompt engineering for large language models and generative AI systems.
3.	apply advanced prompting techniques like chain-of-thought and meta prompting to solve complex tasks.
4.	familiarize with modern frameworks and tools to build agentic AI systems integrating memory and tool use.
5.	analyze the ethical, safety, and societal implications of deploying agentic AI systems in real-world domains.

UNIT I	FOUNDATIONS OF AGENTIC AI	9

Introduction to AI agents: reactive vs deliberative vs hybrid agents - Concept of agency and autonomy in AI systems - Goal-based, utility-based and learning agents - Applications: conversational agents, autonomous systems, digital assistants - Introduction to agent environments (fully vs partially observable, deterministic vs stochastic).

UNIT II	BASICS OF PROMPT ENGINEERING	9

Prompt Engineering - Types of prompting: zero-shot, one-shot, few-shot - Designing effective prompts: instructions, context, examples - Prompt evaluation metrics (fluency, relevance, faithfulness) - Introduction to LLMs (ChatGPT, LLaMA, Claude, etc.) and their prompt APIs.

UNIT III	ADVANCED TECHNIQUES IN PROMPT ENGINEERING	9

Chain-of-Thought prompting - Self-consistency and reasoning improvements - Role prompting and meta prompting - Prompt chaining for complex workflows - Common prompt failures (hallucinations, biases) and mitigation.

UNIT IV	ARCHITECTURES AND TOOLS FOR AGENTIC SYSTEMS	9

Frameworks for agentic AI: LangChain, Semantic Kernel, LlamaIndex - ReAct pattern: reasoning + acting - Tool use: integrating calculators, retrievers, web browsing - Memory in agents: short-term vs long-term memory, vector databases - Case studies: autonomous research agents, multi-modal agents.

UNIT V	SAFETY, ETHICS AND APPLICATIONS	9

Prompt injection attacks and security issues - Safety alignment, controllability and reliability in agentic systems - Societal impacts: misinformation, privacy, job displacement - Ethical guidelines for building AI systems - Future trends: personal AIs, collaborative agents.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the principles of agentic AI, differentiating types of agents and their environments.	Understanding (K2)

CO2	formulate effective prompts for LLMs using zero-shot, few-shot, and chain-of-thought techniques.	Applying (K3)
CO3	design prompt workflows and apply advanced strategies like role/meta prompting and prompt chaining.	Applying (K3)
CO4	develop simple agentic systems integrating external tools and memory using frameworks like LangChain.	Analyzing (K3)
CO5	assess the ethical, security, and societal challenges associated with agentic AI systems.	Applying (K3)

TEXT BOOKS

1. Russell, S. and Norvig, P., Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2021
2. Sander Schulhoff, Prompt Engineering for Generative AI, Independently Published, 2023.

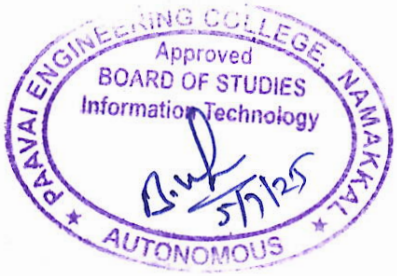
REFERENCES

1. Yoav Shoham and Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press, 2009.
2. Sandra Kublik and Rafal Kocielnik, GPT-3: Building Innovative NLP Products Using Large Language Models, O'Reilly Media, 2021.
3. LangChain Documentation, Available at: https://python.langchain.com/
4. OpenAI Cookbook and API Guides, Available at: https://github.com/openai/openai-cookbook

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	2	1	-	-	-	-	-	-	2	3	2
CO2	3	2	3	2	3	-	-	-	-	-	-	2	3	3
CO3	2	2	3	2	3	-	-	-	-	-	-	2	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	2	2	2
CO5	2	2	2	2	2	-	-	-	-	-	-	3	2	3



IT23654	COGNITIVE SCIENCE	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the foundational concepts of cognitive computing and its interdisciplinary basis.
2.	explore computational intelligence models including AI and neural networks.
3.	learn to use probabilistic programming for modeling and inference.
4.	understand inference and learning models used in cognition.
5.	study applications of cognitive science in real-world domains.

UNIT I	INTRODUCTION TO COGNITIVE COMPUTING, PHILOSOPHY, PSYCHOLOGY , NEUROSCIENCE	9

Philosophy - Mental-physical Relation , From Materialism to Mental Science , Logic and the Sciences of the Mind ; Psychology - Place of Psychology within Cognitive Science , Science of Information Processing; Cognitive Neuroscience – Perception , Decision , Learning and Memory ; Language Understanding and Processing; Cognitive Computing –Concepts,Architectures,Systems and Applications.

UNIT II	COMPUTATIONAL INTELLIGENCE	9

Machines and Cognition - Artificial Intelligence ; Architectures of Cognition ; Knowledge Based Systems – Expert systems and rule-based reasoning; Logical Representation and Reasoning , Logical Decision Making ; Learning – Supervised, unsupervised, and reinforcement learning; Neural Networks and Deep Learning- Cognitive parallels in pattern recognition and abstraction; Language , Visual cognition and computer vision

UNIT III	PROBABILISTIC PROGRAMMING LANGUAGE	9

WebPPL Language – Syntax ,Using Javascript Libraries , Manipulating probability types and distributions ,Finding Inference,Exploring random computation; Coroutines - Functions that receive continuations Enumeration ; Bayesian Inference and Modeling ; Probabilistic Graphical Models ; Model Debugging and Visualization.

UNIT IV	INFERENCE MODELS AND LEARNING MODELS OF COGNITION	9

Generative Models – Conditioning,Causal and statistical dependence,Conditional dependence ; Data Analysis – Algorithms for Inference ; Learning as Conditional Inference – Learning with a Language of Thought , Hierarchical Models, Learning (Deep) Continuous Functions , Mixture Models..

UNIT V	APPLICATIONS	9

Cognitive Science Applications in Healthcare and AI;Cognitive Science in AutonomousVehicles ;Cognitive Science in User Experience (UX) Design;Cognitive Science in Education; Cognitive Ergonomics.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the relationship between philosophy, psychology, neuroscience, and cognitive computing.	Understanding (K2)
CO2	demonstrate knowledge of architectures and learning in cognitive systems.	Analyzing (K4)

CO3	apply probabilistic models and Bayesian inference techniques effectively.	Applying (K3)
CO4	implement and analyze generative and hierarchical cognitive models.	Analyzing (K4)
CO5	identify cognitive science's role in healthcare, AI, UX, and education.	Analyzing (K4)

TEXT BOOKS

1. Vijay V Raghavan,Venkat N.Gudivada, VenuGovindaraju, C.R. Rao, Cognitive Computing: Theory and Applications: (Handbook of Statistics 35), Elsevier publications, 2016
2. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley Publications, 2015

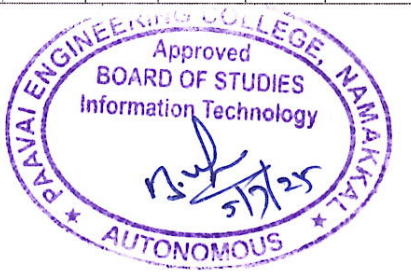
REFERENCES

1. Noah D. Goodman, Andreas Stuhlmuller, "The Design and Implementation of Probabilistic Programming Languages", Electronic version of book, https://dippl.org/.
2. Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, "Probabilistic Models of Cognition", Second Edition, 2016, https://probmods.org/.
3. Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences",The MIT Press, 1999.
4. Jose Luis Bermúdez, Cognitive Science -An Introduction to the Science of the Mind, Cambridge University Press 2020

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	1	1	1	-	-	-	-	-	-	2	2	1
CO2	3	4	2	2	3	-	-	-	-	-	-	2	3	2
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3
CO5	2	2	2	2	2	-	-	-	-	-	-	2	2	2



IT23655	NATURAL LANGUAGE PROCESSING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce the fundamentals of Natural Language Processing and linguistic structures.
2.	explain morphological, syntactic, and semantic analysis techniques.
3.	develop understanding of statistical models and algorithms in NLP.
4.	explore the design of language generation systems and machine translation.
5.	familiarize students with applications of NLP such as discourse analysis and conversational agents.

UNIT I	OVERVIEW AND MORPHOLOGY	9

Introduction – Models -and Algorithms - -Regular Expressions Basic Regular Expression Patterns – Finite State Automata Understand the wireless sensor network principles. Morphology -Inflectional Morphology - Derivational Morphology. Finite-State Morphological Parsing -- Porter Stemmer.

UNIT II	WORD LEVEL AND SYNTACTIC ANALYSIS	9

N-grams Models of Syntax - Counting Words - Unsmoothed N-grams .Smoothing- Back-off Deleted Interpolation– Entropy - English Word Classes - Tag sets for English Part of Speech Tagging-Rule Based Part of Speech Tagging - Stochastic Part of Speech Tagging - Transformation-Based Tagging.

UNIT III	CONTEXT FREE GRAMMARS	9

Context Free Grammars for English Syntax- Context-Free Rules and Trees -Understand the network simulation tools. Sentence- Level Constructions–Agreement – Sub Categorization .Parsing – Top-down – Early Parsing -feature Structures – Probabilistic Context-Free Grammars.

UNIT IV	SEMANTIC ANALYSIS	9

Representing Meaning-Meaning Structure of Language-First Order Predicate Calculus Representing Linguistically Relevant Concepts -Syntax-Driven Semantic Analysis - Semantic Attachments -Syntax-Driven Analyzer. Robust Analysis - Lexemes and Their Senses – Internal Structure - Word Sense Disambiguation - Information Retrieval

UNIT V	LANGUAGE GENERATION AND DISCOURSE ANALYSIS	9

Discourse -Reference Resolution - Text Coherence -Discourse Structure – Coherence. Dialog and Conversational Agents - Dialog Acts – Interpretation -Conversational Agents. Language Generation– Architecture-Surface Realizations - Discourse Planning .Machine Translation -Transfer Metaphor– Interlingua – Statistical Approaches.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	learn knowledge in automated Natural Language Generation and Machine Translation.	Understanding (K2)

CO2	provide the student with knowledge of various levels of analysis involved in NLP.	Understanding (K2)
CO3	understand the applications of NLP	Understanding (K2)
CO4	analyze the semantic analysis of natural language	Analyzing (K3)
CO5	understand language generation and discourse analysis	Understanding (K2)

TEXT BOOKS

1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing,Computational Linguistics and Speech Recognition". Prentice Hall, 3rd Edition, 2025
2. Manning and H. Schutze,"Foundations of Statistical Natural Language Processing". MIT Press, Cambridge, MA:,1999

REFERENCES

1. Bharati A., Sangal R., ChaitanyaV.. Natural language processing: a Paninian perspective, PHI, 2000
2. Siddiqui T., Tiwary U. S. Natural language processing and Information retrieval, OUP 2008

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	2	1	2	-	-	-	-	-	-	2	2	3
CO2	3	3	1	2	3	-	-	-	-	-	-	2	3	3
CO3	2	3	3	2	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	3
CO5	3	2	3	3	3	-	-	-	-	-	-	3	3	3

IT23656	KNOWLEDGE ENGINEERING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the basics of Knowledge Engineering
2.	discuss methodologies and modeling for Agent Design and Development
3.	design and develop ontologies
4.	apply reasoning with ontologies and rules
5.	understand learning and rule learning

UNIT I	REASONING UNDER UNCERTAINTY	9

Introduction to reasoning - Abductive reasoning - Probabilistic reasoning: Enumerative probabilities - Subjective Bayesian view - Belief functions - Baconian probability - Fuzzy probability - Uncertainty methods - Evidence-based reasoning - Intelligent agent - Mixed-initiative reasoning - Knowledge engineering Knowledge graphs.

UNIT II	METHODOLOGY AND MODELING	9

Conventional design and development - Development tools and reusable ontologies - Agent design and development using learning technology Problem solving through analysis and synthesis Inquiry-driven analysis and synthesis Evidence-based assessment - Believability assessment -Drill-down analysis, Assumption-based reasoning, and What-if scenarios.

UNIT III	ONTOLOGIES - DESIGN AND DEVELOPMENT	9

Concepts and instances Generalization hierarchies Object features Defining features Representation Transitivity Inheritance Concepts as feature values Ontology matching Design and development methodologies Steps in ontology development - Domain understanding and concept elicitation-Modelling-based ontology specification.

UNIT IV	REASONING WITH ONTOLOGIES AND RULES	9

Production system architecture Complex ontology Based concepts - Reduction and synthesis rules and the inference engine - Evidence-based hypothesis analysis - Rule and ontology matching - Partially learned knowledge - Reasoning with partially learned knowledge.

UNIT V	LEARNING AND RULE LEARNING	9

Machine learning concepts Generalization and specialization rules, Types Formal definition of generalization Modelling, leaming and problem-solving Rule learning and refinement Rule generation and analysis - Hypothesis leaming.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the basics of knowledge engineering.	Understanding (K2)
CO2	apply methodologies and modelling for agent design and development.	Analyzing (K4)

CO3	design and develop ontologies.	Applying (K3)
CO4	apply reasoning with ontologies and rules.	Applying (K3)
CO5	differentiate the learning and rule learning in knowledge engineering.	Analyzing (K4)

TEXT BOOKS

1. Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum," Knowledge Engineering Building Cognitive Assistants for Evidence-based Reasoning", 1st Edition, Cambridge University Press, 2016.
2. Ela Kumar," Knowledge Engineering", 1st Edition, I K International Publisher House, 2018.

REFERENCES

1. Ronald J. Brachman, Hector J. Levesque, "Knowledge Representation and Reasoning", 1st Edition, Morgan Kaufmann, 2004
2. John F. Sowa, "Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole", 1st Edition, Thomson Learning, 2000
3. King, "Knowledge Management and Organizational Learning", 1st Edition Springer, 2009
4. Jay Liebowitz, Knowledge Management Learning from Knowledge Engineering," 1st Edition, 2001.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	1	2	2	-	-	-	-	-	-	2	2	3
CO2	3	2	3	2	2	-	-	-	-	-	-	3	2	3
CO3	3	2	3	2	2	-	-	-	-	-	-	3	3	3
CO4	3	2	3	2	2	-	-	-	-	-	-	2	3	2
CO5	3	2	2	3	2	-	-	-	-	-	-	2	2	2

IT23657	TEXT AND SPEECH ANALYTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	introduce the basic structure, semantics, and usage of natural language and the fundamentals of NLP and text analytics.
2.	process and analyze text using tokenization, normalization, stemming, lemmatization, tagging, and parsing techniques.
3.	understand and apply text classification techniques using normalization, feature extraction, and machine learning algorithms.
4.	explore and implement techniques for summarizing text, extracting key phrases, and analyzing textual similarity.
5.	provide practical knowledge on speech recognition and processing using Python for speech-to-text applications.

UNIT I	INTRODUCTION TO NLP	9

Introduction- Natural Language - Language Acquisition and usage - Language Syntax and Structure - Language Semantics - Lexical Semantic Relations - Semantics Representation - Text Corpora - Accessing Text Corpora - Natural Language Processing – Text Analytics.

UNIT II	TEXT PROCESSING	9

Processing and Understanding Text - Text Tokenization - Text Normalization- Correcting Words – Stemming – Lemmatization - Text Syntax and Structure - POS Tagging - Shallow Parsing – Dependency-based Parsing - Constituency based Phrasing.

UNIT III	TEXT CLASSIFICATION	9

Introduction – Automated Text classification - Text classification Blue Print- Text Normalization – Feature Extraction -Classification Algorithm - Application and uses

UNIT IV	TEXT SUMMARIZATION	9

Text Summarization -Key Phrase Extraction - Topic Modeling - Automated Document Summarization - Text Similarity and Clustering - Analyzing Term Similarity - Analyzing Document Similarity.

UNIT V	SPEECH ANALYTICS	9

Introduction-Python Speech Recognition Package - Installing Speech Recognition - The Recognizer Class-Working with Audio Files - Working with Microphones.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explore various text extraction techniques.	Understanding (K2)
CO2	apply various text processing techniques.	Applying (K3)
CO3	build text classification model .	Analyzing (K4)

CO4	perform automatic text summarization.	Analyzing (K4)
CO5	discuss about speech processing techniques.	Applying (K3)

TEXT BOOKS

1. Dipanjan Sarkar,"Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data", 1st Edition, APress publication, 2016 (UNIT-I,II,III and IV)
2. Michael W. Berry and Jacob Kogan,"Text Mining Applications and Theory", Wiley publications, 2010(UNIT-V)

REFERENCES

1. Jurafsky and Martin, "Speech and Language Processing", 2nd Edition, Pearson Prentice Hall, 2008
2. https://realpython.com/python-speech-recognition/#supported-file-types.

CO PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	1	2	2	-	-	-	-	-	-	2	2	3
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	3	2	3
CO4	3	2	3	2	2	-	-	-	-	-	-	2	2	3
CO5	3	2	2	3	2	-	-	-	-	-	-	3	2	3