JANSONS INSTITUTE OF TECHNOLOGY

(Autonomous)

Accredited by NAAC 'A Grade' and ISO 9001: 2015 Certified Institution

Approved by AICTE and Affiliated to Anna University

Coimbatore – 641 659, Tamil Nadu, India.

M.E. Computer Science and Engineering (AI & ML)

Curriculum and Syllabi

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Coimbatore – 641 659, Tamil Nadu, India.

Regulations 2024
Choice Based Credit System

M.E. Computer Science and Engineering
(with specialization In Artificial Intelligence and Machine Learning)
Curriculum and Syllabi for Semesters I and II

Semester - I

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Course								
1	P24ML1101	Applied Mathematics for Computer Science Engineers	FC	3	1	0	4	4
2	P24CD4101	Research Methodology and IPR	RM	2	0	0	2	2
3	P24ML2101	Advanced Data Structures and Algorithms	PC	3	0	0	3	3
4	P24ML2102	Principles of Programming Languages	PC	3	0	0	3	3
5	P24ML2103	Artificial Intelligence	PC	3	0	0	3	3
6		Audit Course - I*	AC	2	0	0	2	0
Theory cum Laboratory Course								
7	P24ML2104	Database Practices	PC	3	0	2	5	4
Practical Courses								
8	P24ML2105	Advanced Data Structures and Algorithms Laboratory	PC	0	0	4	4	2
			Total	**19**	**1**	**6**	**26**	**21**

***Audit course is optional**

Semester – II

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Course								
1	P24ML2201	Big Data Mining and Analytics	PC	3	0	0	3	3
2		Professional Elective I	PE	3	0	0	3	3
3		Professional Elective II	PE	3	0	0	3	3
4		Audit Course - II*	AC	2	0	0	2	0
Theory cum Laboratory Courses								
5	P24ML2202	Internet of Things	PC	3	0	2	5	4
6	P24ML2203	Machine Learning	PC	3	0	2	5	4
7	P24ML2204	Natural Language Processing	PC	2	0	2	4	3
Practical Courses								
8	P24ML2205	Data Analytics Laboratory	PC	0	0	2	2	1
9	P24ML5201	Term Paper Writing and Seminar	EE	0	0	2	2	1
			Total	**19**	**0**	**10**	**29**	**22**

***Audit course is optional**

PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE I

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Course								
1	P24ML3201	Social Network Analysis	PE	3	0	0	3	3
2	P24ML3202	Predictive Modeling	PE	3	0	0	3	3
3	P24ML3203	Smart Convergent Technologies	PE	3	0	0	3	3
4	P24ML3204	Probabilistic Graphical Models	PE	3	0	0	3	3
5	P24ML3205	Quantum Computing	PE	3	0	0	3	3

PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE II

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Course								
1	P24ML3206	Multimedia Communication Networks	PE	3	0	0	3	3
2	P24ML3207	Information Retrieval Techniques	PE	3	0	0	3	3
3	P24ML3208	Image Processing	PE	3	0	0	3	3
4	P24ML3209	Autonomous Systems	PE	3	0	0	3	3
5	P24ML3210	Web Analytics	PE	3	0	0	3	3
6	P24ML3211	Cognitive Computing	PE	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

Sl. No.	Course Code	Course Title	Category	Periods per Week	Co	Cred

				L	T	P		
Theory Course								
1	P24AC7001	English for Research Paper Writing	AC	2	0	0	2	0
2	P24AC7002	Disaster Management	AC	2	0	0	2	0
3	P24AC7003	Constitution of India	AC	2	0	0	2	0
4	P24AC7004	நற்றமிழ் இலக்கியம்	AC	2	0	0	2	0

P24ML1101	APPLIED MATHEMATICS FOR COMPUTER SCIENCE ENGINEERS	L	T	P	C
		3	1	0	4

Course Objectives:	Encourage mastery of linear algebra and matrices. Foster comprehension of probability, random variables, 2D random variables, central limit theorem, hypothesis testing, multivariate normal distribution, and principal components analysis.

Unit - I	LINEAR ALGEBRA AND MATRIX OPERATIONS	12

Vector spaces – Subspaces – Norms – Inner Products Space – Gram Schmidth orthogonalization process – Eigenvalues and Eigen vectors – Diagonalization – QR factorization – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

Unit - II	PROBABILITY AND RANDOM VARIABLES	12

Probability – Axioms of probability – Conditional probability – Bayes theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions

Unit - III	TWO DIMENSIONAL RANDOM VARIABLES	12

Joint distributions – Marginal and conditional distributions – Functions of two-dimensional random variables – Regression curve – Correlation.

Unit – IV	TESTING OF HYPOTHESIS	12

Sampling distributions – Type I and Type II errors – Small and Large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

Unit - V	MULTIVARIATE ANALYSIS	12

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

Total Periods:	60

Course Outcomes

On completion of the course, the student can

CO	Statements	K-Level
CO1	Apply the concepts of linear algebra and matrix operations to solve problems.	K3
CO2	Make use of the probability and random variables in solving engineering problems.	K3
CO3	Develop the concepts of one-dimensional random variable in two-dimensional engineering problems.	K3
CO4	Identify the types of testing of hypothesis for small and large samples in real life problems.	K3
CO5	Choose appropriate concepts of multivariate analysis. for real-world issues	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	-	1
CO2	2	-	1
CO3	3	-	1
CO4	3	-	1
CO5	3	-	1
CO	3	-	1

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Howard Anton and Chris Rorres, "Elementary Linear Algebra", John Wiley & Sons, 11th edition, Canada, 2014.
2	Dallas E Johnson, "Applied multivariate methods for data Analysis", Thomson and Duxbury press, Singapore, 1998.
3	Richard A. Johnson and Dean W. Wichern, "Applied multivariate statistical Analysis", Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2013.
4	Bronson, R.,"Matrix Operation" Schaum's outline series, Tata McGraw Hill, New York, 2011.
5	Oliver C. Ibe, "Fundamentals of Applied probability and Random Processes", Academic Press, Boston, 2014.
6	Johnson R. A. and Gupta C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson India Education, Asia, 9th Edition, New Delhi, 2017.
7	Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009
8	Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
9	Jain. R. K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.
10	Ramana. B. V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd,New Delhi, 2016.
11	Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.

P24CD4101	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	2

Course Objectives:	To understand and familiarize with search problems, process and design, data collection, preparing process, statistical concepts in data analysis and reporting. To gain knowledge about statistical concepts in data analysis and reporting, intellectual property rights and its practices, patent rights and agents.

Unit - I	**RESEARCH DESIGN**	6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.		
Unit - II	**DATA COLLECTION AND SOURCES**	6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.		
Unit - III	**DATA ANALYSIS AND REPORTING**	6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.		
Unit – IV	**INTELLECTUAL PROPERTY RIGHTS**	6
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in PR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.		
Unit - V	**PATENTS**	6
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.		
	Total Periods:	30

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Outline the research process and its design.	K2
CO2	Apply the various methods for data collection and sources.	K3
CO3	Build data analysis and reporting methods for multivariate analysis.	K3
CO4	Explain the concepts of intellectual property rights and its practices.	K2
CO5	Summarize the concepts of patents.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	2
CO2	2	1	2
CO3	3	2	2
CO4	2	1	3
CO5	2	2	3
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

P24ML2101	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the usage of algorithms in computing, hierarchical data structures, graphs and its applications. To select and design data structures and algorithms and study about NP Completeness of problems.

Unit - I	**ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS**	**9**

Algorithms - Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic Analysis-Average and worst-case analysis-Asymptotic Notation-Importance of efficient algorithms- Program performance measurement - Recurrences: The Substitution Method - The Recursion-Tree Method- Data structures and algorithms.

Unit - II	**HIERARCHICAL DATA STRUCTURES**	**9**

Binary Search Trees: Basics - Querying a Binary search tree - Insertion and Deletion- Red Black trees: Properties of Red-Black Trees - Rotations - Insertion - Deletion -B-Trees: Definition of B - trees - Basic operations on B-Trees - Deleting a key from a B-Tree- Heap - Heap Implementation - Disjoint Sets - Fibonacci Heaps: structure - Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

Unit - III	**GRAPHS**	**9**

Elementary Graph Algorithms: Representations of Graphs - Breadth-First Search - Depth-First Search - Topological Sort - Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree - Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm - Single-Source Shortest paths in Directed Acyclic Graphs - Dijkstra's Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication - The Floyd- Warshall Algorithm

Unit – IV	**ALGORITHM DESIGN TECHNIQUES**	**9**

Dynamic Programming: Matrix-Chain Multiplication - Elements of Dynamic Programming - Longest Common Subsequence- Greedy Algorithms: - Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

Unit - V	**NP COMPLETE AND NP HARD**	**9**

NP-Completeness: Polynomial Time - Polynomial-Time Verification - NP- Completeness and Reducibility - NP-Completeness Proofs - NP-Complete Problems.

	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Relate the data structures and algorithms to solve computing problems	K2
CO2	Interpret the efficient data structures to solve problems.	K2
CO3	Apply the algorithms using graph structure and various string-matching algorithms to solve real-life problems.	K3
CO4	Build an algorithm for an unknown problem.	K3
CO5	Explain the suitable design strategy for problem solving.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	3
CO2	2	1	3
CO3	3	2	2
CO4	3	2	3
CO5	2	1	3
CO	**3**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	S.Sridhar," Design and Analysis of Algorithms", Oxford University Press, 1st Edition, 2014.
2	Adam Drozdex, "Data Structures and algorithms in C++", Cengage Learning, 4th Edition, 2013.
3	T.H. Cormen, C.E.Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012.
4	Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, 3rd Edition, 2009.
5	E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, 2nd Edition, 2008.
6	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

P24ML2102	PRINCIPLES OF PROGRAMMING LANGUAGES	L	T	P	C
		3	0	0	3

Course Objectives:	To understand and describe data, data types, basic statements, syntax and semantics of programming languages, call-return architecture, object-orientation, concurrency and event handling in programming languages. To develop programs in non-procedural programming paradigms.

Unit - I	**SYNTAX AND SEMANTICS**	**9**

Evolution of programming languages – describing syntax – context – free grammars –attribute grammars – describing semantics – lexical analysis – parsing – recursive-descent – bottom- up parsing.

Unit - II	**DATA, DATA TYPES AND BASIC STATEMENTS**	**9**

Names – variables – binding – type checking – scope – scope rules – lifetime and garbage collection –primitive data types–strings–array types– associative arrays–record types– union types – pointers and references – Arithmetic expressions – overloaded operators – type conversions – relational and boolean expressions – assignment statements – mixed- mode assignments – control structures – selection – iterations – branching – guarded statements

Unit - III	**SUBPROGRAMS AND IMPLEMENTATIONS**	**9**

Subprograms – design issues – local referencing – parameter passing – overloaded methods – generic methods – design issues for functions – semantics of call and return – implementing simple subprograms – stack and dynamic local variables – nested subprograms – blocks – dynamic scoping

Unit – IV	**OBJECT-ORIENTATION, CONCURRENCY, AND EVENT HANDLING**	**9**

Object-orientation – design issues for OOP languages – implementation of object-oriented constructs – concurrency – semaphores – monitors – message passing – threads – statement level concurrency – exception handling – event handling

Unit - V	**FUNCTIONAL AND LOGIC PROGRAMMING LANGUAGES**	**9**

Introduction to lambda calculus – fundamentals of functional programming languages – Programming with Scheme – Programming with ML – Introduction to logic and logic programming – Programming with Prolog – multi-paradigm languages

	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the syntax and semantics of programming languages.	K2
CO2	Outline about data, data types, and basic statements of programming languages.	K2
CO3	Select the subprogram constructs using functions.	K3
CO4	Construct object-oriented concurrency and event handling programming constructs.	K3
CO5	Develop programs using Scheme, ML and Prolog for multi-paradigm languages.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	2
CO2	2	1	2
CO3	3	2	3
CO4	2	1	3
CO5	3	2	3
CO	**2**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Robert W. Sebesta, "Concepts of Programming Languages", Eleventh Edition, Addison Wesley, 2012
2	W. F. Clocksin and C. S. Mellish, "Programming in Prolog: Using the ISO Standard", Fifth Edition, Springer, 2003
3	Michael L.Scott, "Programming Language Pragmatics", Fourth Edition, Morgan Kaufmann, 2009
4	R. Kent Dybvig, "The Scheme programming language", Fourth Edition, MIT Press, 2009
5	Richard A. O'Keefe, "The craft of Prolog", MIT Press, 2009
6	W.F.Clocksin and C.S.Mellish, "Programming in Prolog : Using the ISO Standard", Fifth Edition, Springer 2003

P24ML2103	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

Course Objectives:	To outline basic problem-solving strategies, game theory-based search, constraint satisfaction, probabilistic, knowledge representation techniques and other types of reasoning. To explore reasoning and planning, ethical and safety issues associated with AI.

Unit - I	**INTRODUCTION AND PROBLEM SOLVING**	**9**
Artificial Intelligence -Introduction - Problem-solving -Solving Problems by Searching – Uninformed Search Strategies -Informed (Heuristic) Search Strategies - Local Search – Search in Partially Observable Environments		
Unit - II	**ADVERSARIAL SEARCH AND CONSTRAINT SATISFACTION PROBLEMS**	**9**
Game Theory- Optimal Decisions in Games - Heuristic Alpha--Beta Tree Search- Monte Carlo Tree Search - Stochastic Games - Partially Observable Games - Limitations of Game Search Algorithms Constraint Satisfaction Problems (CSP)– Examples - Constraint Propagation- Backtracking Search for CSPs - Local Search for CSPs		
Unit - III	**KNOWLEDGE, REASONING AND PLANNING**	**9**
First Order Logic – Inference in First Order Logic -Using Predicate Logic – Knowledge Representation - Issues - Ontological Engineering - Categories and Objects – Reasoning Systems for Categories - Planning -Definition - Algorithms -Heuristics for Planning -Hierarchical Planning		
Unit – IV	**UNCERTAIN KNOWLEDGE AND REASONING**	**9**
Quantifying Uncertainty - Probabilistic Reasoning - Probabilistic Reasoning over Time Probabilistic Programming - Making Simple Decisions - Making Complex Decisions – Case Based Reasoning –Explanation-Based Learning – Evolutionary Computation		
Unit - V	**PHILOSOPHY, ETHICS AND SAFETY OF AI**	**9**
The Limits of AI – Knowledge in Learning –Statistical Learning Methods – Reinforcement Learning - Introduction to Machine Learning and Deep Learning - Can Machines Really Think - Distributed AI Artificial Life-The Ethics of AI - Interpretable AI- Future of AI - AI Components -AI Architectures		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain problem solving methods for a puzzle.	K2
CO2	Build game theory for CSP using AI techniques.	K3
CO3	Experiment with predicate logic using real time application.	K3
CO4	Summarize case-based reasoning systems.	K2
CO5	Relate the methodologies to design ethical AI systems.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	3
CO2	3	2	3
CO3	2	-	2
CO4	2	1	2
CO5	2	1	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 4th Edition, 2020.
2	Zhongzhi Shi "Advanced Artificial Intelligence", World Scientific; 2019.
3	Kevin Knight, Elaine Rich, Shivashankar B. Nair, "Artificial Intelligence", McGraw Hill Education; 3rd edition, 2017.
4	Richard E. Neapolitan, Xia Jiang, "Artificial Intelligence with an Introduction to Machine Learning", Chapman and Hall/CRC; 2nd edition, 2018.
5	Dheepak Khemani, "A first course in Artificial Intelligence", McGraw Hill Education Pvt Ltd., NewDelhi, 2013.
6	Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann Publishers Inc; Second Edition, 2003.

P24ML2104	DATABASE PRACTICES	L	T	P	C
		3	0	2	4

Course Objectives:	To understand basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL, query processing in a distributed database system, basics of XML, create well-formed and valid XML documents. To familiarize the different models involved in database security and their applications in the real time world to protect the database and information associated with them.

Unit - I	RELATIONAL DATA MODEL	15

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization.

Suggested Activities:

Data Definition Language

- Create, Alter and Drop
- Enforce Primary Key, Foreign Key, Check, Unique and Not Null Constraints
- Creating Views

Data Manipulation Language

- Insert, Delete, Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full Outer Join
- Aggregate Functions
- Set Operations
- Nested Queries

Transaction Control Language

- Commit, Rollback and Save Points

Unit - II	DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY	15

Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Event Condition Action Model – Design and Implementation Issues for Active Databases – Open Database Connectivity.

Suggested Activities:

- Distributed Database Design and Implementation
- Row Level and Statement Level Triggers
- Accessing a Relational Database using PHP, Python and R

Unit - III	XML DATABASES	15

Structured, semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery

Suggested Activities:

- Creating XML Documents, Document Type Definition and XML Schema
- Using a Relational Database to store the XML documents as text
- Using a Relational Database to store the XML documents as data elements
- Creating or publishing customized XML documents from pre-existing relational databases
- Extracting XML Documents from Relational Databases
- XML Querying

Unit – IV	NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS	15

NoSQL – Categories of NoSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Wide Column NoSQL Systems – Hbase Data Model – Hbase Crud Operations – Hbase Storage and Distributed System Concepts – NoSQL Graph Databases and Neo4j – Cypher Query Language of Neo4j – Big Data – MapReduce – Hadoop – YARN.

Suggested Activities:

• Creating Databases using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j. • Writing simple queries to access databases created using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j		
Unit - V	**DATABASE SECURITY**	**15**
Database Security Issues – Discretionary Access Control Based on Granting and Revoking Privileges – Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection – Statistical Database Security – Flow Control – Encryption and Public Key Infrastructures – Preserving Data Privacy – Challenges to Maintaining Database Security – Database Survivability – Oracle Label-Based Security. **Suggested Activities:** • Implementing Access Control in Relational Databases		
	Total Periods:	**75**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Build ER-model from relational tables, populate the relational databases and formulate SQL queries.	K3
CO2	Make use of the various methods and techniques for distributed query processing in Distributed Databases.	K3
CO3	Utilize the well-formed XML documents in Structured, semi structured, and Unstructured Data.	K3
CO4	Infer about data control, definition and manipulation languages of the NoSQL databases.	K2
CO5	Explain about secure database systems.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	2
CO2	2	2	2
CO3	3	2	3
CO4	2	3	3
CO5	2	2	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education 2016
2	Henry F. Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2019.
3	C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006.
4	Raghu Ramakrishnan, Johannes Gehrke "Database Management Systems", Fourth Edition, McGraw Hill Education, 2015.
5	Harrison, Guy, "Next Generation Databases, NoSQL and Big Data", First Edition, Apress publishers, 2015

P24ML2105	ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY	L	T	P	C
		0	0	4	2
Course Objectives:	To understand the usage of advanced tree structures, heap structures, graph structures and spanning trees. To understand the problems such as matrix chain multiplication, activity selection and Huffman coding.				

Exp. No	Title	
1	Implementation of recursive function for tree traversal and Fibonacci.	
2	Implementation of iteration function for tree traversal and Fibonacci.	
3	Implementation of Merge Sort and Quick Sort.	
4	Implementation of a Binary Search Tree.	
5	Red-Black Tree Implementation.	
6	Heap Implementation.	
7	Fibonacci Heap Implementation.	
8	Graph Traversals.	
9	Spanning Tree Implementation.	
10	Shortest Path Algorithms (Dijkstra's algorithm, Bellman Ford Algorithm).	
11	Implementation of Matrix Chain Multiplication.	
12	Activity Selection and Huffman Coding Implementation	
	Total Periods:	**60**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Explain the basic and advanced data structures.	K2
CO2	Interpret about the algorithms using graph structures.	K2
CO3	Make use of the efficient algorithms with minimum complexity using design techniques.	K3
CO4	Develop the programs using various algorithms.	K3
CO5	Apply appropriate data structures and algorithms to design algorithms for a specific problem.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	2
CO2	3	2	2
CO3	2	1	3
CO4	2	2	3
CO5	2	2	3
CO	2	2	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Lipschutz Seymour, "Data Structures Schaum's Outlines Series", Tata McGraw Hill, 3rd Edition, 2014.
2	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.
3	http://www.coursera.org/specializations/data-structures-algorithms
4	http://www.tutorialspoint.com/data_structures_algorithms
5	http://www.geeksforgeeks.org/data-structures/

P24ML2201	BIG DATA MINING AND ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the computational approaches to modeling, feature extraction, need and application of map reduce, various search algorithms applicable to big data. To understand how to handle large data sets in main memory and learn the various clustering techniques applicable to big data.

Unit - I	**DATA MINING AND LARGE-SCALE FILES**	**9**
Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining - Distributed File Systems – Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.		
Unit - II	**SIMILAR ITEMS**	**9**
Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Methods for High Degree of Similarities.		
Unit - III	**MINING DATA STREAMS**	**9**
Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.		
Unit – IV	**LINK ANALYSIS AND FREQUENT ITEMSETS**	**9**
Page Rank –Efficient Computation - Topic Sensitive Page Rank – Link Spam – Market Basket Model – A-priori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets.		
Unit - V	**CLUSTERING**	**9**
Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non – Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems.		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Infer the algorithms by employing map reduce technique for solving big data problems.	K2
CO2	Build the algorithms for big data by deciding on an apt features set.	K3
CO3	Apply the algorithms for handling petabytes of datasets.	K3
CO4	Relate the algorithms and propose solutions for big data.	K2
CO5	Develop the solutions for problems in big data by appropriate clustering techniques	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	2
CO2	2	1	3
CO3	2	2	3
CO4	2	1	2
CO5	3	2	3
CO	2	2	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 3rd Edition, 2020.
2	Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufman Publications, Third Edition, 2012.
3	Ian H.Witten, Eibe Frank "Data Mining – Practical Machine Learning Tools and Techniques", Morgan Kaufman Publications, Third Edition, 2011.
4	David Hand, Heikki Mannila and Padhraic Smyth, "Principles of Data Mining", MIT PRESS, 2001.

Web References

1	https://swayam.gov.in/nd2_arp19_ap60/preview
2	https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106104189/lec1.pdf

Online Resources

1	https://examupdates.in/big-data-analytics/
2	https://www.tutorialspoint.com/big_data_analytics/index.htm
3	https://www.tutorialspoint.com/data_mining/index.htm

P24ML2202	INTERNET OF THINGS	L	T	P	C
		3	0	2	4

Course Objectives:	To understand the architectural overview of IoT, IoT reference architecture and real-world design constraints. To familiarize the basics of cloud architecture and various IoT levels. To gain experience in Raspberry PI and experiment with a simple IoT application on it.

Unit - I	INTRODUCTION	9

Internet of Things- Domain Specific IoTs - IoT and M2M-Sensors for IoT Applications–Structure of IoT– IoT Map Device- IoT System Management with NETCONF-YANG

Unit - II	IoT ARCHITECTURE, GENERATIONS AND PROTOCOLS	9

IETF architecture for IoT - IoT reference architecture -First Generation – Description & Characteristics–Advanced Generation – Description & Characteristics–Integrated IoT Sensors – Description & Characteristics

Unit - III	IoT PROTOCOLS AND TECHNOLOGY	9

SCADA and RFID Protocols - BACNet Protocol -Zigbee Architecture - 6LowPAN - CoAP -Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sensing Module

Unit – IV	CLOUD ARCHITECTURE BASICS	9

The Cloud types; IaaS, PaaS, SaaS - Development environments for service development; Amazon, Azure, Google Appcloud platform in industry

Unit - V	IoT PROJECTS ON RASPBERRY PI	9

Building IoT with RASPBERRY PI- Creating the sensor project - Preparing Raspberry Pi – Clayster libraries – Hardware Interacting with the hardware - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data

	Total Periods:	45

Exp. No	Title
1	Develop an application for LED Blink and Pattern using arduino or Raspberry Pi.
2	Develop an application for LED Pattern with Push Button Control using Arduino or Raspberry Pi.
3	Develop an application for LM35 Temperature Sensor to display temperature values using arduino or Raspberry Pi.
4	Develop an application for Forest fire detection end node using Raspberry Pi device and sensor.
5	Develop an application for home intrusion detection web application.
6	Develop an application for Smart parking application using python and Django for web application.
	Total Periods: 30

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Explain the various concepts of the IoT and their technologies.	K2

COs	Statements	K - Level
CO2	Interpret the IoT application using different hardware platforms.	K2
CO3	Apply the various IoT Protocols.	K3
CO4	Outline the basic principles of cloud computing.	K2
CO5	Make use of IoT applications in a cloud environment.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	1	3
CO2	3	2	3
CO3	2	1	2
CO4	2	1	2
CO5	3	2	3
CO	3	1	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on approach, Universities Press, 2015
2	Dieter Uckelmann, Mark Harrison, Florian Michahelles (Eds), Architecting the Internet of Things, Springer, 2011
3	Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
4	Ovidiu Vermesan Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014
5	N. Ida, Sensors, Actuators and Their Interfaces: A Multidisciplinary Introduction, 2nd Edition Scitech Publishers, 2014.
6	Reese, G. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc, 2009.

P24ML2203	MACHINE LEARNING	L	T	P	C
		3	0	2	4

Course Objectives:	To understand the concepts and mathematical foundations, neural networks and deep learning, role of probabilistic methods of machine learning and types of problems tackled by machine learning. To explore the different supervised learning techniques including ensemble methods, unsupervised learning and reinforcement learning.

Unit - I	**INTRODUCTION AND MATHEMATICAL FOUNDATIONS**	**9**

What is Machine Learning - Need – History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry - Probability and Statistics- Bayesian Conditional Probability -Vector Calculus & Optimization - Decision Theory - Information theory

Unit - II	**SUPERVISED LEARNING**	**9**

Introduction-Discriminative and Generative Models - Linear Regression - Least Squares -Under-fitting / Overfitting - Cross-Validation – Lasso Regression - Classification - Logistic Regression - Gradient Linear Models - Support Vector Machines – Kernel Methods - Instance based Methods - K-Nearest Neighbours - Tree based Methods – Decision Trees – ID3 – CART - Ensemble Methods – Random Forest - Evaluation of Classification Algorithms

Unit - III	**UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING**	**9**

Introduction - Clustering Algorithms - K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction – Principal Component Analysis – Recommendation Systems – EM algorithm. Reinforcement Learning – Elements - Model based Learning – Temporal Difference Learning

Unit – IV	**PROBABILISTIC METHODS FOR LEARNING**	**9**

Introduction - Naïve Bayes Algorithm - Maximum Likelihood - Maximum Apriori - Bayesian Belief Networks - Probabilistic Modelling of Problems - Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models

Unit - V	**NEURAL NETWORKS AND DEEP LEARNING**	**9**

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – BackPropagation - Activation and Loss Functions - Limitations of Machine Learning – Deep Learning– Convolution Neural Networks – Recurrent Neural Networks – Use cases

Suggested Activities:

1. Give an example from our daily life for each type of machine learning problem
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN.

	Total Periods:	**45**

Exp. No	Title
1	Implement a Linear Regression with a Real Dataset (https://www.kaggle.com/harrywang/housing). Experiment with different features in building a model. Tune the model's hyperparameters.
2	Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.

Exp. No	Title
3	Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset
4	In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5	Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usagedataset
6	Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/datasets/Gait+Classification dataset
7	Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data. a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach. b. You can either pick a project of your own design, or you can choose from the set of pre- defined projects. c. You are free to use any third-party ideas or code that you wish as long as it is publicly available. d. You must properly provide references to any work that is not your own in the writeup. e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read. **List of Projects (datasets available)** 1. Sentiment Analysis of Product Reviews 2. Stock Prediction 3. Sales Forecasting 4. Music Recommendation 5. Handwriting Digit Classification 6. Fake News Detection 7. Sports Prediction 8. Object Detection 9. Disease Prediction
Total Periods:	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Develop the problems for various types of machine learning.	K3
CO2	Make use of decision trees and random forests for an application.	K3
CO3	Interpret an application using probabilistic discriminative and generative algorithms.	K2
CO4	Apply typical clustering algorithms for different types of applications.	K3
CO5	Summarize the concepts of neural networks and deep learning.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	3
CO2	2	2	3
CO3	2	1	2
CO4	3	2	3
CO5	2	2	2
CO	2	2	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2	Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
3	Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4	Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
5	Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
6	Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
7	Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
8	Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
9	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
10	Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

P24ML2204	NATURAL LANGUAGE PROCESSING	L	T	P	C
		2	0	2	3

Course Objectives:	To understand basics of linguistics, probability and statistics, semantics of words and semantic role labeling of sentences, discourse analysis, question answering and chatbots. To outline the different parsing techniques associated with NLP and statistical approaches to NLP and understand sequence labelling.

Unit - I	INTRODUCTION	6

Natural Language Processing – Components - Basics of Linguistics and Probability and Statistics – Words-Tokenization-Morphology-Finite State Automata

Unit - II	STATISTICAL NLP AND SEQUENCE LABELING	6

N-grams and Language models –Smoothing -Text classification- Naïve Bayes classifier – Evaluation - Vector Semantics – TF-IDF - Word2Vec- Evaluating Vector Models -Sequence Labeling – Part of Speech – Part of Speech Tagging -Named Entities –Named Entity Tagging

Unit - III	CONTEXTUAL EMBEDDING	6

Constituency –Context Free Grammar –Lexicalized Grammars- CKY Parsing – Earley's algorithm- Evaluating Parsers -Partial Parsing – Dependency Relations- Dependency Parsing -Transition Based - Graph Based

Unit – IV	COMPUTATIONAL SEMANTICS	6

Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labeling – Proposition Bank- FrameNet-Selectional Restrictions - Information Extraction - Template Filling

Unit - V	DISCOURSE ANALYSIS AND SPEECH PROCESSING	6

Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue–State Architecture

Suggested Activities:

1. Probability and Statistics for NLP Problems
2. Carry out Morphological Tagging and Part-of-Speech Tagging for a sample text
3. Design a Finite State Automata for more Grammatical Categories
4. Problems associated with Vector Space Model
5. Hand Simulate the working of a HMM model
6. Examples for different types of work sense disambiguation
7. Give the design of a Chatbot

	Total Periods:	**30**

Exp. No	Title
1	Download nltk and packages. Use it to print the tokens in a document and the sentences from it.
2	Include custom stop words and remove them and all stop words from a given document using nltk or spaCY package
3	Implement a stemmer and a lemmatizer program.
4	Implement a simple Part-of-Speech Tagger
5	Write a program to calculate TFIDF of documents and find the cosine similarity between any two documents.
6	Use nltk to implement a dependency parser.

Exp. No	Title
7	Implement a semantic language processor that uses WordNet for semantic tagging.
8	Project - (in Pairs) Your project must use NLP concepts and apply them to some data. a. Your project may be a comparison of several existing systems, or it may propose a new system in which case you still must compare it to at least one other approach. b. You are free to use any third-party ideas or code that you wish as long as it is publicly available. c. You must properly provide references to any work that is not your own in the write-up. d. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read. **List of Possible Projects** 1. Sentiment Analysis of Product Reviews 2. Information extraction from News articles 3. Customer support bot 4. Language identifier 5. Media Monitor 6. Paraphrase Detector 7. Identification of Toxic Comment 8. Spam Mail Identification
	Total Periods: **30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Explain the basics of linguistics, probability and statistics associated with NLP.	K2
CO2	Interpret about Part-of-Speech Tagger.	K2
CO3	Apply the sequence labeling problem for a given domain.	K3
CO4	Outline the semantic processing tasks, simple document indexing and searching system using the concepts of NLP.	K2
CO5	Build a simple chatbot using dialogue system concepts.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	2
CO2	3	2	2
CO3	2	1	3
CO4	2	2	2
CO5	2	2	3
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference 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 Series in Artificial Intelligence), 2020.
2	Jacob Eisenstein. "Natural Language Processing ", MIT Press, 2019
3	Samuel Burns "Natural Language Processing: A Quick Introduction to NLP with Python and NLTK, 2019
4	Christopher Manning, "Foundations of Statistical Natural Language Processing", MIT Press, 2009.
5	Nitin Indurkhya, Fred J. Damerau, "Handbook of Natural Language Processing", Second edition, Chapman & Hall/CRC: Machine Learning & Pattern Recognition, Hardcover,2010
6	Deepti Chopra, Nisheeth Joshi, "Mastering Natural Language Processing with Python", Packt Publishing Limited, 2016
7	Mohamed Zakaria Kurdi "Natural Language Processing and Computational Linguistics: Speech, Morphology and Syntax (Cognitive Science)", ISTE Ltd., 2016
8	Atefeh Farzindar, Diana Inkpen, "Natural Language Processing for Social Media (Synthesis Lectures on Human Language Technologies)", Morgan and Claypool Life Sciences, 2015

P24ML2205	DATA ANALYTICS LABORATORY	L	T	P	C
		0	0	2	1
Course Objectives:	To analyse the data using statistical methods and to understand data analysis tools. To learn various data analysis algorithms, data mining algorithms and tools.				

Exp. No	Title
1	Data Analysis- Getting to know the Data (Using ORANGE, WEKA) • Parametric - Means, T-Test, Correlation • Prediction for numerical outcomes - Linear regression • Correlation analysis • Preparing data for analysis • Pre-processing techniques
2	Data Mining (Using ORANGE, WEKA or any open source data mining tool) • Implement clustering algorithm • Implement classification using • Decision tree • Back propagation • Visualization methods.
	Total Periods: **30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Make use of statistical techniques to carry out the analysis of data.	K3
CO2	Experiment with the various Data Analysis algorithms.	K3
CO3	Utilize the Data Mining algorithms.	K3
CO4	Infer about Data Analysis tools	K2
CO5	Interpret about Data Mining tools	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	3
CO2	2	1	3
CO3	3	2	3
CO4	2	2	2
CO5	2	2	2
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

P24ML5201	TERM PAPER WRITING AND SEMINAR	L	T	P	C
		0	0	2	1
Course Objectives:	In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps: 1. Selecting a subject, narrowing the subject into a topic 2. Stating an objective. 3. Collecting the relevant bibliography (atleast 15 journal papers) 4. Preparing a working outline. 5. Studying the papers and understanding the authors contributions and critically analysing each paper. 6. Preparing a working outline 7. Linking the papers and preparing a draft of the paper. 8. Preparing conclusions based on the reading of all the papers. 9. Writing the Final Paper and giving final Presentation				

Please keep a file where the work carried out by you is maintained. Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways	4th week	**6%** (the list of standard papers and reason for selection)

Activity	Instructions	Submission week	Evaluation
	and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme /categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next5	Repeat Reading Paper Process	6th week	**8%** (the table given should

Activity	Instructions	Submission week	Evaluation
papers			indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11th week	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and Viva-voce)
Periods		**Total**	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Build scientific and technical reading and writing skills.	K3
CO2	Choose information from Journals, dictionaries and reference books.	K3
CO3	Make use of research papers for the final draft of paper.	K3
CO4	Construct a paper with formatting and plagiarism check reports.	K3
CO5	Summarize the presentation of the entire work.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	2	3
CO2	2	2	2
CO3	3	2	3
CO4	2	1	2
CO5	2	1	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

P24ML3201	SOCIAL NETWORK ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:	To demonstrate the Information diffusion in Social Networks and to illustrate cascading in Social Networks. To explain link analysis and community detection, graph theory and structure.

Unit - I	GRAPH THEORY AND STRUCTURE	10

Breadth First Search (BFS) Algorithm. Strongly Connected Components (SCC) Algorithm. Weakly Connected Components (WCC) Algorithm. First Set of Experiments—Degree Distributions. Second Set of Experiments—Connected Components. Third Set of Experiments—Number of Breadth First Searches. Rank Exponent R. Out-Degree Exponent O. Hop Plot Exponent H. Eigen Exponent E. Permutation Model. Random Graphs with Prescribed Degree Sequences. Switching Algorithms. Matching Algorithm. "Go with the Winners" Algorithm. HyperANF Algorithm. Iterative Fringe Upper Bound (iFUB) Algorithm. Spid. Degree Distribution. Path Length. Component Size. Clustering Coefficient and Degeneracy. Friends-of-Friends. Degree Assortativity. Login Correlation.

Unit - II	SOCIAL NETWORK GRAPH ANALYSIS	9

Social network exploration/ processing and properties: Finding overlapping communities, similarity between graph nodes, counting triangles in graphs, neighborhood properties of graphs. Pregel paradigm and Apache Giraph graph processing system.

Unit - III	INFORMATION DIFFUSION IN SOCIAL NETWORKS	9

Strategic network formation: game theoretic models for network creation/ user behavior in social networks. Information diffusion in graphs: Cascading behavior, spreading, epidemics, heterogeneous social network mining, influence maximization, outbreak detection. Opinion analysis on social networks: Contagion, opinion formation, coordination and cooperation.

Unit – IV	CASCADING IN SOCIAL NETWORKS	8

Cascading in Social Networks. Decision Based Models of Cascade. Collective Action. Cascade Capacity. Co-existence of Behaviours. Cascade Capacity with Bilinguality. Probabilistic Models of Cascade. Branching Process. Basic Reproductive Number. SIR Epidemic Model. SIS Epidemic Model. SIRS Epidemic Model. Transient Contact Network. Cascading in Twitter.

Unit - V	LINK ANALYSIS & COMMUNITY DETECTION	9

Search Engine. Crawling. Storage. Indexing. Ranking. Google. Data Structures. Crawling. Searching. Web Spam Pages Strength of Weak Ties. Triadic Closure. Detecting Communities in a Network. Girvan-Newman Algorithm. Modularity. Minimum Cut Trees. Tie Strengths in Mobile Communication Network. Exact Betweenness Centrality. Approximate Betweenness Centrality.

Suggested Activities:

1: Twitter Intelligence project performs tracking and analysis of the Twitter
2: Large-Scale Network Embedding as Sparse Matrix Factorization
3: Implement how Information Propagation on Twitter
4: Social Network Analysis and Visualization software application.
5: Implement the Structure of Links in Networks

	Total Periods:	45

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Utilize the graph theory and structure for executing network analytical computations.	K3

COs	Statements	K-Level
CO2	Apply the mining algorithms for social network graph analysis.	K3
CO3	Relate the Information diffusion in Social Networks.	K2
CO4	Illustrate social network analysis in behavior models.	K2
CO5	Explain about the link analysis and community detection on large social networks.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	2	2
CO2	2	1	3
CO3	3	2	2
CO4	2	2	2
CO5	3	1	2
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Practical Social Network Analysis with Python, Krishna Raj P. M. Ankith Mohan and K. G. Srinivasa. Springer, 2018.
2	Social Network Analysis: Methods and Applications, Stanley Wasserman, and Katherine F' Aust. Cambridge University Press, 2012.
3	Social Network Analysis: History, Theory and Methodology by Christina Prell, SAGE Publications, 1st edition, 2011.
4	Sentiment Analysis in Social Networks, Federico Alberto Pozzi, Elisabetta Fersini, Enza Messina, and Bing. LiuElsevier Inc, 1st edition, 2016.
5	Social Network Analysis, John Scott. SAGE Publications, 2012

P24ML3202	PREDICTIVE MODELING	L	T	P	C
		3	0	0	3

Course Objectives:	To explain about the terms and terminologies of predictive modeling, various predictive models, their merits, demerits and application. To demonstrate the various analytical tools and technologies available for predictive modeling.

Unit - I	INTRODUCTION TO PREDICTIVE MODELING	9

Core ideas in data mining - Supervised and unsupervised learning - Classification vs. Prediction - Steps in data mining- SEMMA Approach - Sampling -Pre-processing - Data cleaning - Data Partitioning - Building a model - Statistical models - Statistical models for predictive analytics.

Unit - II	PREDICTIVE MODELING BASICS	9

Data splitting – Balancing- Over fitting –Oversampling –Multiple Regression Artificial neural networks (MLP) - Variable importance- Profit/loss/prior probabilities - Model specification - Model selection - Multivariate Analysis.

Unit - III	PREDICTIVE MODELS	9

Association Rules-Clustering Models –Decision Trees- Ruleset Models- KNearest Neighbors – Naive Bayes - Neural Network Model – Regression Models – Regression Trees – Classification & Regression Trees (CART) – Logistic Regression – Multiple Linear Regression Scorecards – Support Vector Machines – Time Series Models - Comparison between models - Lift chart Assessment of a single model.

Unit – IV	PREDICTIVE MODELING MARKUP LANGUAGE	9

Introduction to PMML – PMML Converter - PMML Structure – Data Manipulation in PMML – PMML Modeling Techniques - Multiple Model Support – Model Verification.

Unit - V	TECHNOLOGIES AND CASE STUDIES	9

Weka – RapidMiner – IBM SPSS Statistics- IBM SPSS Modeler – SAS Enterprise Miner – Apache Mahout – R Programming Language. -Real time case study with modeling and analysis.

	Total Periods:	45

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Outline the terms and terminologies in predictive modeling.	K2
CO2	Explain the various predictive models with their merits and demerits.	K2
CO3	Apply the various analytical tools for predictive modeling.	K3
CO4	Infer about the predictive modeling markup language.	K2
CO5	Utilize the technologies used in predictive modeling.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	2
CO2	3	2	2
CO3	2	1	3
CO4	3	2	2
CO5	2	2	3
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Kattamuri S. Sarma, "Predictive Modeling with SAS Enterprise Miner: Practical Solutions for Business Applications", 3rd Edition, SAS Publishing, 2017.
2	Alex Guazzelli, Wen-Ching Lin, Tridivesh Jena, James Taylor, "PMML in Action Unleashing the Power of Open Standards for Data Mining and Predictive Analytics", 2nd Edition, Create Space Independent Publishing Platform, 2012.
3	Ian H. Witten, Eibe Frank, "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann Series in Data Management Systems, Morgan Kaufmann, 3rd Edition, 2011.
4	Eric Siegel, "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die", 2nd Edition, Wiley, 2016.
5	Conrad Carlberg, "Predictive Analytics: Microsoft Excel", 1st Edition, Que Publishing, 2012.
6	Jeremy Howard, Margit Zwemer, Mike Loukides, "Designing Great Data Products- Inside the Drivetrain train Approach, a Four-Step Process for Building Data Products – Ebook", 1st Edition, O'Reilly Media, March 2012.

Web References

1	https://nptel.ac.in/courses/108108111/
2	https://www.coursera.org/learn/predictive-modeling-analytics

Online Resources

1	https://bookdown.org/egarpor/PM-UC3M/
2	https://cics.nd.edu/research/applications/materials/

P24ML3203	SMART CONVERGENT TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives:	To learn the outline about Fundamentals of IoT with real-time environment and IoT applications in Industry and to explain about RFID Pervasive networks. To infer the Internet of Things with the industrial architecture and IoT implementation in industry.

Unit - I	**TOWARDS THE IoT UNIVERSE**	**9**

Internet of Things Vision - IoT Strategic Research and Innovation Directions - IoT Applications - Internet of Things and Related Future Internet Technologies -Infrastructure - Networks and Communication - Processes - Data Management, Security, Privacy & Trust - Device Level Energy Issues.

Unit - II	**IoT APPLICATIONS — VALUE CREATION FOR INDUSTRY**	**9**

Introduction - IoT Applications for Industry — Value Creation and Challenges - Future Factory Concepts - Brownfield IoT: Technologies for Retrofitting - Smart Objects, Smart Applications - Four Aspects in your Business to Master IoT - Value Creation from Big Data and Serialization in the Pharmaceutical Industry - IoT for Retailing Industry- IoT for Oil and Gas Industry - Opinions on IoT Application and Value for Industry- Data Aggregation for the IoT in Smart Cities.

Unit - III	**RFID PERVASIVE NETWORKS**	**9**

RFID Tags- RFID Automatic Identification and Data Capture RFID Data Warehousing and analysis, - RFID Data Management Issues, Solutions, and Directions- RFID Security: Threats and Solutions- RFIG Geometric Context of Wireless Tags- RFID Application in Animal Monitoring- RFID Enabled Logistics Services - Location Tracking in an Office Environment: The Nationwide Case Study- Pervasive Computing Security: Bluetooth's Example- Internet of Things: A Context Awareness Perspective - Index.

Unit – IV	**INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS**	**9**

Industrial Internet- Key IIoT Technologies- Innovation and the IIoT - Key Opportunities and Benefits - The Digital and Human Workforce - Logistics and the Industrial Internet- IoT Innovations in Retail - Cyber Physical Systems (CPS) – IP Mobility – Network Virtualization - SDN (Software Defined Networks)- The Cloud and Fog

Unit - V	**IIoT ARCHITECTURE AND DESIGNING INDUSTRIAL INTERNET SYSTEMS**	**9**

Industrial Internet Architecture Framework (IIAF) -Industrial Internet Viewpoints -, Architectural Topology: The Three-Tier Topology - Wireless Communication Technologies- Proximity Network Communication Protocols-Gateways: industrial gateways - CoAP (Constrained Application Protocol) – NFC

	Total Periods: **45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Interpret the core principles of IoT Network Management.	K2
CO2	Relate the applications of IoT in Industry.	K2
CO3	Experiment with the concepts of RFID and Pervasive Networks.	K3
CO4	Explain the fundamental concepts in IIoT, CPS and Network Virtualization.	K2
CO5	Infer the Internet of Things with industrial architecture.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	2
CO2	2	1	3
CO3	2	2	3
CO4	2	2	2
CO5	2	2	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Ovidiu Vermesan, Peter Friess, "Internet of Things – From Research and Innovation to Market Deployment"', River Publishers, 2014. (Unit I)
2	Ovidiu Vermesan, Peter Friess, "The Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems", River Publications, 2013. (Unit II)
3	Lu Yan, Yan Zhang, Laurence T. Yang and Huansheng Ning "The Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems", Auerbach Publications, 2019. (Unit III)
4	Gilchrist, Alasdair, "Industry 4.0 The Industrial Internet of Things", Apress, 2017. (Unit IV and Unit V)

P24ML3204	PROBABILISTIC GRAPHICAL MODELS	L	T	P	C
		3	0	0	3

Course Objectives:	To understand basic concepts of probabilistic graphical models and to explore different aspects of representation of probabilistic graphical models. To study and apply different inference techniques.

Unit - I	**INTRODUCTION**	**9**

Probabilistic Graphical Models – Motivation – Foundations – Probability Theory – Graphs - Independence Properties - Bayesian Network Representation - Independence in Graphs – From Distribution to Graphs

Unit - II	**REPRESENTATION**	**9**

Undirected Graphical Models - Parameterization – Markov Network Independencies – Bayesian Networks and Markov Networks – Local Probabilistic Models – Tabular CPDs – Template – Based Representation – Temporal Models - Exponential Family – Entropy and Relative Entropy

Unit - III	**INFERENCE**	**9**

Exact Inference – Variable Elimination- Conditioning – Clique Trees – Message Passing – Inference as Optimization – Exact Inference as Optimization – Propagation based Approximation

Unit – IV	**ADVANCED INFERENCE**	**9**

Particle Based Approximate Inference – Forward Sampling - Markov Chain Monte Carlo Methods – Map Inference - Variable Elimination for Map – Max-Product in Clique Trees – Exact Inference in Temporal Models

Unit - V	**LEARNING**	**9**

Learning Graphical Models – Overview – Goals – Learning Tasks –Maximum Likelihood Estimation for Bayesian Networks – Bayesian Parameter Estimation – Structure Learning in Bayesian Networks -Methods –Learning Undirected Models

Suggested Activities:

1. Problems in Probability
2. Design examples of Probabilistic Graphical Models
3. Hand simulate all inferences possible with graphical models for examples of your choice
4. Give an example for temporal probabilistic graphical model
5. Discuss pros and cons of different learning techniques

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Apply basic concepts of probabilistic graphical models.	K3
CO2	Interpret the problems in a probabilistic graphical model.	K2
CO3	Experiment with a simple graphical model.	K3
CO4	Relate the issues associated with temporal models.	K2
CO5	Explain a learning system for the graphical model.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	3
CO2	2	2	3
CO3	3	2	3
CO4	2	1	2
CO5	3	2	2
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	D. Koller and N. Friedman, "Probabilistic Graphical Models: Principles and Techniques", MIT Press, 2009.
2	Probabilistic Machine Learning: An Introduction by Kevin Patrick Murphy, MIT Press, March 2022.
3	M.I. Jordan, "An Introduction to Probabilistic Graphical Models", Preprint.
4	C.M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
5	K.P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
6	David Barber. "Bayesian Reasoning and Machine Learning", Cambridge University Press. 2012.
7	David Mackay, "Information Theory, Inference, and Learning Algorithms", Cambridge university press. 15 February 2010.

P24ML3205	QUANTUM COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:	To introduce the building blocks of Quantum computers and highlight the paradigm change between conventional computing and quantum computing. To understand entangled quantum subsystems and properties of entangled states, Quantum state transformations and the algorithms, applications of quantum computing.

Unit - I	**QUANTUM BUILDING BLOCKS**	**9**
The Quantum Mechanics of Photon Polarization, Single-Qubit Quantum Systems, Quantum State Spaces, Entangled States, Multiple-Qubit Systems, Measurement of Multiple-Qubit States, EPR Paradox and Bell's Theorem, Bloch sphere		
Unit - II	**QUANTUM STATE TRANSFORMATIONS**	**9**
Unitary Transformations, Quantum Gates, Unitary Transformations as Quantum Circuits, Reversible Classical Computations to Quantum Computations, Language for Quantum Implementations.		
Unit - III	**QUANTUM ALGORITHMS**	**9**
Computing with Superpositions, Quantum Subroutines, Quantum Fourier Transformations, Shor's Algorithm and Generalizations, Grover's Algorithm and Generalizations		
Unit – IV	**ENTANGLED SUBSYSTEMS AND ROBUST QUANTUM COMPUTATION**	**9**
Quantum Subsystems, Properties of Entangled States, Quantum Error Correction, Graph states and codes, CSS Codes, Stabilizer Codes, Fault Tolerance and Robust Quantum Computing		
Unit - V	**QUANTUM INFORMATION PROCESSING**	**9**
Limitations of Quantum Computing, Alternatives to the Circuit Model of Quantum Computation, Quantum Protocols, Building Quantum, Computers, Simulating Quantum Systems, Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the basic principles of quantum computing.	K2
CO2	Compare conventional computing with quantum computing.	K2
CO3	Apply the various basic quantum computing algorithms.	K3
CO4	Relate the classes of problems to be solved by quantum computation.	K2
CO5	Utilize the characteristics of quantum computing systems.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	2
CO2	2	2	2
CO3	2	1	3
CO4	3	2	3
CO5	2	2	2
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	John Gribbin, Computing with Quantum Cats: From Colossus to Qubits, 2021
2	William (Chuck) Easttom, Quantum Computing Fundamentals, 2021
3	Parag Lala, Quantum Computing, 2019
4	Eleanor Rieffel and Wolfgang Polak, Quantum Computing a Gentle Introduction, 2011
5	Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press.2002
6	Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific. 2004
7	Pittenger A. O., An Introduction to Quantum Computing Algorithms 2000

P24ML3206	MULTIMEDIA COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

Course Objectives:	To recapitulate the fundamentals of networking and requirements for multimedia communication, guaranteed service models and communication protocols that are used in IoT ecosystems. To explore the support provided for multimedia communication in 3G and 4G networks, VoIP and real time multimedia network applications.

Unit - I	**INTRODUCTION**	**9**

Switched Networks and Shared media Networks – Circuit Switching, Packet Switching and Virtual Circuits – Flow Control and Congestion Control – TCP/IP reference model – Network Externalities – Service Integration – Elastic and Inelastic Traffic – Playback Applications Additional Requirements for Inelastic Traffic – Core Networks and Access/Edge Networks.

Suggested Activities:

- Flipped classroom on network externalities and Economies of scale.
- External learning – Inter-continental backbone network and Autonomous Systems model of the Internet.
- Assignments on computing the playout time of packets.

Suggested Evaluation Methods:

- Quiz and discussion on network externalities and economies of scale.
- Assignments on proprietary protocols used in IoT and M2M.
- Assignments on problems related to playout time of multimedia applications.

Unit - II	**GUARANTEED SERVICE MODEL**	**9**

Best Effort Service Model and Its Limitations – Qos Metrics – Diffserv and Intserv Networks –Queuing Techniques – WFQ and Its Variants – RED – Qos Aware Routing – Call Admission Control – RSVP – Policing and Traffic Shaping Algorithms – Multicast Routing – IGMP, Protocol Independent Multicast – PIM SM and PIM DM Variants.

Suggested Activities:

- Flipped classroom on IntServ and DiffServ networks.
- External learning – Exploring the ways of using DSCP in IP header.
- Assignments on finish time problems related to WFQ and its variants.

Suggested Evaluation Methods:

- Quiz and discussion on IntServ and DiffServ networks.
- Assignments on configuring a router in such a way that DSCP fielder is exploited to provide QoS.
- Assignments on problems related to the virtual finish and actual finish of packets in WFQ and its variants.

Unit - III	**MULTIMEDIA TRANSPORT**	**9**

End To End Solutions – Laissez Faire Approach – Multimedia over TCP – Significance of UDP Multimedia Streaming – Audio and Video Streaming – Accessing Audio and Video from a Web Server and Media Server – Removing Jitter at the Receiver – Recovering from Packet Loss Forward Error Correction and Interleaving – Interactive and Non-Interactive Multimedia – Transcoding – RTSP – RTP/RTCP.

Suggested Activities:

- External learning – Exploring various media players available and the ways to customize them.
- Exploring the ways to configure RTP.
- Flipped classroom on RTP and RTCP.

Suggested Evaluation Methods:

- Assignments on media players available and configuring them.
- Configuring RTP and RTSP.
- Quiz and discussion on RTP and RTCP

Unit – IV	**MULTIMEDIA OVER WIRELESS NETWORKS**	**9**

Architecture of IP Multimedia Subsystem in 3G Networks – Application, Control and Data Planes in IMS Networks – Session Control, AAA, Real Time Data Transfer and Policy Control Protocols of IMS Networks – Relay Node and Multiple Radio Access Technologies in LTE – Voice Over IP Basics – IMS Volte Architecture – IP Multimedia Service

Identity Module, Private Identity, Public Identity (ISIM, IMPI And IMPU) – SIP User Agent (SIP UAC And SIP UAE) – Real Time Polling Service and Extended Real Time Polling Service in IEEE 802.16/Wimax Networks.

Suggested Activities:

- Flipped classroom on IMSVoLTE architecture.
- External learning – Multimedia support in 5G networks.
- Analyzing the protocols of IP media subsystem.

Suggested Evaluation Methods:

- Quiz and discussion on IMSVoLTE architecture.
- Assignments on multimedia support in 5G networks.
- Assignments on analyzing the headers of IP multimedia subsystem

Unit - V	MULTIMEDIA NETWORKED APPLICATIONS	9

H.322 Standard – Protocol Stack and Call Setup – Session Initiation Protocol – Components, Messages and Operation – Supporting Protocols for SIP – Media Gateway Access Protocol, Resource Reservation Protocol, Session Description Protocol – Case Study – Video Conferencing – Military Surveillance – Interactive TV – Video on Demand – Smart Phone.

Suggested Activities:

- Flipped classroom on SCIBus and S.100.
- External learning – Multimedia access networks and edge networks.
- Exploring the ways to configure SIP.

Suggested Evaluation Methods:

- Quiz and discussion on SCIBus and S.100.
- Assignments on multimedia access networks and edge networks.
- Configuring SIP using suitable commands.

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Outline the fundamental concepts of multimedia communication models.	K2
CO2	Explain the multimedia network applications at the network level, routing techniques with efficient scheduling.	K2
CO3	Infer the knowledge on VoIP based solutions for multimedia transport.	K2
CO4	Experiment with the concepts of IP multimedia subsystem and IP initiatives in cellular networks.	K3
CO5	Apply multimedia networks for real time applications.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	2
CO2	2	2	2
CO3	2	1	2
CO4	2	2	3
CO5	2	2	3

CO	2	2	2

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Mario Marques da Silva, "Multimedia Communications and Networking", CRC Press, 2012.
2	K. R. Rao, Zoron S. Bojkovic, Bojan M. Bakmaz, "Wireless Multimedia Communication Systems: Design, Analysis and Implementation", CRC Press, 2017.
3	Jim Kurose, Keith Ross, "Computer Networking: A Top Down Approach", Pearson Education, 2017.
4	K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Introduction to Multimedia Communications Applications, Middleware, Networking", John Wiley and Sons, 2009.

P24ML3207	INFORMATION RETRIEVAL TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the basics of information retrieval with pertinence to modeling, query operations and indexing, concepts of digital libraries, machine learning techniques for text classification and clustering. To understand the various applications of information retrieval giving emphasis to multimedia IR, web search.

Unit - I	**INTRODUCTION: MOTIVATION**	**9**
Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval – Retrieval Evaluation – Open-Source IR Systems–History of Web Search – Web Characteristics–The impact of the web on IR —IR Versus Web Search–Components of a Search engine.		
Unit - II	**MODELING**	**9**
Taxonomy and Characterization of IR Models – Boolean Model – Vector Model – Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing		
Unit - III	**INDEXING**	**9**
Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion – Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency		
Unit – IV	**EVALUATION AND PARALLEL INFORMATION RETRIEVAL**	**9**
Traditional Effectiveness Measures – Statistics in Evaluation – Minimizing Adjudication Effect – Nontraditional Effectiveness Measures – Measuring Efficiency – Efficiency Criteria –Queueing Theory – Query Scheduling – Parallel Information Retrieval – Parallel Query Processing – MapReduce		
Unit - V	**SEARCHING THE WEB**	**9**
Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries.		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the concepts of information retrieval system using the available tools.	K2
CO2	Relate the various components of an information retrieval system.	K2
CO3	Infer the different types of IR Models.	K2
CO4	Apply machine learning techniques to text classification and clustering for efficient information retrieval.	K3
CO5	Develop an efficient search engine for web content structure.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	2
CO2	2	2	2
CO3	3	2	2
CO4	2	2	3
CO5	2	1	3
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval, Cambridge University Press, First South Asian Edition, 2008.
2	Stefan Buttcher, Implementing and Evaluating Search Engines, The MIT Press, Cambridge, Massachusetts London, England, 2016.
3	Ricardo Baeza – Yates, Berthier Ribeiro – Neto, "Modern Information Retrieval: The concepts and Technology behind Search (ACM Press Books), Second Edition, 2011.
4	Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval".

P24ML3208	IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:	To study the fundamental concepts of digital image processing and image compression and to get exposed to simple image enhancement techniques in Spatial and Frequency domain recognition methods. To gather knowledge on image segmentation and Morphological Processing.

Unit - I	INTRODUCTION	9

Examples of fields that use digital image processing, fundamental steps in digital image processing, components of image processing system. Digital Image Fundamentals: A simple image formation model, image sampling and quantization, basic relationships between pixels. Color Image Processing: Color fundamentals, color models, pseudo color image processing, basics of full–color image processing, color transforms, smoothing and sharpening, color segmentation

Unit - II	IMAGE ENHANCEMENT	9

Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing, and sharpening spatial filters, combining the spatial enhancement methods. Filtering in the Frequency Domain: Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering. A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering.

Unit - III	WAVELETS AND IMAGE COMPRESSION	9

Wavelets and Multiresolution Processing. Fundamentals, image compression models, error-free compression, lossy predictive coding, image compression standards

Unit – IV	IMAGE SEGMENTATION	9

Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation, Segmentation by Morphological Watersheds, The Use of Motion in Segmentation Morphological Image Processing: Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms.

Unit - V	REPRESENTATION AND OBJECT RECOGNITION	9

Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description. Object Recognition: Patterns and patterns classes, recognition based on decision–theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods –matching shape numbers, string matching.

	Total Periods:	45

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the concepts of mathematics for image understanding and analysis.	K2
CO2	Infer the techniques / processes for image Enhancement.	K2
CO3	Interpret the techniques / processes for image compression.	K2
CO4	Make use of the current trends in the field of image segmentation.	K3
CO5	Apply the various algorithms for image processing for realization and troubleshooting.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	2	2
CO2	2	2	2
CO3	2	1	3
CO4	3	2	3
CO5	2	2	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Digital Image Processing, Rafeal C.Gonzalez, Richard E.Woods, fourth Edition, Pearson Education/PHI, 2018
2	Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, fourth Edition, Thomson Learning, 2015
3	Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology, 2021
4	Computer Vision and Image Processing, Adrian Low, Second Edition, B.S. Publications, 2022
5	Digital Image Processing using Matlab, Rafeal C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education, 2006

P24ML3209	AUTONOMOUS SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:	To impart knowledge on the functional architecture of autonomous vehicles, localization and mapping fundamentals, process end effectors and robotic controls. To learn about robot cell design, robot transformation, sensors and micro/nano robotic systems.

Unit - I	**INTRODUCTION AND FUNCTIONAL ARCHITECTURE**	**9**

Functional architecture - Major functions in an autonomous vehicle system, Motion Modeling - Coordinate frames and transforms, point mass model, Vehicle modeling (kinematic and dynamic bicycle model - two-track models), Sensor Modeling - encoders, inertial sensors, GPS.

Unit - II	**PERCEPTION FOR AUTONOMOUS SYSTEMS**	**9**

SLAM - Localization and mapping fundamentals, LIDAR and visual SLAM, Navigation – Global path planning, Local path planning, Vehicle control - Control structures, PID control, Linear quadratic regulator, Sample controllers.

Unit - III	**ROBOTICS INTRODUCTION, END EFFECTORS AND CONTROL**	**9**

Robot anatomy-Definition, law of robotics, Simple problems Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems, Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers- Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems- Robot controls-Point to point control, Continuous path control, Intelligent robot Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT Motion Interpolations- Adaptive control.

Unit – IV	**ROBOT TRANSFORMATIONS, SENSORS AND ROBOT CELL DESIGN**	**9**

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile, Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software.

Unit - V	**MICRO/NANO ROBOTICS SYSTEM**	**9**

Micro/Nano robotics system overview - Scaling effect - Top down and bottom-up approach Actuators of Micro/Nano robotics system-Nano robot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot- Nano robot in targeted drug delivery system

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Outline the architecture and modeling of autonomous systems.	K2
CO2	Explain the employ localization mapping techniques for autonomous systems.	K2
CO3	Infer and design the solutions for autonomous systems control.	K2
CO4	Utilize the concepts of robot transformations, sensors and cell design.	K3
CO5	Build micro & nano robotic systems.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	2	2
CO2	3	2	2
CO3	2	1	3
CO4	2	2	3
CO5	2	1	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education.,2009.
2	Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
3	Karsten Berns, Ewald Puttkamer, Springer, Autonomous Land Vehicles: Steps towards Service Robots, 2009
4	Sebastian Thrun, Wolfram Burgard, Dieter Fox., Probabilistic robotics. MIT Press, 2005.
5	Steven M. LaValle., Planning algorithms, Cambridge University Press, 2006.
6	Daniel Watzenig and Martin Horn (Eds.), Automated Driving: Safer and More Efficient Future Driving, Springer, 2017.
7	Markus Maurer, Autonomous driving: technical, legal and social aspects. Springer, 2016.
8	Jha, Theory, Design and Applications of Unmanned Aerial Vehicles, CRC Press, 2016.

P24ML3210	WEB ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the web analytics platform, and their evolution, common metrics of web as well as KPI related concepts. To learn about the various data streams, benefits of surveys and capturing of data, various web analytics versions.

Unit - I	**INTRODUCTION**	**9**

Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, on site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations.

Unit - II	**DATA COLLECTION**	**9**

Click stream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: Ecommerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.

Unit - III	**QUALITATIVE ANALYSIS**	**9**

Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; SiteVisits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, creating and running a survey, Benefits of surveys. Capturing data: Web logs or JavaScript's tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding click stream data quality, Identifying unique page definition, Using cookies, Link coding issues.

Unit – IV	**WEB METRICS**	**9**

Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bouncerate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI. Relevant Technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

Unit - V	**WEB ANALYTICS 2.0**	**9**

Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities. Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the web analytics platform and their evolution.	K2
CO2	Utilize the various click streams data.	K3
CO3	Select how to capture data by qualitative analysis.	K3
CO4	Interpret the common metrics of web and KPI related concepts.	K2

COs	Statements	K-Level
CO5	Make use of various web analytics versions.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	2
CO2	2	1	3
CO3	2	1	3
CO4	3	2	2
CO5	2	2	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc.2nd ed, 2012.
2	Kaushik A., Web Analytics 2.0, The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. 1st ed, 2010.
3	Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons, 2002

P24ML3211	COGNITIVE COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:	To familiarize the use of innovation canvas to justify potentially successful products and to learn various ways in which to develop a product idea and applications of cognitive computing. To understand how big data can play a vital role in cognitive computing, business applications of cognitive computing.

Unit - I	FOUNDATION OF COGNITIVE COMPUTING	9

Foundation of Cognitive Computing: cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, understanding cognition Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation, and visualization services.

Unit - II	NATURAL LANGUAGE PROCESSING IN COGNITIVE SYSTEMS	9

Natural Language Processing in support of a Cognitive System: Role of NLP in a cognitive system, semantic web, Applying Natural language technologies to Business problems Representing knowledge in Taxonomies and Ontologies: Representing knowledge, Defining Taxonomies and Ontologies, knowledge representation, models for knowledge representation, implementation considerations.

Unit - III	BIG DATA AND COGNITIVE COMPUTING	9

Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data Applying Advanced Analytics to cognitive computing: Advanced analytics is on a path to cognitive computing, Key capabilities in advanced analytics, using advanced analytics to create value, Impact of open-source tools on advanced analytics.

Unit – IV	BUSINESS IMPLICATIONS OF COGNITIVE COMPUTING	9

Preparing for change, advantages of new disruptive models, knowledge meaning to business, difference with a cognitive systems approach, meshing data together differently, using business knowledge to plan for the future, answering business questions in new ways, building business specific solutions, making cognitive computing a reality, cognitive application changing the market. The process of building a cognitive application: Emerging cognitive platform, defining the objective, defining the domain, understanding the intended users and their attributes, questions and exploring insights, training and testing.

Unit - V	APPLICATION OF COGNITIVE COMPUTING	9

Building a cognitive health care application: Foundations of cognitive computing for healthcare, constituents in healthcare ecosystem, learning from patterns in healthcare Data, Building on a foundation of big data analytics, cognitive applications across the health care eco system, starting with a cognitive application for healthcare, using cognitive applications to improve health and wellness, using a cognitive application to enhance the electronic medical record Using cognitive application to improve clinical teaching.

	Total Periods:	45

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the applications in Cognitive Computing.	K2
CO2	Make use of the Natural language processor's role in Cognitive computing.	K3

COs	Statements	K-Level
CO3	Infer the future directions of Cognitive Computing.	K2
CO4	Identify suitable cognitive computing solutions for business implications.	K3
CO5	Relate applications involved in Cognitive Computing.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	2
CO2	2	2	3
CO3	2	1	2
CO4	2	2	3
CO5	3	2	3
CO	**2**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive computing and Big Data Analytics", Wiley, 2015.
2	Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences", The MIT Press, 1999.
3	Noah D. Goodman, Joshua B. Tenenbaum, The ProbMods Contributors, "Probabilistic Models of Cognition", Second Edition, 2016, https://probmods.org/

P24AC7001	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

Course Objectives:	Teach how to improve writing skills and level of readability and to impart the writing skills. Infer the skills needed when writing the Conclusion and ensure the quality of paper at very first-time submission.

Unit - I	**INTRODUCTION TO RESEARCH PAPER WRITING**	**6**
Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness		
Unit - II	**PRESENTATION SKILLS**	**6**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction		
Unit - III	**TITLE WRITING SKILLS**	**6**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check		
Unit – IV	**RESULT WRITING SKILLS**	**6**
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions		
Unit - V	**VERIFICATION SKILLS**	**6**
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission		
	Total Periods:	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Interpret writing meaningful sentences and coherent paragraphs.	K2
CO2	Outline the paraphrasing and plagiarism for presentation skills.	K2
CO3	Summarize about review literature, write methodology, results and conclusion.	K2
CO4	Illustrate how to write methodology, discussions, results and conclusion.	K2
CO5	Infer how to use useful phrases and checking plagiarism	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	3

	Programme Outcomes		
	01	02	03
CO2	2	2	3
CO3	3	2	2
CO4	2	1	3
CO5	3	2	2
CO	2	2	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2	Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3	Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4	Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

P24AC7002	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0
Course Objectives:	To explain the critical understanding of key concepts in disaster risk reduction and humanitarian response and to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. To understand standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.				

Unit - I	**INTRODUCTION**	**6**
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.		
Unit - II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6**
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.		
Unit - III	**DISASTER PRONE AREAS IN INDIA**	**6**
Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.		
Unit – IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6**
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.		
Unit - V	**RISK ASSESSMENT**	**6**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival		
	Total Periods:	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Summarize the basics of disaster.	K2
CO2	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.	K2
CO3	Illustrate the disaster risk reduction and humanitarian response policy.	K2
CO4	Summarize the standards of humanitarian response and practical relevance in disaster and conflict situations.	K2
CO5	Outline the disaster risk assessment approaches.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	2	2
CO2	2	1	2
CO3	1	2	2
CO4	2	1	3
CO5	1	2	2
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2	Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company, 2007.
3	Sahni, Pradeep Et.Al.," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi, 2001.

P24AC7003	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

Course Objectives:	To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective and to address the growth of Indian opinion regarding modern Indian intellectuals' constitution. To infer the role and entitlement of civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

Unit - I	**HISTORY OF MAKING OF THE INDIAN CONSTITUTION**	**3**
History, Drafting Committee, (Composition & Working)		
Unit - II	**PHILOSOPHY OF THE INDIAN CONSTITUTION**	**3**
Preamble, Salient Features		
Unit - III	**CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**	**5**
Fundamental Rights, Right to Equality, Right to Freedom, right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.		
Unit – IV	**ORGANS OF GOVERNANCE**	**5**
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.		
Unit - V	**LOCAL ADMINISTRATION AND ELECTION COMMISSION**	**14**
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy. Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.		
	Total Periods:	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Outline the history of the Indian constitution.	K2
CO2	Summarize the philosophy of the Indian constitution.	K2
CO3	Infer the concepts of fundamental rights and directive principles of state policy.	K2
CO4	Interpret the importance of organs of governance.	K2
CO5	Explain the local administration and election commission.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	1	1	2
CO2	1	1	2
CO3	2	2	3
CO4	2	1	2
CO5	1	2	2
CO	1	1	2

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	The Constitution of India,1950(Bare Act), Government Publication.
2	Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3	M.P. Jain, Indian Constitution Law, 7th Edn., LexisNexis,2014.
4	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015.

P24AC7004	நற்றமிழ் இலக்கியம்	L	T	P	C
		2	0	0	0

Unit - I	சங்க இலக்கியம்	6

1 தமிழின் துவக்க நூல் தொல்காப்பியம்
- எழுத்து, சொல், பொருள்

2 அகநானூறு (82)
- இயற்கை இன்னிசை அரங்கம்

3 குறிஞ்சிப் பாட்டின் மலர்க்காட்சி

4 புறநானூறு (95, 195)
- போரை நிறுத்திய ஔவையார்

Unit - II	அறநெறித் தமிழ்	6

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

Unit - III	இரட்டை காப்பியங்கள்	6

1 கண்ணகியின் புரட்சி
- சிலப்பதிகார வழக்குரை காதை

2 சமூகசேவை இலக்கியம் மணிமேகலை
- சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

Unit – IV	அருள்நெறித் தமிழ்	6

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

Unit - V	நவீன தமிழ் இலக்கியம்	6

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

Total Periods:	30

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1	தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) www.tamilvu.org
2	தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
3	தர்மபுர ஆதீன வெளியீடு
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