MANONMANIAM SUNDARANAR UNIVERSITY

M.Sc.,
COMPUTER SCIENCE
with
ARTIFICIAL INTELLIGENCE

SYLLABUS

FROM THE ACADEMIC YEAR

2024 - 2025

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION,
CHENNAI - 600 005

CONTENTS

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc., COMPUTER SCIENCE with ARTIFICIAL INTELLIGENCE**
Duration	**PG - Two Years**
Programme Outcomes (POs)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of society by collaborating with stakeholders for mutual benefit.

Template for P. G., Programmes

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1. Core-I	4	5	**2.1. Core-IV**	4	5	3.1. Core-V	4	5	4.1 Project with Viva- Voce	20	30
1.2 Core-II	4	5	**2.2 Core-V**	4	5	3.2 Core-VI	4	4	4.2 Extension Activity	1	
1.3 **Core III**	4	4	**2.3 Elective – III**	3	4	3.3 Core – VII	4	4			
1.4 Elective-I	3	4	**2.4 Elective-IV**	3	4	3.4 Elective (Generic / Discipline Centric) – V	3	4			
1.5 Elective-II	3	4	2.5 **Core LAB-III**	3	4	3.5 Core Practical V	3	4			
1.6 **Core LAB-I**	3	4	2.6 **Core LAB-IV**	3	4	3.6 Mini Project	6	6			
1.7 **Core LAB-II**	3	4	2.7 **Skill Enhancement Course SEC 1**	2	4	3.7 Skill Enhancement Course –SEC 2	2	3			
						3.8 Internship/ Industrial Activity/Research Updation Activity	2	-			
	24	30		22	30		28	30		21	30
Total Credits 91											

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline
Based Credits and Hours Distribution System
for all Post – Graduate Courses including Lab Hours

Part	List of Courses	Credits	No. of Hours
Semester I	Core – I	4	5
	Core – II	4	5
	Core – III	4	4
	Elective – I	3	4
	Elective – II	3	4
	Core Practical 1	3	4
	Core Practical 2	3	4
	Total	**24**	**30**

Part	List of Courses	Credits	No. of Hours
Semester II	Core – IV	4	5
	Core – V	4	5
	Elective – III	3	4
	Elective – IV	3	4
	Core Practical 3	3	4
	Core Practical 4	3	4
	Skill Enhancement Course [SEC] - I	2	4
	Total	**22**	**30**

Part	List of Courses	Credits	No. of Hours
Semester III	Core – VI	4	5
	Core – VII	4	4
	Core – VIII	4	4
	Elective – V	3	4
	Core Practical 5	3	4
	Mini Project	6	6
	Skill Enhancement Course [SEC] - 2	2	3
	Internship/Industry Activity/Research Updation Activity	2	-
		28	**30**

Part	List of Courses	Credits	No. of Hours
Semester IV	Project with VIVA VOCE	16	30
	Extension Activity	1	-
		17	**30**

METHODS OF EVALUATION		
Internal Evaluation	Continuous Internal Assessment Test	**25 Marks**
	Assignments / Snap Test / Quiz	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	**75 Marks**
Total		**100 Marks**

METHODS OF ASSESSMENT	
Remembering (K1)	The lowest level of questions require students to recall information from the course content Knowledge questions usually require students to identify information in the text book.
Understanding (K2)	Understanding of facts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in theirown words. The questions go beyond ample recall and require students to combine data together
Application (K3)	Students have to solve problems by using/ applying a concept learned in the classroom. Students must use their knowledge to determine a exact response.
Analyze (K4)	Analyzing the question is one that asks the students to break down something into its component parts. Analyzing requires students to identify reasons causes or motives and reach conclusions or generalizations.
Evaluate (K5)	Evaluation requires an individual to make judgment on something. Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. Students are engaged in decision-making and problem–solving. Evaluation questions do not have single right answers.
Create (K6)	The questions of this category challenge students to get engaged in creative and original thinking. Developing original ideas and problem solving skills

Testing Pattern (25+75)

Internal Assessment

Theory Course: For theory courses, there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 25 marks. The duration of each test shall be one / one and a half hours.

Computer Laboratory Courses: For Computer Laboratory Oriented Courses, there shall be two tests in the Theory part and two tests in the Laboratory part. Choose one best from the Theory part and the other best from the two Laboratory parts. The average of the best two can be treated as the CIA for a maximum of 25 marks. The duration of each test shall be one /one and a half hours.

There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examination.

Written Examination: Theory Paper (Bloom's Taxonomy based)

Question Paper Model

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50%** **Duration: Three Hours**
	Part –A (15x 1 = 15 Marks) Answer ALL Questions **Each Question carries 1 mark**
Memory Recall / Example/ Counter Example / Knowledge about the Concepts/ Understanding	Three questions from each UNIT
	Question 1 to Question 10
	Part – B (5 x 4 = 20 Marks) **Answer ALL Questions** **Each question carries 5 Marks**
Descriptions/ Application (problems)	**Either-or Type** Both parts of each question from the same UNIT
	Question 11(a) or 11(b) To **Question 15(a) or 15(b)**
	Part-C (5x 8 = 40 Marks) **Answer ALL questions** **Each question carries 8 Marks** **Either or Type** Both parts of each question from the sameUNIT
Analysis /Synthesis / Evaluation	There shall be FIVE questions covering all five units
	Question 16 to Question 20

Each question should carry the course outcome and cognitive level

For instance,

1. [CO1 : K2] Question xxxx
2. [CO3 : K1] Question xxxx

PROGRAMME OUTCOMES (PO) - PROGRAMME SPECIFIC OUTCOMES (PSO) MAPPING

PROGRAMME SPECIFIC OUTCOMES (PSO)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
PSO1	**3**	**3**	**3**	**3**	**3**
PSO2	**3**	**3**	**3**	**3**	**3**
PSO3	**3**	**3**	**3**	**3**	**3**
PSO4	**3**	**3**	**3**	**3**	**3**
PSO5	**3**	**3**	**3**	**3**	**3**

Level of Correlation between PO's and PSO's
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Assign the value
1 – Low
2 – Medium
3 – High
0 – No Correlation

M. Sc., COMPUTER SCIENCE WITH ARTIFICIAL INTELLIGENCE

SEMESTER - I

Course status	Course Title	Credits	Hours
Core	Artificial Intelligence & Expert Systems	4	5
Core	Fundamentals of Data Science	4	5
Core	Design & Analysis of Algorithms	4	4
Elective - I	Mathematics for Data Science/ Web services	3	4
Elective - II	Compiler Design / Virtual and Augmented Reality	3	4
Practical	Algorithm Lab	3	4
Practical	Python Programming Lab	3	4
	Total	**24**	**30**

SEMESTER - II

Course status	Course Title	Credits	Hours
Core	Machine Learning	4	5
Core	Big Data Analytics	4	5
Elective 3	Pattern Recognition & Image Analysis / Optimization Techniques	3	4
Elective 4	Wireless Networks & Mobile Computing/ Databases for Data Science	3	4
Practical	Machine Learning Lab	3	4
Practical	Big Data Analytics Lab	3	4
Skill Enhancement Course [SEC]	Social Network Analysis	2	4
	Total	22	30

Semester –I Core 1	L	T	P	C
	5	1	0	4

ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS

Course Objectives:

1. To understand the basic concepts and principles of Artificial Intelligence
2. To learn various applications domains of AI
3. To study the concepts of Expert Systems

Unit-I Fundamentals of Artificial Intelligence

Introduction: What is AI? AI Techniques, Representation of Knowledge, Knowledge-Based Systems, State Space Search. Production Systems: Problem Characteristics, Types of Production Systems. Intelligent Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem-solving agents, problem formulation, Knowledge-based agents

Unit-II Search Strategies

Informed Search: Generate & test, Hill Climbing, Best First Search, A* and AO* Algorithm, Constraint Satisfaction, Means-Ends Analysis. Game playing: Minimax Search, Alpha-Beta Cutoffs, Waiting for Quiescence

Unit-III Knowledge Representation

Propositional Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. First-order Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining.

Unit-IV Expert systems

Architecture of expert systems, Steps to build Expert Systems - Role of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, PROSPECTOR

Unit-V Prolog Programming

Introduction to Prolog: Syntax and Numeric Function, Basic List Manipulation Functions in Prolog, Functions, Predicates and Conditional, Input, Output and Local Variables, Iteration and Recursion, Property Lists and Arrays

Course Outcome:

On successful completion of the course, the learners will be able to

1. Delineate Artificial intelligence.
2. Build knowledge-based systems.
3. Understand the basics of knowledge representations
4. Develop Expert Systems
5. Reformulate a problem from an AI perspective

CO-PO, PSO Mapping

ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO1	S	S	S	M	S	S	S	M	S	S	K-1
CO2	S	S	M	S	S	S	S	S	S	S	K-4
CO3	S	S	M	S	S	S	S	S	S	S	K-2
CO4	S	S	M	S	S	S	S	S	S	S	K-3
CO5	S	S	M	S	S	S	S	S	S	S	K– 6

Strongly Correlated–S, Moderately Correlated–M, Weekly Correlated-L

Text Books:

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence." Tata McGraw Hill, 3rd Edition
2. Stuart Russell & Peter Norvig, "Artificial Intelligence : A Modern Approach", Pearson Education, 2nd Edition.
3. Donald A. Waterman, “A Guide to Expert Systems”, Addison Wesley Publishing Company
4. Carl Townsend, “Introduction to Prolog Programming”
5. Ivan Bratko, “PROLOG Programming for Artificial Intelligence”, Addison-Wesley, 2nd Edition.
6. Klocksin and Mellish, “Programming with PROLOG”

Reference Books:

1. Eugene, Charniak, Drew McDermott, "Introduction to Artificial Intelligence", Addison Wesley
2. Patterson, “Introduction to AI and Expert Systems”, PHI
3. Nilsson, “Principles of Artificial Intelligence”, Morgan Kaufmann.
4. Carl Townsend, “Introduction to Turbo Prolog”, Paperback

https://nptel.ac.in/courses/106/105/106105077/

https://lecturenotes.in/materials/29314-note-for-artificial-intelligence-ai-by-jaswanth-chowdary
https://www.tutorialspoint.com/artificial_intelligence/index.htm

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">FUNDAMENTALS OF DATA SCIENCE</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>5</td><td colspan="2"></td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic understanding of data and process</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce the concepts and fundamentals of data science and its life cycle</td></tr>
<tr><td colspan="2">Learning Outcome</td><td colspan="6">Students will be able to
CO1: Understand the types of data and analytics, the data science process,and its life cycle.
CO 2: Apply math in data science
CO 3: Analyze the various data-intensive operations and tools
CO 4: Evaluate the tools and methods for analyzing the data
CO 5: Investigate the recent potential applications and development of data science with real-time case studies</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="6">UNIT-I: INTRODUCTION OF DATA SCIENCE
Data Science – Data science Venn diagram - Basic terminology – Data science case studies- Types of data – levels of data- Types of data analytics - Descriptive analytics-Diagnostic analytics- Predictive analytics- Prescriptive analytics- Five steps of Data Science
Book 1 - Chapter 1,2,3</td></tr>
<tr><td colspan="6">UNIT-II: MATHEMATICAL PRELIMINARIES
2.1 Basic Maths – mathematics as a discipline – basic symbols andterminology –linear algebra
2.2 Basic Probability – definitions- probability – Bayesian vs frequentist – compound events – conditional probability – rules of probability
Book 1: Unit 2.1 – Chapter 4, Unit 2.2 – Chapter 5</td></tr>
<tr><td colspan="6">UNIT-III: DATA MINING AND DATA WAREHOUSING
Introduction to Data warehousing – Design consideration of data warehouse - Data loading process – case study – Data mining – Data mining techniques – Tools and platforms – case study
Book 2 – Chapter 3 and 4</td></tr>
<tr><td colspan="6">UNIT-IV : VISUALIZING DATA
Exploratory Data Analysis – Developing the visual aesthetic – chart types – Great visualizations – Reading graphs – Interactive visualizations
Book 3 - Chapter 6</td></tr>
</table>

	UNIT-V: Data Science – Recent Trends Applications of Data Science, recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.
Extended Professional Component	Case study on recent developments and presentation
Skills acquired from this course	Data Science Process, Fundamentals, Applications
Recommended Text	1. Ozdemir, Sinan. Principles of data science. Packt Publishing Ltd, 2016.(Unit 1- Chapter 1,2,3 Unit 2.1 – Chapter 4, Unit 2.2 – Chapter 5) 2. Maheshwari, Anil. "Data analytics made accessible." Seattle: Amazon Digital Services, 2 nd edition (2023).(Unit 3 – Chapter 3 and 4) 3. Skiena, Steven S. The data science design manual. Springer, 2017.(Unit 4- chapter 6)
Reference Books	1. Hadrien Jean.Education, C. (2023). Data Science. Certybox Education. 2. Pierson, Lillian. Data science for dummies. John Wiley & Sons, 2021. 3. Grus, Joel. Data science from scratch: first principles with python. O'Reilly Media, 2019. 4. Blum, Avrim, John Hopcroft, and Ravindran Kannan. Foundations of data science. Cambridge University Press, 2020.
Website and e-Learning Source	https://www.analyticsvidhya.com/ https://www.simplilearn.com https://www.ibm.com/in-en/topics/data-science https://www.mygreatlearning.com/blog/what-is-data-science/

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	3	3	2
CO2	3	2	2	3	3	2
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	2	3	3	3
Weightage of course contributed toeach PSO	15	10	12	15	15	13

L	T	P	C
4	0	0	4

DESIGN AND ANALYSIS OF ALGORITHMS

Course Objective:
To learn effective problem-solving in computing applications and analyze the algorithmic procedure to determine the computational complexity

Unit I: Introduction: Algorithm Definition – Algorithm Specification – Performance Analysis-Asymptotic Notations. Elementary Data Structures: Stacks and Queues – Trees – Dictionaries –Priority Queues – Sets and Disjoint Set Union – Graphs

Unit II: Divide and Conquer: The General Method – Defective Chessboard – Binary Search – Finding the Maximum and Minimum – Merge Sort – Quick Sort – Selection - Strassen's Matrix Multiplication.
Unit III: The Greedy Method: General Method - Container Loading - Knapsack Problem - Tree Vertex Splitting – Job Sequencing With Deadlines - Minimum Cost Spanning Trees - Optimal Storage On Tapes – Optimal Merge Patterns - Single Source Shortest Paths.
Unit IV: Dynamic Programming: The General Method – Multistage Graphs – All-Pairs Shortest Paths – Single-Source Shortest Paths - Optimal Binary Search Trees - String Editing - 0/1 Knapsack - Reliability Design - The Traveling Salesperson Problem - Flow Shop Scheduling. Basic Traversal and Search Techniques: Techniques for Binary Trees – Techniques for Graphs – Connected Components and Spanning Trees – Bi-connected Components and DFS.
Unit V: Backtracking: The General Method – The 8-Queens Problem – Sum of Subsets – Graph Coloring – Hamiltonian Cycles – Knapsack Problem Branch and Bound: Least Cost search - 0/1 Knapsack Problem.

Course Outcome:
On successful completion of the course, the learners will be able to
1. Understand and solve complex problems
2. Select an appropriate algorithm for the problem
3. Evolve as a competent programmer capable of designing and analyzing algorithms and data structures for different kinds of problems
4. Classify problems into complexity classes like P and NP.
5. Analyze graphs and determine shortest path

DESIGN AND ANALYSIS OF ALGORITHMS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	M	H	H	M	H	H	H	M	H	H	K – 2
CO 2	H	M	M	H	H	H	H	H	H	H	K – 1
CO 3	H	H	M	H	H	H	H	H	H	H	K – 3
CO 4	H	H	M	H	H	H	H	H	H	H	K – 4
CO 5	H	H	M	H	M	H	H	H	H	H	K – 6

Text Book

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

References

1. Data Structures Using C - Langsam, Augenstien, Tenenbaum, PHI
2. Data structures and Algorithms, V.Aho, Hopcropft, Ullman , LPE
3. Introduction to design and Analysis of Algorithms - S.E. Goodman, ST. Hedetniem- TMH.
4. Carlos A.Coello Coello, Gary B.Lamont, David A.Van Veldhuizen, “Evolutionary Algorithms for Solving Multi-Objective Problems”, Springer 2nd Edition, 2007.

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">MATHEMATICS FOR DATA SCIENCE</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
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<tr><td>4</td><td colspan="2"></td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To build the mathematical background necessary to understand and implement in data science practical/research work</td></tr>
<tr><td colspan="2">Learning Outcome</td><td colspan="8">Students will be able to
CO1: Demonstrate understanding of basic mathematical concepts in datascience, relating to linear algebra
CO2: Describe properties of linear systems using vectors, a n d perform andinterpret matrix operations.
CO3: Describe and compute orthogonality and determinants
CO4: Solve linear differential equations
CO5: Understand and apply the concept of Linear transformations</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="8">UNIT-I:
1.1 Vectors and Matrices
Vectors and Linear Combinations-Lengths and Angles from Dot Products-Matrices and Their Column Spaces-Matrix Multiplication AB and CR
1.2 Solving Linear Equations Ax = b
Elimination and Back Substitution-Elimination Matrices and Inverse Matrices-Matrix Computations and A = LU-Permutations and Transposes</td></tr>
<tr><td colspan="8">UNIT-II:
2.2 The Four Fundamental Subspaces
Vector Spaces and Subspaces-Computing the Nullspace by Elimination: A = CR-The Complete Solution to Ax = b-Independence, Basis, andDimension-Dimensions of the Four Subspaces</td></tr>
<tr><td colspan="8">UNIT-III:
3.1 Orthogonality
Orthogonality of Vectors and Subspaces-Projections onto Lines and Subspaces-Least Squares Approximations-Orthonormal Bases and Gram-Schmidt-The Pseudoinverse of a Matrix
3.2 Determinants
3 by 3 Determinants and Cofactors-Computing and Using Determinants-Areas and Volumes by Determinants</td></tr>
<tr><td colspan="8">UNIT-IV :
4.1 Eigenvalues and Eigenvectors
Introduction to Eigenvalues : Ax = λx - Diagonalizing a Matrix- Symmetric Positive Definite Matrices-Complex Numbers and Vectors andMatrices-Solving Linear Differential Equations</td></tr>
</table>

	UNIT-V: **5.1 The Singular Value Decomposition (SVD)** Singular Values and Singular Vectors-Image Processing by LinearAlgebra-Principal Component Analysis (PCA by the SVD) **5.2 Linear Transformations** The Idea of a Linear Transformation-The Matrix of a LinearTransformation-The Search for a Good Basis

Extended Professional Component	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency
Recommended Text	[1] Gilbert Strang, Introduction to Linear Algebra, Wellesley - Cambridge Press, Sixth Edition, 2023
Reference Books	[1] David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications 5th Edition, Pearsons [2] Sheldon Axler, Linear Algebra Done Right (Undergraduate Texts in Mathematics) 3rd ed., Springer, 2015 Edition [3] Jim Hefferon, Linear Algebra, Fourth edition [4] Jeff M Philips, Mathematical Foundations for Data Analysis
Website and e-Learning Source	**https://joshua.smcvt.edu/linearalgebra/**

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	2	3	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
Weightage of course contributed toeach PSO	15	13	11	15	15	15

Course code		WEB SERVICES	L	T	P	C
Core/Elective/Supportive		Elective 1-2	4			3
Pre-requisite		Basics of Distributed Computing				

Course Objectives:

The main objectives of this course are to:

1. Present the Web Services , Building real world Enterprise applications using Web Services with Technologies XML, SOAP , WSDL , UDDI
2. Get overview of Distributed Computing, XML, and its technologies
3. Update with QoS and its features
4. Develop Standards and future of Web Services

Expected Course Outcomes:

On the successful completion of the course ,student will be able to:

1	Understand web services and its related technologies	K1,K2
2	Understand XML concepts	K2,K3
3	Analyze on SOAP and UDDI model	K4,K5
4	Demonstrate the road map for the standards and future of web services	K5
5	Analyze QoS enabled applications in web services	K5,K6

K1-Remember; **K2**-Understand; **K3**-Apply; **K4**-Analyze; **K5**-Evaluate; **K6**-Create

Unit:1	INTRODUCTION	12hours

Introduction to web services – Overview of Distributed Computing- Evolution and importance of web services-Industry standards, Technologies and concepts underlying web services-Web services and enterprises-web services standards organization-web services platforms.

Unit:2	XMLFUNDAMENTALS	12hours

XMLFundamentals–XMLdocuments-XMLNamespaces-XMLSchema–ProcessingXML.

Unit:3	SOAP MODEL	12hours

SOAP: The SOAP model- SOAP messages-SOAP encoding- WSDL: WSDL structure- interface definitions-bindings-services-Using SOAP and WSDL-UDDI: About UDDI- UDDI registry Specification- Core data structures-Accessing UDDI

Unit:4	TECHNOLOGIESANDSTANDARDS	12hours

advanced web services technologies and standards: Conversations overview-web services conversation language-WSCL interface components. Workflow: business process management-workflows and workflow management systems Security: Basics-data handling and forwarding-data storage-errors-Web services security issues.

Unit:5	QUALITY OF SERVICE	10 hours

Quality of Service: Importance of QoS for web services-QoS metrics-holes-design patterns-QoS-enabled web services-QoS-enabled applications. Web services management services standards and future trends.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars –webinars

	Total Lecture hours	60 hours

Text Books

1	Sandeep Chatterjee, James Webber, "Developing Enterprise Web Services: An Architects Guide", Prentice Hall, Nov 2003.
2	Keith Ballinger, "NET Web services: Architecture and Implementation with .Net", Pearson Education, First Edition, Feb 2003.

Reference Books

1	RameshNagappan,"DevelopingJavaWebServices:Architectinganddevelopingsecure Web Services Using Java", John Wiley and Sons, first Edition Feb 2003.
2	Eric A Marks and Mark J Werrell ," Executive Guide to Webservices" ,John Wiley and sons, March 2003.
3	Anne Thomas Manes, "Web Services :A managers Guide", AddisonWesley,June2003.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.tutorialspoint.com/webservices/index.htm
2	https://www.javatpoint.com/web-services-tutorial
3	https://www.btechguru.com/training--programming--xml--web-services--web-services-part-1-video-lecture--11801--24--147.html

Mapping with Programming Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	M	M	M	S
CO2	S	S	S	M	M	S	M	S	M	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">COMPILER DESIGN</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE I (EC1)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2"></td><td>-</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic knowledge in one of the programming language and data structures</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To acquire the knowledge about the compiler design and to understand the different phases of Compiler</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I : Compilers & Translators, Need of Translators, Structure of a Compiler, Phases,Lexical Analysis, Syntax Analysis, Intermediate Code Generation, Code Optimization, Code Generation, Book Keeping, A Symbol Table in brief, Semantic Analysis, L-value, r-values, Error Handling</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT-II : Rules of Lexical Analyser, Need for Lexical Analysis, Input Buffering, Preliminary Scanning, A simple Approach to the Design of Lexical Analysers, Transition Diagrams, Regular Expression, String & Languages, Finite Automata, Non-deterministic Automata, Deterministic Automata, From regular Expression to Finite Automata, Context free Grammars, Derivations & Parse Trees, Parsers,Shift Reduce Parsing, Operator-Precedence Parsing</td></tr>
</table>

	UNIT-III : Symbol Table Management, Contents of a Symbol Table, Names & Symbol table records, reusing of symbol table spaces, array names, Indirection in Symbol Table entries, Data Structures for Symbol Tables, List, Self Organizing Lists, Search Trees, Hash Tables, Errors, Reporting Errors, Sources of Errors Syntactic Errors, Semantic Errors, Dynamic Errors, Lexical Phase Errors, Minimum Distance Matching, Syntactic Phase Error, Time of Detection, Ponic mode, Case study on Lex and Yacc
	UNIT-IV : Principal Sources of Optimization, Inner Loops, Language Implementation Details Inaccessible to the User. Further Optimization, Algorithm Optimization, Loop Optimization , Code Motion, Induction Variables, Reduction in Strength, Basic Blocks, Flow Graphs, DAG Representation of Basic Blocks, Value Numbers & Algebraic Laws, Global Data Flow Analysis, Memory Management Strategies , Fetch Strategy, Placement Strategies, Replacement Strategies, Address Binding, Compile Time, Load Time, Execution Time, Static Loading, Dynamic Loading, Dynamic Linking

	UNIT-V: Problems in Code Generation, a Simple Code Generator, Next-Use Information, Register Descriptors, Address Descriptors, Code Generation Algorithm, Register Allocation & Assignment, Global Register Allocation, Usage Counts, Register Assignment for Outer Loops, Register Allocation by Graph Coloring, Code Generation from DAG's, Peep-Hole Optimization, Redundant Loads & Stores, Un-Reachable Code, Multiple Jumps, Algebraic Simplifications, Use of Machine Idioms
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Compilers: Principles, Techniques & Tools, Second Edition by A. V. Aho, Monicas. Lam, Ravi Sethi, J. D. Ullman
Reference Books	1. Dhamdhere D.M., "Compiler Construction: Theory and Practice", McMillan India Ltd., 1983 2. Holub Allen, "Compiler Design in C", Prentice Hall of India, 1990
Website and e-Learning Source	1. https://www.geeksforgeeks.org/compiler-design-tutorials/ 2. https://www.tutorialspoint.com/compiler_design/ 3. https://www.javatpoint.com/compiler-tutorial 4. https://onlinecourses.nptel.ac.in/noc19_cs01/preview 5. http://ecomputernotes.com/compiler-design

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Identify the major phases of compilation and the functionality of LEX and YACC
CLO2	Describe the functionality of compilation process and symbol table management
CLO3	Apply the various parsing, optimization techniques and error recovery routines to have a better code for code generation
CLO4	Analyze the techniques and tools needed to design and implement compilers.
CLO5	Test a compiler and experiment the knowledge of different phases in compilation

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	2	2	2	3	2
CLO2	3	2	2	2	3	3
CLO3	3	2	3	3	2	3
CLO4	3	3	3	3	2	3
CLO5	3	3	3	3	3	3
Weightage of course contribute to each PSO	15	12	13	13	13	14

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">VIRTUAL AND AUGMENTED REALITY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>I</td><td colspan="3"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2"></td><td>-</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic knowledge of computer graphics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To provide knowledge on basic principles of virtual & augmented reality and have the ability to use its technology as a platform for real-world applications.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I :

Virtual Reality: The Three I’s of VR – History – Early commercial VR Technology – Components of a VR System – Input Devices: Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces</td></tr>
<tr><td colspan="2" rowspan="4"></td><td colspan="6">UNIT-II :

Output Devices: Graphics Displays – Sound Displays – Haptic Feedback - Computer Architecture for VR: The Rendering Pipeline- PC Graphics Architecture - VR Programming: Toolkits and Scene Graphs – Traditional and Emerging Applications of VR</td></tr>
<tr><td colspan="6">UNIT-III :

Augmented Reality: Introduction – Augmented Reality Concepts: Working Principle of AR –Concepts related to AR- Ingredients of an Augmented Reality Experience</td></tr>
<tr><td colspan="6">UNIT-IV :

Augmented Reality Hardware– Augmented Reality Software– Software to create content for AR Application – Tools and Technologies</td></tr>
<tr><td colspan="6">UNIT-V:

Augmented Reality Content: Introduction- CreatingContent for Visual, Audio, and other senses – Interaction in AR - Mobile Augmented Reality: Introduction – Augmented Reality Applications Areas- Collaborative Augmented Reality</td></tr>
</table>

Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Grigore C. Burdea and Philippe Coiffet, "Virtual Reality Technology", Wiley Student Edition , Second Edition (Unit I: Chapter 1,2 & Unit II: Chapter 3,4,6,8 & 9) 2. Alan B. Craig(2013), "Understanding Augmented Reality: Concepts and Applications"(Unit III: Chapter 1, 2, Unit IV : Chapter 3, 4 & Unit V: Chapter 5,6,8) 3. Jon Peddie (2017), "Augmented Reality: Where We Will All Live", Springer, Ist Edition (Unit IV: Chapter 7 (Tools & Technologies)
Reference Books	1. Alan Craig & William R. Sherman & Jeffrey D. Will, Morgan Kaufmann(2009), "Developing Virtual Reality Applications: Foundations of Effective Design", Elsevier(Morgan Kaufmann Publishers) 2. Paul Mealy (2018), "Virtual and Augmented Reality",Wiley 3. Bruno Arnaldi & Pascal Guitton & Guillaume Moreau(2018), "Virtual Reality and Augmented Reality: Myths and Realities", Wiley
Website and e-Learning Source	1. Manivannan, M., (2018), "Virtual Reality Engineering," IIT Madras, https:// nptel.ac.in/ courses/121106013 2. Dube, A., (2020), "Augmented Reality - Fundamentals and Development," NPTEL Special Lecture Series, https:// www.youtube.com /watch?v=MGuSTAqlZ9Q 3. http://msl.cs.uiuc.edu/vr/ 4. http://www.britannica.com/technology/virtual reality/Living-in -virtual-worlds 5. https://mobidev.biz/blog/augmented-reality-development-guide

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Outline the basic terminologies, techniques and applications of VR and AR
CLO2	Describe different architectures and principles of VR and AR systems
CLO3	Use suitable hardware and software technologies for different varieties of virtual and augmented reality applications
CLO4	Analyze and explain the behavior of VR and AR technology relates to human perception and cognition
CLO5	Assess the importance of VR/AR content and interactions to implement for the real-world problem

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	1	1	2	2	2
CLO2	3	2	2	2	2	2
CLO3	3	2	2	3	3	3
CLO4	3	2	2	3	3	2
CLO5	3	2	3	3	3	3
Weightage of course contribute to each PSO	15	9	10	13	13	12

ALGORITHM LAB

L	T	P	C
0	0	5	3

Prolog:

1. Write Prolog program to implement A* algorithm.
2. Write Prolog program to implement MinMax search
3. Write Prolog program to solve water jug problem
4. Write Prolog program to implement TicTacToe
5. Write Prolog program to implement alpha-beta pruning
6. Write Prolog program to solve 4 Queen problem

C++

1. Sort a given set of elements using the Quick sort method and determine the time required to sort the elements. Repeat the experiment for different values of n.

2. Write a program to obtain the topological ordering of vertices in a given digraph.

3. Implement travelling salesman problem.

4. Find minimum cost spanning tree of a given undirected path using a Prim's algorithm.

5. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.
6. Solve N queen problem

CO - PO - PSO Mapping

ALGORITHM LAB											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	H	H	H	M	H	H	H	M	H	H	K - 1
CO 2	H	H	M	H	H	H	H	H	H	H	K - 4
CO 3	H	H	M	H	H	H	H	H	H	H	K - 5
CO 4	H	H	M	H	H	H	H	H	H	H	K - 3
CO 5	H	H	M	H	H	H	H	H	H	H	K - 5

Strongly Correlated - H, Moderately Correlated - M, Weekly Correlated - L

PYTHON PROGRAMMING LAB

L	T	P	C
0	0	5	3

1. Program using Strings - Program to Sort Words in Alphabetic Order
2. Program to perform various list operations, such as:

- Insert an element (include appending also)
- Search an element
- Modify an existing element
- Delete an existing element (position & Value)
- Sort the list

3. Program using Tuples - swap two numbers without using a temporary variable.
4. Program using Dictionaries - count the number of times a character appears in a given string
5. Write a function to convert number into corresponding number in words

For eg, if the input is 876 then the output should be 'Eight Seven Six'.

6. Program using Inheritance.
7. Program using Interfaces.
8. Program involving Overloading
9. Program using Regular Expressions.
10. Working with Widgets.
11. Program to Insert, Delete and Update in Database.
12. Program to create and perform operations using Data Frames.
13. Program to implement Data Visualization.
14. Reading and Writing Text Files and Binary Files
15. Combining and Merging Data Sets
16. Data Aggregation and GroupWise Operations

Course Outcome:

On successful completion of the course, the learners will be able to

1. Appreciate programming concepts in Python
2. Work with Widgets.
3. Insert, Delete and Update in Database.
4. Create and perform operations using Data Frames.

5. Implement Data Visualization

CO - PO - PSO Mapping

PYTHON PROGRAMMING LAB											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	H	H	H	M	H	H	H	M	H	H	K - 2
CO 2	H	H	M	H	H	H	H	H	H	H	K - 3
CO 3	H	H	M	H	H	H	H	H	H	H	K - 2
CO 4	H	H	M	H	H	H	H	H	H	H	K - 6
CO 5	H	H	M	H	H	H	H	H	H	H	K - 5

Strongly Correlated - H, Moderately Correlated - M, Weekly Correlated - L

Semester II

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Machine Learning</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic Programming Skill and Data Knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To understand the different types, steps and algorithms involved in Machine Learning Process</td></tr>
<tr><td colspan="2">Learning Outcome</td><td colspan="6">CO1: Describe the data, essential steps for creating a typical ML model and the fundamentals of pattern classification
CO2: Able to examine different ML algorithms and unprocessed data and features
CO3: Implement the essential techniques to reduce the number of features in a dataset and test the performance of predictive models
CO4: Select multiple algorithms, combine and produce ensembles, discuss the essential techniques for modeling linear relations
CO5: Discuss the clustering algorithms, develop a Web application embedding a ML model</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I : Data Analytics with pandas and NumPy - NumPy and basic stats - Matrices - pandas library - Working with data - Null Values - Creating statistical graphs Book 1, Chapter -10
Giving Computers the ability to learn from data - Introduction - Building intelligent systems to transform data into knowledge - The three different types of Machine Learning(ML) - Introduction to basic terminology and notations - A roadmap for building ML systems - Using Python for ML Book 2, Chapter - 1
Training Simple ML Algorithms for Classification - Early History of ML - Implementing a Perceptron learning algorithm - Adaptive linear neurons and the convergence of learning Book 2, Chapter – 2</td></tr>
<tr><td colspan="6">UNIT-II : ML Classifiers using sckikit-learn - Choosing a classification algorithm - Training a perceptron - Modeling class probabilities via logistic regression - Maximum margin classification with support vector machines(SVM) - Solving nonlinear problems using a kernel SVM - Decision tree learning - K-nearest neighbours: a lazy learning algorithm Book 2 Chapter3
Data Preprocessing - Missing data - Categorical data - Partitioning a dataset into separate training and test datasets - Bringing features onto the same scale - Selecting meaningful features - Assessing feature importance with random forests Book 2 Chapter – 4</td></tr>
</table>

	UNIT-III : Compressing Data via Dimensionality Reduction - Unsupervised dimensionality reduction via principal component analysis - Supervised data compression via linear discriminant analysis - Using kernel principal component analysis for nonlinear mappings **Book 2, Chapter - 5** **Learning Best Practices for Model Evaluation and Hyperparameter Tuning** - Streamlining workflows with pipelines - Using k-fold cross-validation to assess model performance - Debugging algorithms with learning and validation curves - Fine-tuning ML models via grid search - Looking at different performance evaluation metrics **Book 2, Chapter – 6**
	UNIT-IV : Combining different models for ensemble learning - Learning with ensembles - Combining classifiers via majority vote - Bagging: building an ensemble of classifiers from bootstrap samples - Leveraging weak learners via adaptive boosting **Book 2, Chapter - 7** **Predicting Continuous Target Variables with Regression Analysis - Introducing Linear regression -** Implementing an ordinary least squares linear regression model - Fitting a robust regression model using RANSAC - Evaluating the performance of linear regression models - Using regularised methods for regression - Turning a linear regression model into a curve - polynomial regression - Dealing with nonlinear relationships using random forests **Book 2, Chapter – 10**
	UNIT-V: Working with Unlabelled Data – Grouping objects by similarity using k-means - Organising clusters as a hierarchical tree - Locating regions of high density via DBSCAN **Book 2, Chapter - 11** **Introduction to Embedding a ML model into a Web Application -** Serialising fitted scikit-learn estimators - Setting up an SQLite database for data storage - Developing a web application with Flask - Turning any classifier into aweb application - Deploying the web application to a public server **Book 2, Chapter – 9**
Extended Professional Component	Mini project applying ML concepts in existing / real time data(is a part of internal component only, Not to be included in the External Examination question paper)
Skills acquired from this course	Preprocessing, ML steps, Prediction and Performance evaluation , Embedding ML model into a web application
Recommended Text	1. Corey Wade et al, Vahid Mirjalili, The Python Workshop, 2nd Edition, packs publishing, 2022 2. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning, 3rd Edition, packt publishing, 2019

Reference Books	1. Andreas C. Mueller, Sarah Guido. Introduction to Machine Learning with Python. O'Reilly Media, Inc., 2016. 2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012, 2010 3. Wes McKinney. Python for Data Analysis. O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, second edition, 2018
Website and e-Learning Source	1. https://data-flair.training/blogs/machine-learning-tutorial/ 2. https://www.geeksforgeeks.org/machine-learning/

Course Outcome

Upon completion of the course, the student will be able to

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2	2	2
CO2	3	3	2	3	3	2
CO3	3	2	3	2	3	3
CO4	3	2	3	2	3	3
CO5	3	3	3	3	3	3
Weightage of course contributed to eachPSO	15	13	13	12	14	13

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">BIG DATA ANALYTICS</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic understanding of programming and logical thinking</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce the concepts of big data analytics and developing a real time applications</td></tr>
<tr><td colspan="2">Learning Outcome</td><td colspan="6">Students will be able to
CO 1: Understand the basic concepts of big data analytics and technologies
CO 2: Apply the concept of HDFS, Map reduce for storing and processing of Big data
CO 3: Analyze and perform different operations on data using Pig, Hive, and Hbase
CO 4: Evaluate tools and methods for analyzing Big data analytics model
CO 5: Develop real time big data analytics applications</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT-I : INTRODUCTION TO BIG DATA ANALYTICS
Classification of Digital Data, Structured and Unstructured Data - Introduction to Big Data: Characteristics – Evolution – Definition - Challenges with Big Data - Other Characteristics of Data - Why Big Data - Traditional Business Intelligence versus Big Data - Data Warehouse and Hadoop Environment Big Data Analytics: Classification of Analytics – Challenges - Big Data Analytics important - Data Science - Data Scientist - Terminologies used in Big Data Environments. Book 1 - Chapter 1,2,3</td></tr>
<tr><td colspan="6">UNIT-II : BIG DATA TECHNOLOGY LANDSCAPE
NoSQL, Comparison of SQL and NoSQL, Hadoop -RDBMS Versus Hadoop - Distributed Computing Challenges – Hadoop Overview - Hadoop Distributed File System - Processing Data with Hadoop - Managing Resources and Applications with Hadoop YARN - Interacting with Hadoop Ecosystem Book 1: Chapter 4, 5</td></tr>
<tr><td colspan="6">UNIT-III : HADOOP AND HDFS
Introduction to Hadoop – RDBMS vs Hadoop- distributed computing challenges - A Brief History of Hadoop- The Hadoop Distributed Filesystem- Processing Data with Hadoop - Anatomy of a MapReduce Works - Anatomy of a MapReduce Job Run- Job Scheduling- Shuffle and Sort- Task Execution Book 2 – Chapter 1, 3,6</td></tr>
</table>

	UNIT-IV : HADOOP ECO SYSTEM Hive: Introduction – Architecture - Data Types - File Formats - Hive Query Language Statements – Partitions – Bucketing – Views - Sub- Query – Joins – Aggregations - Group by and Having - RCFile Implementation - Hive User Defined Function - Serialization and Deserialization. Pig: Introduction - Anatomy – Features – Philosophy - Use Case for Pig - Pig Latin Overview - Pig Primitive Data Types - Running Pig - Execution Modes of Pig - HDFS Commands - Relational Operators - Eval Function - Complex Data Types - Piggy Bank - User- Defined Functions - Parameter Substitution - Diagnostic Operator - Word Count Example using Pig - Pig at Yahoo! - Pig Versus Hive Hbase - HBasics, Concepts. **Book 1 - Chapter 9, 10 Book 2 - Chapter 11, 12,13**
	UNIT-V: Case Studies Hadoop Usage at Last.fm - Hadoop and Hive at Facebook- Nutch Search Engine- Log Processing at Rackspace – Cascading - TeraByte Sort on Apache Hadoop 601 - Using Pig and Wukong to Explore Billion-edge Network Graphs - Recent Trends in Big Data Analytics **Book 2 - Chapter 16**
Extended Professional Component	Case study on recent developments and presentation (is a part of internal component only, Not to be included in the External Examination question paper)
Skills acquired	Developing application using big data analytic techniques
Recommended Text	1. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, First Edition, 2015, Wiley. 2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media Inc., 2015.
Reference Books	1. Lublinsky, Boris, Kevin T. Smith, and Alexey Yakubovich. Professional hadoop solutions. John Wiley & Sons, 2013. 2. Big Data Analytics, RadhaShankarmani, M Vijayalakshmi, Second Edition, 2017, Wiley 3. Hadoop Essentials: A Quantitative Approach, Henry H. Liu, First Edition, 2012, PerfMath Publishers
Website and e-Learning Source	https://www.ibm.com/analytics/big-data-analytics https://www.simplilearn.com/what-is-big-data-analytics-article https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/what-is-big-data-analytics

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
Weightage of coursecontributed to each PO/PSO	15	15	10	15	15	15

PATTERN RECOGNITION AND IMAGE ANALYSIS	L	T	P	C
	4	1	0	3

Course Objective:

To be familiar with processing of images, recognition of the pattern and their applications

Unit I: Introduction to Image Processing: Image formation, image geometry perspective and other transformation, stereo imaging elements of visual perception. Digital Image- sampling and quantization serial & parallel Image processing.

Unit II: Image Restoration: Constrained and unconstrained restoration Wiener filter , motion blur remover, geometric and radiometric correction Image data compression-Huffman and other codes transform compression, predictive compression two tone image compression, block coding, run length coding, and contour coding.

Unit III: Segmentation Techniques-thresh holding approaches, region growing, relaxation, line and edge detection approaches, edge linking, supervised and unsupervised classificationtechniques, remotely sensed image analysis and applications, Shape Analysis – Gestalt principles, shape number, moment Fourier and other shape descriptors, Skelton detection, Hough transform, topological and texture analysis, shape matching.

Unit IV: Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi square test.

Unit V: Statistical Pattern Recognition -Bayesian Decision Theory, Classifiers, Normal density and discriminant functions, Parameter estimation methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods – Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM),Gaussian mixture models.

Course Outcome:

On successful completion of the course, the learners will be able to

1. Get acquainted with image processing
2. Apply basic algorithms in image processing
3. Grasp basics of knowledge representation
4. Analyze the texture of images
5. Recognize patterns

CO - PO - PSO MAPPING

PATTERN RECOGNITION AND IMAGE ANALYSIS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	H	H	H	M	H	H	H	M	H	H	K - 1
CO 2	H	H	M	H	H	H	H	H	H	H	K - 2
CO 3	H	H	M	H	H	H	H	H	H	H	K - 3
CO 4	H	H	M	H	H	H	H	H	H	H	K - 4
CO 5	H	H	M	H	H	H	H	H	H	H	K - 5

Strongly Correlated - H, Moderately Correlated - M, Weekly Correlated - L

TEXT BOOKS

1. Digital Image Processing – Gonzalez and Wood, Addison Wesley, 1993.
2. Fundamental of Image Processing – Anil K. Jain, Prentice Hall of India.
3. Pattern Classification – R.O. Duda, P.E. Hart and D.G. Stork, Second Edition John Wiley, 2006

REFERENCE BOOKS

1. Digital Picture Processing – Rosenfeld and Kak, vol.I & vol.II, Academic,1982
2. Computer Vision – Ballard and Brown, Prentice Hall, 1982
3. An Introduction to Digital Image Processing – Wayne Niblack, Prentice Hall, 1986
4. Pattern Recognition and Machine Learning – C. M. Bishop, Springer, 2009.
5. Pattern Recognition – S. Theodoridis and K. Koutroumbas, 4th Edition, Academic Press,2009

OPTIMIZATION TECHNIQUES

L	T	P	C
4	0	0	3

Objective

- To understand the concept of optimization
- To develop mathematical model of real life cases
- To study Optimization algorithms

Unit – I: Linear Programming Problem (LPP): Formulations and graphical solution of (2 variables) canonical and standard terms of linear programming problem. Simplex method, Two phase simplex

Unit – II: Duality in LPP- dual problem to primal- primal to dual problem-dual simplex method-Revised simplex method-Integer programming problem

Unit – III: Transportation Model: North West corner Method, Least cost method, and Vogel's Approximation Method. Determining Net evaluation-Degeneracy in TP
Assignment Model: Hungarian assignment model – Travelling salesman problem.

Unit – IV: Replacement Problem: Replacement policy for equipment that deteriorate gradually, Replacement of item that fail suddenly-Individual and group replacement, Problems in mortality and staffing.

Unit – V: Project Scheduling PERT/CPM Networks – Fulkerson's Rule – Measure of Activity – PERT Computation – CPM Computation – Resource Scheduling.

CO - PO - PSO Mapping

OPTIMIZATION TECHNIQUES											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	H	H	H	M	H	H	H	M	H	H	K - 1
CO 2	H	H	M	H	H	H	H	H	H	H	K - 4
CO 3	H	H	M	H	H	H	H	H	H	H	K - 5
CO 4	H	H	M	H	H	H	H	H	H	H	K - 3
CO 5	H	H	M	H	H	H	H	H	H	H	K - 5

Strongly Correlated - H, Moderately Correlated - M, Weekly Correlated - L

Textbooks

1. KantiSwarup, P.K. Gupta & Manmohan, "Operations Research", Sultan Chand & Sons. 1996.
2. S.Kalavathy, "Operations Research", Second Edition – Vikas Publishing House Pvt.Ltd.,

References

1. P. K. Gupta & Manmohan. Problems in Operations Research: Methods and Solutions Sultan Chand & Sons

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">Wireless Networks and Mobile Computing</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td></td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">Students will try to learn:
➢ Define the fundamentals of wireless networks. Summarize about Learning and analyzing the different wireless technologies.
➢ Interpret the process of building and mobile networks applications.
➢ Understand and evaluate emerging wireless technologies and computing environments
➢ Critically asses the design considerations for wireless networks and J2ME
➢ Conceive the security threats and related security standards on Wireless computing</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">UNIT-I :
Mobile Computing Architecture: Architecture for Mobile Computing, 3-tier Architecture, Design Considerations for Mobile Computing. Wireless Networks : Global Systems for Mobile Communication (GSM and Short Service Messages (SMS): GSM Architecture, Entities, Call routing in GSM, PLMN Interface, GSM Addresses and Identities, Network Aspects in GSM, Mobility Management, GSM Frequency allocation. Introduction to SMS, SMS Architecture, SM MT, SM MO,
SMS as Information bearer, applications, GPRS and Packet Data Network, GPRS Network Architecture, GPRS Network Operations, Data Services in GPRS, Applications for GPRS, Billing and Charging in GPRS, Spread Spectrum technology, IS- 95, CDMA versus GSM, Wireless Data, Third Generation
Networks, Applications on 3G, Introduction to WiMAX</td></tr>
</table>

	UNIT-II : Moving beyond desktop, Mobile handset overview, Mobile phones and their features, PDA, Design Constraints in applications for handheld devices. Mobile IP: Introduction, discovery, Registration, Tunneling, Cellular IP, Mobile IP with IPv6
	UNIT-III : **Mobile OS and Computing Environment :**Smart Client Architecture, The Client: User Interface, Data Storage, Performance, Data Synchronization, Messaging. The Server: Data Synchronization, Enterprise Data Source, Messaging. Mobile Operating Systems: WinCE, Palm OS, Symbian OS, Linux, Proprietary OS Client Development: The development process, Need analysis phase, Design phase, Implementation and Testing phase, Deployment phase, Development Tools, Device Emulators
	UNIT-IV : **Building, Mobile Internet Applications :** Thin client: Architecture, the client, Middleware, messaging Servers, Processing a Wireless request, Wireless Applications Protocol (WAP) Overview, Wireless Languages: Markup Languages, HDML, WML, HTML, cHTML, XHTML, VoiceXML
	UNIT-V: **J2ME:**Introduction, CDC, CLDC, MIDP; Programming for CLDC, MIDlet model, Provisioning, MIDlet life-cycle, Creating new application, MIDlet event handling, GUI in MIDP, Low level GUI Components, Multimedia APIs; Communication in MIDP, Security Considerations in MIDP
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Ashok Talukder, RoopaYavagal, Hasan Ahmed: Mobile Computing, Technology, Applications and Service Creation, 2nd Edition, Tata McGraw Hill, 2010.

Reference Books	1. Martyn Mallik: Mobile and Wireless Design Essentials, Wiley India, 2003 2. Raj kamal: Mobile Computing, Oxford University Press, 2007. 3. ItiSahaMisra: Wireless Communications and Networks, 3G and Beyond, Tata McGraw Hill, 2009.
Website and e-Learning Source	https://nptel.ac.in/courses/108/106/106106167/ https://nptel.ac.in/courses/117/104/117104099/ https://nptel.ac.in/courses/106/106/106106147/

Students will able to:
CLO1: Explain the basic concepts of wireless network and wireless generations
CLO 2: Demonstrate the different wireless technologies such as CDMA, GSM, GPRS etc
CLO 3: Appraise the importance of mobile computing networks and mobile client IP- Protocols
CLO 4: Explain the design considerations for deploying the wireless network infrastructure
CLO 5: Differentiate and support the security measures, standards. Services and layer wise security considerations

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	3	2	2	3	3
CO2	2	3	2	2	3	3
CO3	2	3	2	2	3	3
CO4	3	3	2	2	3	3
CO5	3	3	2	2	3	3
Weightage of course contributed to each PSO	12	15	10	10	15	15

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Databases for Data Science</td></tr>
<tr><td>Category</td><td>Core</td><td>Year
Semester</td><td>I
II</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>--</td><td colspan="2"></td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Fundamental computer knowledge including computer storage and hardware</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To provide fundamentals of database design, modelling systems, data storage, the world of data warehousing and NoSQL</td></tr>
<tr><td colspan="2">Learning Outcome</td><td colspan="6">Students will be able to
CO1: Understand and discuss the importance of relational data modellingand conceptual modelling
CO2: Experiment with various databases and compose effective queries
CO3: Analyse the process of OLAP system construction
CO4: Evaluate the use of NOSQL and its approach to the database
CO5: Develop applications using Relational and NoSQL databases</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">Unit 1: 1.1 Fundamental Concepts of Database Management Applications of Database Technology - Key Definitions - File versus Database Approach to Data Management - Elements of a Database System - Advantages of Database Systems and Database Management - Architecture and Categorization of DBMSs
1.2 Conceptual Data Modeling using the ER Model and UML Class Diagram Phases of Database Design - The Entity-Relationship Model - UML Class Diagram</td></tr>
<tr><td colspan="6">Unit 2: 2.1 Types of Database Systems Legacy Databases - Relational Databases: The Relational Model - Normalization
2.2 Relational Databases Structured Query Language - SQL Data Definition Language - SQL Data Manipulation Language</td></tr>
</table>

	Unit 3: 3.1 Data Warehousing and Business Intelligence Operational versus Tactical/Strategic Decision-Making - Data Warehouse Definition - Data Warehouse Schemas - The Extraction, Transformation, and Loading (ETL) Process - Data Marts - Virtual Data Warehouses and Virtual Data Marts - Operational Data Store - Data Warehouses vs Data Lakes - Business Intelligence **3.2 Introduction of NO SQL** Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database, The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Key Points Comparison of relational databases to new NoSQL stores, Mongo DB, Cassandra, HBASE, Neo4j use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, AggregateOriented Databases. sharding, MapReduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer replication, Combining Sharding and Replication.
	Unit 4 4.2 Key Value Data Stores NoSQL Key/Value databases using MongoDB, Document Databases, Document oriented Database Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure.
	Unit 5: 5.1 Document Oriented Database Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, Column-Family Data Store Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Counters, Expiring Usage. **5.2 Data Modeling with Graph** Comparison of Relational and Graph Modeling, Property Graph Model Graph Analytics: Link analysis algorithm- Web as a graph, Page RankMarkov chain, page rank computation, Topic specific page rank Page Ranking Computation techniques iterative processing, Random walk distribution Querying Graphs
Extended Professional Component	Case studies to understand the limitations of Relational DBMS and the need for NoSQL database Mini project - create a data store and process the data

Skills acquired from this course	Database designer, Data owner of different types of data, Data Scientist fluent in data, Business Professional
Recommended Text	Lemahieu, W., Broucke, S.vanden and Baesens, B. (2018) Principles of database management: The Practical Guide to storing, managing and analyzing big and small data. Cambridge, United Kingdom: Cambridge University Press. Sadalage, P. & Fowler,NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Wiley Publications,1st Edition,2022
Reference Books	1. SQL for Data Scientists: A Beginner's Guide for Building Datasets for Analysis Renee M. P. Teate 2. SQL for Data Science: Data cleaning, wrangling and analytics with relational databases, Antonio Badia 3. Guy Harrison, Next Generation Database: NoSQL & big data, Apress
Website and e-Learning Source	**https://www.geeksforgeeks.org/introduction-to-nosql/**

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**2**	**3**	**2**	**2**	**3**	**3**
CO2	**2**	**3**	**2**	**2**	**3**	**3**
CO3	**2**	**3**	**2**	**2**	**3**	**3**
CO4	**3**	**3**	**2**	**2**	**3**	**3**
CO5	**3**	**3**	**2**	**2**	**3**	**3**
Weightage of course contributed to each PSO	**12**	**15**	**10**	**10**	**15**	**15**

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Machine Learning – Lab</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic Programming Skill and Data Knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To preprocess the data and build ML models using appropriate techniques and evaluate the model</td></tr>
<tr><td colspan="2">Learning Outcome</td><td colspan="6">Upon completion of the course, the student will be able to
CO1: Apply pandas, NumPy and Matplotlib to read in , process and visualise data, implement linear classification algorithms
CO2: Compare classifiers with linear and non-linear decision boundaries, select relevant features for the model construction
CO3: Apply data compression and best practices for model evaluation and hyper parameter tuning
CO4: Select appropriate algorithms and ensemble
CO5: Apply clustering algorithms on unlabelled data, construct a web application embedding a ML model</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="6">UNIT-I :
1. Programs using NumPy and pandas
2. Visualising using graphs
3. Perceptron learning algorithm
4. Adaline</td></tr>
<tr><td colspan="6">UNIT-II :
5. Training a perceptron
6. Modeling class probabilities via logistic regression
7. Maximum margin classification with support vector machines(SVM)
8. Solving nonlinear problems using a kernel SVM
9. Decision tree</td></tr>
<tr><td colspan="6">UNIT-III :
10. Unsupervised dimensionality reduction via principal component analysis
11. Supervised data compression via linear discriminant analysis
12. Using k-fold cross-validation to assess model performance
13. Debugging algorithms with learning and validation curves
14. Fine-tuning ML models via grid search
15. Implementing different performance evaluation metrics</td></tr>
<tr><td colspan="6">UNIT-IV :
16. Ensemble Learning
17. Ordinary least squares linear regression model
18. Evaluating the performance of linear regression models
19. Regularised methods for regression
20. Nonlinear relationships using random forests</td></tr>
</table>

	UNIT-V: **21.** Grouping objects by similarity using k-means **22.** Organising clusters as a hierarchical tree **23.** Locating regions of high density via DBSCAN **24.** Embedding a ML model into a Web Application
Extended Professional Component	1. Mini project applying ML concepts in existing / real time data 2. Comparing the performance of different ML algorithms on a given dataset
Skills acquired from this course	Preprocessing, ML steps, Prediction and Performance evaluation , Embedding ML model into a web application
Recommended Text	1. Corey Wade et al, Vahid Mirjalili, The Python Workshop, 2nd Edition, packs publishing, 2022 2. Sebastian Raschka and Vahid Mirjalili, Python Machine Learning, 3rd Edition, packt publishing, 2019
Reference Books	1. Andreas C. Mueller, Sarah Guido. Introduction to Machine Learning with Python. O'Reilly Media, Inc., 2016. 2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012, 2010 3. Wes McKinney. Python for Data Analysis. O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, second edition, 2018
Website and e-Learning Source	1. https://machinelearningmastery.com/machine-learning-in-python-step-by-step/ 2. https://www.tutorialspoint.com/machine_learning_with_python/index.htm 3. https://pythonprogramming.net/machine-learning-tutorial-python-introduction/

CO/ PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	3	2	3	2
CO5	3	3	2	3	3	2
Weightage of course contributed to each PSO	15	13	12	14	13	11

<table>
<tr><td colspan="2"></td><td colspan="6"></td></tr>
<tr><td colspan="2">Title of the Course</td><td colspan="6">BIG DATA ANALYTICS LAB</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>-</td><td colspan="2">-</td><td colspan="2">4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic understanding of programming and logical thinking</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce the concepts of big data analytics and developing a real time applications</td></tr>
<tr><td colspan="2">Learning Outcome</td><td colspan="6">Students will be able to
CO 1: Configure Hadoop and perform File Management
CO 2: Apply Map Reduce program to real time issues.
CO 3: Critically analyze huge data set using Hadoop distributed file systems and MapReduce
CO 4: Experimenting different data processing tools like Pig, Hive.
CO 5: Develop real time big data analytics applications</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I :
1. Install Apache Hadoop
2. Perform setting up and Installing Hadoop in its three operating modes:
• Standalone • Pseudo Distributed • Fully Distributed
3. To use Web Based Tools to Manage Hadoop Set-up
4. Implement the following file management tasks in Hadoop:
Adding files and directories
Retrieving files & Deleting Files</td></tr>
<tr><td colspan="6">UNIT-II :
4. Develop a MapReduce program to calculate the frequency of a given word in a given file.
5. Develop a MapReduce program to find the maximum temperature in each year.
6. Develop a MapReduce program to find the grades of student’s.
7. Develop a MapReduce program to implement Matrix Multiplication.
8. Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year.</td></tr>
</table>

	UNIT-III : 9. Develop a MapReduce to analyze weather data set and print whether the day is shinny or cool day. (National Climatic Data Centre (NCDC) Data set) 10. Develop a MapReduce program to find the number of products sold in each country by considering sales data containing fields like Transaction _Date Product Price Payment_Type Name City\State Country Account_Created Last_Login Latitude Login 11. Data sets from different sources as Input 12. Develop a MapReduce program to find the tags associated with each movie by analyzing movie lens data. (https://www.kaggle.com/datasets/grouplens/movielens-20m-dataset) 12. Sorting the data using MapReduce 13. Count the number of missing and invalid values by joining two large given datasets.
	UNIT-IV: 14. Install and Run Pig then write Pig Latin scripts to sort, group, join, project and filter the data. 15. Install and Run Hive then use Hive to Create, alter and drop databases, tables, views, functions and Indexes. 16. Develop a program to calculate the maximum recorded temperature by year wise for the weather dataset in Pig Latin 17. Develop a program to calculate the maximum recorded temperature by year wise for the weather dataset in Pig Latin 18. Write queries to sort and aggregate the data in a table using HiveQL 19. Develop a MapReduce to find the maximum electrical consumption in each year given electrical consumption for each month in each year. 20. Write a program to implement combining and partitioning in Hadoop toimplement a custom partitioner and Combiner
	UNIT-V: 21. Analyze the sentiment for product reviews, this work proposes a MapReduce technique provided by Apache Hadoop 22.Trend Analysis based on Access Pattern over Web Logs using Hadoop. 23. Implementation of decision tree algorithms using MapReduce. 24. Implementation of K-means Clustering using MapReduce. 25. Generation of Frequent Itemset using MapReduce.
Extended Professional Component	Mini Project – Application development (is a part of internal component only, Not to be included in the External Examination question paper)
Skills acquired from this course	Developing application using big data analytic techniques
Recommended Text	1. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, First Edition, 2015, Wiley. 2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media Inc., 2015.

Reference Books	1. Lublinsky, Boris, Kevin T. Smith, and Alexey Yakubovich. Professional hadoop solutions. John Wiley & Sons, 2013. 2. Big Data Analytics, RadhaShankarmani, M Vijayalakshmi, Second Edition, 2017, Wiley 3. Hadoop Essentials: A Quantitative Approach, Henry H. Liu, First Edition, 2012, PerfMath Publishers
Website and e-Learning Source	https://www.ibm.com/analytics/big-data-analytics https://www.simplilearn.com/what-is-big-data-analytics-article https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/what-is-big-data-analytics

Course Learning Outcome (for Mapping with POs and PSOs)

	PSOs						
	1	**1**	**2**	**3**	**4**	**5**	**6**
CO1	3	3	3	3	2	1	1
CO2	3	3	3	3	2	1	1
CO3	3	3	3	3	2	1	1
CO4	3	3	3	3	2	1	1
CO5	3	3	3	3	2	1	1
Weightage of course contributed to each PO/PSO	**15**	**15**	**15**	**15**	**10**	**5**	5

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">SOCIAL NETWORK ANALYSIS</td></tr>
<tr><td colspan="2"></td><td colspan="6"></td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2"></td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic understanding of social networks</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce the concepts and fundamentals of social network components and analysis</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I: INTRODUCTION TO SEMANTIC WEB AND SOCIAL NETWORKS

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources fornetwork analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis- Brief history of Social network analysis

Book 1- Chapter 1,2,3 Book 2: Chapter 1</td></tr>
<tr><td colspan="6">UNIT-II: MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION

Knowledge Representation on the semantic web- Ontology and theirrole in the Semantic Web - Ontology languages for the Semantic Web- Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations

Book 1: Chapter 4,5,6</td></tr>
</table>

	UNIT-III: DATA COLLECTION Boundary specification – Data collection process- Information bias and issue of reliability – Archival data – Understanding SNA data – Managing SNA data **Book2 : Chapter 2**
	UNIT-IV : METHODS IN SOCIAL NETWORK ANALYSIS Descriptive methods – Graph – Density- Centrality – cliques – MDS- structural equivalence – Two mode networks – Inferential methods – QAP- ERGM **Book 2- Chapter 3, 4**
	UNIT-V: CASE STUDIES Case studies – Evaluation of web-based social network extraction – semantic – based social network analysis in the sciences – emergent semantics **Book 1: Chapter 7,8,9**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Apply social network in real time applications
Recommended Text	1. Peter Mika, "Social Networks and the Semantic Web", Springer 2007. 2. Yang, Song, Franziska B. Keller, and Lu Zheng. Social network analysis: Methods and examples. Sage Publications, 2016.

Reference Books	1. Guandong Xu ,Yanchun Zhang and Lin Li, ―Web Mining and Social Networking – Techniques and applications‖, First Edition, Springer, 2011. 2. Dion Goh and Schubert Foo, ―Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively‖, IGI Global Snippet, 2008.
Website and **e-Learning Source**	https://bookdown.org/chen/snaEd/ch4.html https://www.sciencedirect.com/topics/social-sciences/social-network-analysis https://www.publichealth.columbia.edu/research/population-health-methods/social-network-analysis https://www.ibm.com/docs/en/spss-modeler/18.0.0?topic=analysis-about-social-network

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CO's	Course Outcomes
CLO1	Understand the fundamentals of social web and elements of social network analysis.
CLO2	Apply and visualize the knowledge representation in social network.
CLO3	Analyse the various methods in social network analysis.
CLO4	Evaluate the tools and methods for analysing the social network data.
CLO5	Investigate the recent potential applications and development of social network with real time case studies.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CLO1	3	3	3	2	1	1
CLO2	3	3	3	2	1	1
CLO3	3	3	3	2	1	1
CLO4	3	3	3	2	1	1
CLO5	3	3	3	2	1	1
Weightage of course contribute to each PSO						

Third Semester							
Core - V	Deep Learning	4	5		25	75	100
Core – VI	Natural Language processing	4	4		25	75	100
Core – VII	Cryptography and Network Security	4	4		25	75	100
Elective - V	Robotics Process Automation for Business / Advanced Software Engineering /Critical thinking, Design Thinking & Problem Solving	3	4		25	75	100
Core Practical 5	Natural Language Processing Lab	3		4	50	50	100
Mini Project	Web Application Development& Hosting	6		6	50	50	100
SEC 2	Data Visualization Tools	2	3		25	75	100
Internship/ Industrial Activity/ Research Updation Activity		2	-		50	50	100
	Total	28	20	10			
FOURTH SEMESTER							
Core Project	Project work and Viva-voce	20		30	50	50	100
	Extension Activity	1		30	50	50	100
	Total	21		30			

Course code		DEEP LEARNING	L	T	P	C
Core/Elective/Supportive		CORE V	5			4
Pre-requisite		Basics of Cloud &its Applications				

Course Objectives:

The main objectives of this course are to:

1. To introduce the fundamental techniques and principles of Neural Networks
2. To familiarize fundamental concepts in Deep Learning

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	Become familiar with the fundamental concepts in Deep Learning	K1,K2
2	Explore the use of Deep Learning Technology in computer vision, speech analysis, healthcare, agriculture, and understanding climate change.	K3,K4
3	Apply Deep Learning technology in computer vision, speech analysis, Health care, agriculture, and understanding climate change	K4,K5
4	Analyze Deep Reinforcement Learning	K5,K6
5	Evaluate the Practical Challenges in Deep Learning	K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Unit:1	INTRODUCTION	12hours

Introduction to Neural Networks – Introduction – Basic Architecture of Neural Networks – Training and Neural Network with Backpropagation – Practical Issues in Neural Network Training – The Secrets to the Power of Function Composition – Common Neural Architectures – Advanced Topics.

Unit:2		12hours

Machine Learning with Shallow Neural Networks: Introduction – Neural Architectures for Binary Classification Models – Neural Architectures for Multiclass models – Back propagated saliency for Feature Selection – Matrix Factorization with Auto encoders – Simple Neural Architectures for Graph Embedding.

Unit:3		12hours

Training Deep Neural Networks: Introduction – Backpropagation – Setup and Initialization issues – The vanishing and exploding gradient problems – Gradient Descent Strategies' –Batch Normalization–Teaching Deep Learners to Generalize: Introduction –The Bias-Variance trade-off – Generalization issues in model tuning and evaluation – Penalty based regularization – Ensemble methods – Early Stopping – Unsupervised pre-training – Continuation and Curriculum learning – Parameter sharing – Regularization in Unsupervised Applications.

Unit:4		12hours

Recurrent Neural Networks: Introduction – Architecture of Recurrent Neural Networks –ThechallengesoftrainingrecurrentNetworks–Echo-StateNetworks–

Long Short-Term Memory – Gated Recurrent Units – Applications of Recurrent Neural Networks.

Convolutional Neural Networks: Introduction – The Basic Structure of a Convolutional Network – Training a Convolutional Network – Case studies of Convolutional Architectures – Visualization and Unsupervised Learning – Applications of Convolutional Networks.

Unit:5		**12hours**

Deep Reinforcement Learning: Introduction – Stateless Algorithms – The basic framework of Reinforcement Learning – Bootstrapping for value function learning– Policy Gradient Methods – Monte Carlo Tree Search – Case Studies – Practical Challenges associated with safety. Advanced Topics associated with Deep Learning: Generative adversarial networks (GAN) – Competitive Learning – Limitations of Neural Networks

Unit:6	**Contemporary Issues**	
Expert lectures, online seminars –webinars		
	Total Lecture hours	**60hours**

Text Books

1	Charu C. Aggarwal, Neural Networks and Deep Learning, Springer 2018

Reference books

1	Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, The MIT Press, 2016
2	Francois Chollet, Deep Learning with Python, Manning Publications Co, 2018
3	Josh Patterson, Adam Gibson, Deep Learning: A Practitioner's Approach 1st Edition, O'Reilly' 2017

Mapping with Programming Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	L	S	M	S	M	S	M	M	M	S
CO2	M	S	M	S	S	S	M	M	M	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

NATURAL LANGUAGE PROCESSING

L	**T**	**P**	**C**
4	**0**	**0**	**4**

Course Objectives:

1. To understand the algorithms available for the processing of linguistic information and computational properties of natural languages.
2. To conceive basic knowledge on various morphological, syntactic and semantic NLP tasks.

Course Outcome:

On successful completion of the course, the learners will be able to

CO1.Describe the concepts of morphology, syntax, semantics, discourse& pragmatics of natural language.

CO2.DiscovervariouslinguisticsrelevanttoNLPtasks

CO3. Identify statistical features relevant to NLP tasks

CO4. Analyze parsing in NLP

CO5.DevelopsystemsforvariousNLPproblemswithmoderate complexity.

UNIT-I **12hours**

Introduction to NLP: NLP – introduction and applications, NLP phases, Difficulty of NLP including ambiguity; Spelling error and Noisy Channel Model; Concepts of Parts-of-speech and Formal Grammar of English.

UNIT-II **12hours**

Language Modelling: N-gram and Neural Language Models Language Modelling with N-gram, Simple N-gram models, smoothing (basic techniques), Evaluating language models; Neural Network basics, Training; Neural Language Model, Case study: application of neural language model in NLP system development.

UNIT-III **12hours**

Parts-of-speech Tagging Parts-of-speech Tagging: basic concepts; Tag set; Early approaches: Rule-based and TBL; POS tagging using HMM, Introduction to POS Tagging using Neural Model.

UNIT-IV **12hours**

Parsing Basic concepts: top-down and bottom-up parsing, treebank; Syntactic parsing: CKY parsing; Statistical Parsing basics: Probabilistic Context Free Grammar (PCFG); Probabilistic CKY Parsing of PCFGs.

UNIT-V **12hours**

Semantics Vector Semantics; Words and Vector; Measuring Similarity; Semantics with dense vectors; SVD and Latent Semantic Analysis; Embedding from prediction: Skip-gram and CBOW; Concept of Word Sense; Introduction to WordNet

CO-PO -PSO Mapping

NATURAL LANGUAGE PROCESSING											
CO	**PO**					**PSO**					**COGNITIVE LEVEL**
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	
CO1	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**K-1**
CO2	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K-3**
CO3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K-5**
CO4	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K-2**
CO5	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K– 6**

Strongly Correlated–S, Moderately Correlated–M, Weekly Correlated-L

Textbook:

JurafskyDanandMartinJamesS.“SpeechandLanguageProcessing”,3rd Edition, 2018.

Reference books:

1. Jurafsky D.and Martin J.S., “Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, 2nd Edition, Upper Saddle River, NJ: Prentice-Hall, 2008.

2. Goldberg Yoav “A Primer on Neural Network Models for Natural Language Processing”.

Course code		CRYPTOGRAPHY NETWORK SECURITY AND	L	T	P	C
Core/Elective/Supportive		Core VII	4			4
Pre-requisite		Basics of Networks &its Security				

Course Objectives:

The main objectives of this course are to:

1. Enable students to learn the Introduction to Cryptography, Web Security and Case Studies in Cryptography.
2. To gain knowledge of classical encryption techniques and concepts of modular arithmetic and number theory.
3. To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms.
4. To explore the design issues and working principles of various authentication Applications and various secure communication standards including Kerberos, IPsec, SSL/TLS and email.

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	Understand the process of the cryptographic algorithms	K1,K2
2	Compareandapplydifferentencryptionanddecryptiontechniquestosolveproblems related to confidentiality and authentication	K2,K3
3	Applyandanalyzeappropriatesecuritytechniquestosolvenetworksecurity problem	K3,K4
4	Explore suitable cryptographic algorithms	K4,K5
5	Analyzedifferentdigitalsignaturealgorithmstoachieveauthenticationand design secure applications	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Unit:1	INTRODUCTION	12hours

Introduction to Cryptography – Security Attacks – Security Services –Security Algorithm- Stream cypher and Block cypher - Symmetric and Asymmetric-key Cryptosystem Symmetric Key Algorithms: Introduction – DES – Triple DES – AES – IDEA – Blowfish – RC5.

Unit:2	CRYPTOSYSTEM	12hours

Public-key cryptosystem: Introduction to Number Theory-RSA algorithm–Key Management -Diffie-Hellman Key exchange–Elliptic Curve Cryptography Message Authentication and Hash functions – Hash and Mac Algorithm – Digital Signatures and Authentication Protocol.

Unit:3	NETWORK SECURITY	12hours

Network Security Practice: Authentication Applications–Kerberos–X.509Authentication services and Encryption Techniques. E-mail Security – PGP – S / MIME – IP Security.

Unit:4	WEB SECURITY	10hours
WebSecurity-SecureSocketLayer–SecureElectronicTransaction.SystemSecurity-Intruders and Viruses – Firewalls– Password Security.		
Unit:5	**CASE STUDY**	**12hours**
Case Study: Implementation of Cryptographic Algorithms–RSA–DSA–ECC(C/JAVA Programming). Network Forensic – Security Audit - Other Security Mechanism: Introduction to Stenography – Quantum Cryptography – Water Marking - DNA Cryptography		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars–webinars		
	Total Lecture hours	**60hours**

Text Books

1	WilliamStallings,"CryptographyandNetworkSecurity", PHI/PearsonEducation.
2	BruceSchneir,"AppliedCryptography",CRC Press.

ReferenceBooks

1	A.Menezes, P Van Oorschot and S.Vanstone, "Hand Book ofApplied Cryptography", CRC Press, 1997
2	AnkitFadia,"NetworkSecurity",MacMillan.

RelatedOnlineContents[MOOC,SWAYAM,NPTEL,Websitesetc.]

1	https://nptel.ac.in/courses/106/105/106105031/
2	http://www.nptelvideos.in/2012/11/cryptography-and-network-security.html
3	https://www.tutorialspoint.com/cryptography/index.htm

MappingwithProgrammingOutcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	L	S	M	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

Course code		ROBOTICS	L	T	P	C
Core/Elective/Supportive		Elective 5-1	4			3
Pre-requisite		Basics of Software Engineering & SPM				

Course Objectives:

The main objectives of this course are to:

1. To understand the functions of the basic components of a robot
2. To study the use of various types of End Effectors and Sensors
3. To impart knowledge in Robot Kinematics and Programming

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	Understand the functions of the basic components of a Robot	K1,K2
2	Analyze the use of various types of End Effectors and Sensors	K2,K3
3	Gain knowledge in Robot Kinematics and Programming	K3,K4
4	Ascertain Safety Considerations for Robot Operations	K4,K5
5	Determine the feasibility of implementing a Robot	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Unit:1	INTRODUCTION	12hours

Fundamentals of Robot: Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load Robot Parts and their Functions-Need for Robots-Different Applications

Unit:2		12hours

Robot Drive Systems And End Effectors**:** Pneumatic Drives-Hydraulic Drives-Mechanical Drives – Electrical Drives- D.C.Servo Motors, Stepper Motors, A/C Servo Motors -Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers- Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

Unit:3		12hours

Sensors& Machine Vision: Requirements, Principles & Applications of the following types of sensors- Position - Piezo Electric, LVDT, Resolvers, Optical Encoders, pneumatic Position, Range- Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Sensors- Touch–binary–Analog-Wrist-Compliance-Slip-Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing & Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.		
Unit:4		**12hours**
Robot Kinematics And Robot Programming: Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces- Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs		
Unit:5		**12hours**
Implementation and Robot Economics: RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars –webinars		
	Total Lecture hours	**75 hours**

Text Books	
1	KlafterR.D.,ChmielewskiT.A and Negin M.,“Robotic Engineering – An Integrated Approach”, Prentice Hall, 2019.
2	GrooverM.P.,“Industrial Robotics-Technology Programming and Applications”, McGrawHill, 2018.
Reference Books	
1	CraigJ.J.,“Introduction to Robotics Mechanics and Control”, Pearson Education, 2017.
2	KorenY.,“Robotics forEngineers", McGrawHillBookCo.,2019.
3	Fu. K. S., Gonzalez R. C.and LeeC. S. G.,“Robotics Control, Sensing, Vision and Intelligence”, McGrawHillBookCo.,2017
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.javatpoint.com/software-engineering-tutorial
2	https://onlinecourses.swayam2.ac.in/cec20_cs07/preview
3	https://onlinecourses.nptel.ac.in/noc19_cs69/preview

Mapping with Programming Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
1	S	S	M	S	S	S	M	M	M	M
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code		ADVANCED SOFTWARE ENGINEERING	L	T	P	C
Core/Elective/Supportive		Elective 5-2	4			3
Pre-requisite		Basics of Software Engineering & SPM				

Course Objectives:

The main objectives of this course are to:

4. Introduce Software Engineering, Design, Testing and Maintenance.
5. Enable the students to learn the concepts of Software Engineering.
6. Learn about Software Project Management, Software Design & Testing.

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	Understand about Software Engineering process	K1,K2
2	Understand about Software project management skills, design and quality management	K2,K3
3	Analyze Software Requirements and Specification	K3,K4
4	Analyze Software Testing, Maintenance and Software Re-Engineering	K4,K5
5	Design and conduct various types and levels of software quality for software project	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Unit:1	INTRODUCTION	15hours

Introduction: The Problem Domain – Software Engineering Challenges - Software Engineering Approach – Software Processes: Software Process – Characteristics of a Software Process – Software Development Process Models – Other software processes.

Unit:2	SOFTWARE REQUIREMENTS	15hours

Software Requirements Analysis and Specification: Requirement engineering – Type of Requirements – Feasibility Studies – Requirements Elicitation – Requirement Analysis – Requirement Documentation – Requirement Validation – Requirement Management – SRS - Formal System Specification – Axiomatic Specification – Algebraic Specification - Case study: Student Result management system. Software Quality Management –Software Quality, Software Quality Management System, ISO 9000, SEI CMM.

Unit:3	PROJECT MANAGEMENT	15hours

Software Project Management: Responsibilities of a software project manager – Project planning – Metrics for Project size estimation – Project Estimation Techniques – Empirical Estimation Techniques – COCOMO – Halstead's software science – Staffing level estimation – Scheduling– Organization and Team Structures – Staffing – Risk management – Software Configuration Management – Miscellaneous Plan.

Unit:4	SOFTWARE DESIGN	15hours

Software Design: Outcome of a Design process – Characteristics of a good software design – Cohesion and coupling - Strategy of Design – Function Oriented Design – Object Oriented Design - Detailed Design - IEEE Recommended Practice for Software Design Descriptions.		
Unit:5	**SOFTWARE TESTING**	**13hours**
Software Testing: A Strategic approach to software testing – Terminologies – Functional testing– Structural testing – Levels of testing – Validation testing - Regression testing – Art of Debugging– Testing Tools- Metrics-Reliability Estimation. Software Maintenance -Maintenance Process - Reverse Engineering – Software Re-engineering - Configuration Management Activities.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars –webinars		
	Total Lecture hours	**75 hours**
Text Books		
1	An Integrated Approach to Software Engineering – Pankaj Jalote, Narosa Publishing House, Delhi, 3rd Edition.	
2	Fundamentals of Software Engineering –Rajib Mall, PHI Publication,3rdEdition.	
Reference Books		
1	Software Engineering– K.K. Aggarwal and Yogesh Singh, New Age International Publishers, 3rd edition.	
2	A Practitioner Approach-Software Engineering, - R.S. Pressman, McGraw Hill.	
3	Fundamentals of Software Engineering Carlo Ghezzi, M Jarayeri, D. Manodrioli, PHI Publication.	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	https://www.javatpoint.com/software-engineering-tutorial	
2	https://onlinecourses.swayam2.ac.in/cec20_cs07/preview	
3	https://onlinecourses.nptel.ac.in/noc19_cs69/preview	

Mapping with Programming Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
1	S	S	M	S	S	S	M	M	M	M
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course code		CRITICAL THINKING, DESIGN THINKING AND PROBLEM-SOLVING	L	T	P	C
Core/Elective/Supportive		Elective 5-3	4			3
Pre-requisite		Basics of Logical & Reasoning Skills				

Course Objectives:

The main objectives of this course are to:

1. Learn critical thinking and its related concepts
2. Learn design thinking and its related concepts
3. Develop Thinking patterns, Problem solving & Reasoning

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	Understand the concepts of Critical thinking and its related technology	K1,K2
2	Focus on the explicit development of critical thinking and problem-solving skills	K2,K3
3	Apply design thinking to problems	K3,K4
4	Decide and take action based on the analysis	K4,K5
5	Analyze the concepts of Thinking patterns, Problem-solving & Reasoning in real-time applications	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply; **K4**-Analyze;**K5**-Evaluate; **K6**-Create

Unit:1	CRITICAL THINKING	12hours

Critical Thinking: Definition, Conclusions and Decisions, Beliefs and Claims, Evidence–finding, evaluation, Inferences, Facts – opinion, probable truth, probably false, Venn diagram. Applied critical thinking: Inference, Explanation, Evidence, Credibility, Two Case Studies, critical thinking and science, critical evaluation, self-assessment.

Unit:2	DESIGN THINKING	12hours

Design Thinking: Introduction, Need of Design Thinking, problem to question - design thinking process, Traditional Problem Solving versus Design Thinking, phases of Design Thinking, problem exploration, Stakeholder assessment, design thinking for manufacturers, smart idea to implementation.

Unit:3	CASE STUDY	12hours

Thinking to confidence, fear management, duty Vs passion, Team management, Tools for Thinking, prototype design, Relevance of Design and Design Thinking in engineering, human-centred design, case study: apply design thinking in problem.

Unit:4	PROBLEM-SOLVING	10hours

Problem-solving: problem definition, problem-solving methods, selecting and using information, data processing, solution methods, solving problems by searching, recognizing patterns, spatial reasoning, necessity and sufficiency, choosing and using models, and making choices and decisions.

Unit:5	REASONING	12hours

Reasoning: Deductive and hypothetical reasoning, computational problem solving; generating, implementing, and evaluating solutions, interpersonal problem solving. Advanced problem solving: Combining skills – using imagination, developing models, Carrying out investigations, Data analysis and inference. Graphical methods of solution, Probability, tree diagrams and decision trees

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars –webinars

	Total Lecture hours	60hours

Text Books

1	John Butterworth and Geoff Thwaites, Thinking skills: Critical Thinking and Problem Solving, Cambridge University Press, 2013.
2	H.S. Fogler and S.E. LeBlanc, Strategies for Creative Problem Solving, 2nd edition, Pearson, Upper Saddle River, NJ, 2008.

Reference Books

1	A. Whimbey and J. Lochhead, Problem Solving & Comprehension, 6th edition, Lawrence Erlbaum, Mahwah, NJ, 1999.
2	M. Levine, Effective Problem Solving, 2nd edition, Prentice Hall, Upper Saddle River, NJ, 1994.
3	Michael Baker, The Basic of Critical Thinking, The Critical Thinking Co. press, 2015.
4	David Kelley and Tom Kelley, Creative Confidence, 2013.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.tutorialspoint.com/critical_thinking/index.htm
2	https://www.tutorialspoint.com/design_thinking/design_thinking_quick_guide.htm
3	https://nptel.ac.in/courses/109/104/109104109/

Mapping with Programming Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	M	S	S	S
CO2	S	S	M	S	S	S	M	S	S	S
CO3	S	S	M	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

*S-Strong; M-Medium; L-Low

NATURAL LANGUAGE PROCESSING LAB	L	T	P	C
	4	0	0	3

Course Objective:

1. To familiarize the students with practical aspects of processing Natural Language.

Course Outcome:

On successful completion of the course, the learners will be able to

CO1.ImplementcommonNLPtasksusingPythonandNaturalLanguage Toolkit, NLTK

CO2.Describe the concepts of morphology, syntax, semantics, discourse& pragmatics of natural language.

CO3.DiscovervariouslinguisticsrelevanttoNLPtasks

CO4. Analyze parsing in NLP

CO5.DevelopsystemsforvariousNLPproblemswithmoderate complexity.

Practical List

1. Tokenizing Text and WordNet basics: Tokenizing text into sentences, Tokenizing sentences into words, Tokenizing sentences using regular expressions, Filtering stop words in a tokenized sentence, looking up synsets for a word in WordNet, looking up lemmas and synonyms in WordNet, Calculating WordNet synset similarity Discovering word collocations.

2. Replacing and correcting words: Stemming words, Lemmatizing words with WordNet, translating text with Babel fish, Replacing words matching regular expressions, Removing repeating characters, Spelling correction with Enchant, Replacing synonyms, Replacing negations with antonyms.

3. Creating Custom Corpora: Setting up a custom corpus, Creating a word list corpus, Creating a part of speech tagged word corpus, Creating a chunked phrase corpus, Creating a categorized text corpus, Creating a categorized chunk corpus reader, Lazy corpus loading, Creating a custom corpus view, Creating a MongoDB backed corpus reader, Corpus editing with file locking.

4. Parts-of-Speech Tagging: Training a unigram part-of-speech tagger, Combining taggers with backoff tagging, Training and combining Ngram taggers, Creating a model of likely word tags, Tagging with regular expressions, Affix tagging, Training a Brill tagger, Training the TnT tagger Using WordNet for tagging, Tagging proper names, Classifier based tagging.

5. Extracting Chunks: Chunking and chinking with regular expressions, Merging and splitting chunks with regular expressions, Expanding and removing chunks with regular expressions, Partial parsing with regular expressions, training a tagger-based chunker, Classification-based chunking, extracting named entities, extracting proper noun chunks, extracting location chunks, Training a named entity chunker.

6. Transforming Chunks and Trees: Filtering insignificant words, Correcting verb forms, swapping verb phrases, Swapping noun cardinals, Swapping infinitive phrases, Singularizing plural nouns, Chaining chunk transformations, Converting a chunk tree to text, Flattening a deep tree, Creating a shallow tree, Converting tree nodes.

7. Parsing Specific Data: Parsing dates and times with Dateutil, Time zone lookup and conversion, Tagging temporal expressions with Timex, Extracting URLs from HTML with XML, Cleaning and stripping HTML, and Converting HTML entities with Beautiful Soup.

CO-PO -PSO Mapping

NATURAL LANGUAGE PROCESSING LAB											
CO	**PO**					**PSO**					**COGNITIVE LEVEL**
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	
CO1	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**K– 1**
CO2	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K– 3**
CO3	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K– 5**
CO4	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K– 4**
CO5	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**K– 6**

Strongly Correlated–S, Moderately Correlated–M, Weekly Correlated-L

References

1. PythonTextprocessingwithNLTK2.0Cookbook, Jacob Perkins, PACKT Publishing

2. Natural Language Processing with Python, Steven Bird, Ewan Klein, Edward Loper, O'Reilly

Course code		Mini Project	L	T	P	C
Core/Elective/Supportive		Core			6	6
Pre-requisite		Basic Programming of Software Tools & Introduction to developing Project work				

Course Objectives:

The main objectives of this course are to:

1. to enable the third-semester students to study Project development
2. to undertake a unique project title
3. to get a novel idea for the project
4. to define the problem
5. to design and implement using a n available software development tool /Programming
6. Prepare a report

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	To define the problem	K1,K2
2	Design the Project using Software tools	K2,K3
3	Capable of implementing the problem with techniques	K3,K4
4	Report Formation	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Mapping with Programming Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	M	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S

Mini Project Guidelines

Mode of Mini Project: Individual Project

Nature of Mini Project: Every student shall undertake a unique project title (Novel Concept/ idea/system or a small research problem, which shall be designed and implemented using Web Application Development and hosting using open-source software like Python, PHP, HTML,.NET etc., approved by her/his guide.

Guide: Each Student shall be allotted under the Guidance of one Department faculty member by the Programme coordinator/Head

Duration: One semester - (6 hours per week)

Students carry out the Mini Project work in her/his college itself. In the case of a Company project, students are permitted to do the mini-project work in reputed IT companies without affecting the minimum attendance and other classes of the third semester

Continuous Assessment: Based on periodic reviews (Three reviews during the semester. Tentative review dates are decided by the department and will be communicated to the students at the beginning of the third semester.)

Internal (CIA) (50 Marks) (All the three reviews are mandatory)		**External (50 Marks)**	
Review I (Problem identification, Title & Abstract submission, Novelty of the idea, proposed outcomes, issues in existing methods, tools to be used)	15 Marks	Both the internal and external examiners will evaluate the student at the end of the semester based on the following criteria: an internal examiner, determined by the HOD, such as a faculty member from the Guide or any other department, and an external examiner appointed by the COE.	
Review II System Design / Database Design or Research Methodology / Algorithms and Techniques/ detailed Implementation plan	15 Marks	**Internal Examiner** Project Report	20 Marks
Review III System Implementation status, Testing, demo of working system and completion of report writing	20 Marks	**External Examiner shall evaluate under the following criteria** • Presentation of the Mini Project • Demonstration of the mini-project working • Viva -voce	10 Marks 10 Marks 10 Marks
Total	**50 Marks**		**50 Marks**

SEC 2: DATA VISUALIZATION TOOLS

L	T	P	C
3	0	0	2

Prerequisites:

- Prior experience in image editing or object-oriented programming may lead to a more sophisticated final project but is not required.
-

Objectives:

- To introduce visual perception and core skills for visual analysis
- To understand visualisation for time-series analysis and ranking analysis
- To understand visualisation for deviation analysis
- To understand visualisation for distribution analysis and correlation analysis
- To understand visualisation for multivariate analysis
- To understand issues and best practices in information dashboard design

Outcomes:

- Ability to use the tools for data visualisation.

UNIT I: CORE SKILLS FOR VISUAL ANALYSIS

Information visualisation - effective data analysis - traits of meaningful data - visual perception - making abstract data visible - building blocks of information visualisation - analytical interaction - analytical navigation –

UNIT II: Optimal quantitative scales - reference lines and regions - trellises and crosstabs - multiple concurrent views - focus and context- details on demand - over-plotting reduction - analytical patterns - pattern examples

Unit III: TIME-SERIES, RANKING

Time-series analysis - time-series patterns - time-series displays - time-series best practices- part-to-whole and ranking patterns - part-to-whole and ranking displays - best practices

UNIT IV: **DEVIATION ANALYSIS** AND **DISTRIBUTION**

Deviation analysis - deviation analysis displays - deviation analysis best practices, Distribution analysis - describing distributions - distribution patterns - distribution displays - distribution analysis best practices

UNIT V: CORRELATION, AND MULTIVARIATE ANALYSIS

- correlation analysis - describing correlations – correlation patterns - correlation displays - correlation analysis techniques and best practices – multivariate analysis - multivariate patterns - multivariate displays - multivariate analysis techniques and best practices

Reference Book(s):

1. Stephen Few, Now you see it: Simple Visualization Techniques for quantitative analysis, Analytics Press, 2009.
2. Stephen Few, Information Dashboard Design: The effective visual communication of data, O'Reilly, 2006.
3. Edward R. Tufte, The visual display of quantitative information, Second Edition, Graphics Press, 2001.
4. Nathan Yau, Data Points: Visualization that means something, Wiley, 2013.
5. Ben Fry, Visualizing data: Exploring and explaining data with the processing environment, O'Reilly, 2008.
6. Gert H. N. Laursen and Jesper Thorlund, Business Analytics for Managers: Taking business intelligence beyond reporting, Wiley, 2010.
7. Evan Stubbs, The value of business analytics: Identifying the path to profitability, Wiley, 2011.

III SEMESTER

Course code		Internship/Industrial Activity/Research Updation Activity	L	T	P	C
Core/Elective/Supportive		Supportive	0	0	0	2
Pre-requisite		a well-written resume, transcripts, and letters of recommendation prepared with their application.				

Course Objectives:

The main objectives of this course are to:

1. to build the necessary skills
2. to gain industry working Experience
3. a high capacity for analysis to solve problems,
4. to achieve a goal
5. adapting easily to changes

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	to build the necessary skills	K1,K2
2	to gain industry working Experience	K2,K3
3	a high capacity for analysis to solve problems	K3,K4
4	Report Formation	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Mapping with Programming Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	S	M	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S

Guidelines:

1. Internal: 50marks External: 50 marks TOTAL 100 marks
2. A report should be submitted at the end of 3rd semester and evaluated by the external examiners
3. Internship students should submit a certificate of attendance from the industry along with a report.

IV SEMESTER

Course code		Major Project	L	T	P	C
Core/Elective/Supportive		Core			30	16
Pre-requisite		Basic Programming of Software Tools & Introduction to developing Project work				

Course Objectives:

The main objectives of this course are to:

1. to enable the students to study Project development
2. to undertake a unique project title
3. to get a novel idea for the project
4. to define the problem
5. to design and implement using a n available software development tool /Programming
6. Prepare a report

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	To define the problem	K1,K2
2	Design the Project using Software tools	K2,K3
3	Capable of implementing the problem with techniques	K3,K4
4	Report Formation	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Mapping with Programming Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	S	S	S	M	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S

Major Project Guidelines:

Mode of Major Project: Individual Project

Nature of Major Project: Every student must choose a unique project title (novel concept, idea, system, or a small research problem) approved by their guide and then design and implement it using available software development tools or programming languages.

Guide: Each Student shall be allotted under the Guidance of one Department faculty member by the Programme coordinator/Head

Duration : One semester - (30 hours per week) Major project students may also opt for company projects with prior permission from the Head of the Department/Principal

Continuous Assessment: Based on periodic reviews (Three reviews during the Semester. Tentative review dates are decided by the department and to be intimated to the students at the beginning of the fourth Semester)

Evaluation criteria

Each student is evaluated by the Internal Examiner (Guide) continuously during the respective semester. External Examination will be conducted at the end of the respective semester.

Passing Criteria: Student shall secure a minimum of **50 % marks in the external** evaluation and shall secure a **minimum of 50 % marks in combined Internal and External evaluation**. (There is no passing minimum for the internal evaluation)

Internal (50 Marks) (All the three reviews are mandatory)		**External (50 Marks)**	
Review I (Problem identification, Title & Abstract submission, The novelty of the idea proposed outcomes, issues in existing methods, tools to be used)	15 Marks	Both Internal and External Examiner Shall evaluate the student based on the following criteria at the end of the semester: (Guide or any other department faculty decided by the HOD shall be internal examiner. External Examiner will be appointed by the COE	
Review II System Design / Database Design / Methodology / Algorithms and Techniques/ detailed Implementation plan	15 Marks	**Internal Examiner** Project Report	20 Marks
Review III System Implementation status, Testing, outcomes and report writing	20 Marks	**External Examiner shall evaluate under the following criteria** • Presentation of the Project • Demonstration of the working project • Viva -voce	10 Marks 10 Marks 10 Marks
Total	**50 Marks**		**50 Marks**

IV Semester

Course code		Extension Activities	L	T	P	C
Core/Elective/Supportive		Supportive	-			1
Pre-requisite		high school-level courses like Algebra, Trigonometry, and Pre-Calculus				

Course Objectives:

The main objectives of this course are to:

1. change the outlook of people or develop the individuals.
2. Social and cultural - development of the community.
3. connecting students, faculty
4. institutions with communities, industries,
5. to solve societal needs.

Expected Course Outcomes:

On the successful completion of the course, students will be able to:

1	To define the problem	K1,K2
2	Design the work to be carried	K2,K3
3	Capable of implementing the work	K3,K4
4	Report Formation	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

Mapping with Programming Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	M	M	S	S
CO2	S	S	S	S	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	M	S	S

Outreach Activities

1. Awareness of the Internet in Villages
2. Awareness of women's security app in the public
3. Teaching DTP Courses to school teachers.
4. Teaching computers to School Children
5. Awareness of using Mobile Phones for old age people
6. Motivational Videos on Literacy to the village students., etc and not limited to the above

Guidelines:

1. Internal: 50marks External: 50 marks TOTAL 100 marks
2. students should submit a report about their visit and activities individually.
3. External Examination will be conducted in the 4th semester as per the existing pattern for extension Activity
4. No Viva-Voce