MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI-12

PG COURSES – AFFILIATED COLLEGES

MASTER OF SCIENCE in ARTIFICIAL INTELLIGENCE

REGULATIONS – 2021

(Choice Based Credit System)
(with effect from the academic year 2021-2022)

Vision of the University

To provide quality education to reach the un-reached

Mission of the University

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity.
- To offer a wide variety of off-campus educational and training programs, including the use of Information Technology to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality/ inclusive education, especially for the rural and un-reached segments of economically downtrodden students including socially oppressed and differently abled

PREAMBLE

The Learning Outcome-based Curriculum Framework (LOCF) approach which is student-centric, interactive and outcome oriented with well-defined aims, objectives and goals to achieve has been adopted in M. Sc Artificial Intelligence

Programme to create and disseminate knowledge to the students on the latest technologies by imparting the technical skills to meet industrial needs and inculcate the skills for employability.

Vision

Empowering students with knowledge and technical skill set in the domain of Artificial Intelligence

Mission

To enable the students excel in the field of Artificial Intelligence

PROGRAM EDUCATIONAL OBJECTIVES

1. To understand the core concepts and acquire expertise
2. To facilitate students to develop problem solving and programming skills
3. To empower students to involve in active research
4. To contribute to the developmental needs of India and the world.
5. To make the students employable by imparting domain knowledge.

PROGRAM OUTCOME:

PO 1 Evaluate the contemporary issues, latest trends in technological development and thereby innovate new ideas and solutions to existing problems

PO 2 Analyze, synthesize, model and integrate technologies to develop expert systems

PO 3 Communicate effectively, as a member or team leader, in projects involving multidisciplinary environments.

PO 4 Adapt to new developments and foster technological growth.

PO 5 Develop strong moral and ethical values to contribute as a responsible member of the society

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1 Understand and analyze the fundamental knowledge in the Artificial Intelligence domain.

PSO 2 Enhance the logical and analytical thinking to understand the computational systems.

PSO 3 Ability to comprehend the development methodologies of software systems and to design the software solutions.

PSO 4 Explore the developing areas in the Information Technology sector and to enrich themselves to be skillful to meet the diverse expectations of the industry.

PSO 5 Equipped to be competent in providing optimal and ethical solutions to the technological challenges laid by the professional societies.

REGULATIONS/ PROGRAMME SPECIFIC REQUIREMENTS

Duration of the Course:
M. Sc. Artificial Intelligence is a 2 years full time programme spread over four Semesters.

Eligibility for Admission to the Programme
Bachelor degree in Computer Science / Computer Applications / Information Technology / IT & E-Com/ Computer Technology / Software Engineering with at least 50% (SC/ST-45%) marks in Part III of this University or any other University accepted by the Syndicate of Manonmaniam Sundaranar University as equivalent in the 10+2+3 pattern

Credit Requirement: The general Regulations of the Choice Based Credit System programme of Manonmaniam Sundaranar University are applicable to this programme. The University requirement for the M. Sc. programme is completion of 90 credits of course work, out of which 6 credits should be through the mini project, 16 credits should be through the 4th semester main project work, remaining 64 credits should be through Core, and Elective papers. A Core course has 4 credits elective has 3 credits and Practical subjects weigh 2 credits. No candidate will be eligible for the Degree of M. Sc. (Master of Science) in Artificial Intelligence unless the candidate has undergone the prescribed courses of study for a period not less than 4 semesters and has acquired 90 credits.

A candidate will be permitted to appear for the semester examination only if the candidate keeps not less than 75 percent attendance. The University condonation rules are applicable for those who lack minimum of 75% attendance. The candidates with less than 60% attendance will have to repeat the concerned entire semester. The assessment will comprise Continuous Internal Assessment (CIA) carrying a maximum of 25% marks and end-semester Examination carrying a maximum of 75% marks in each theory subject (Core/Elective/Supportive

Course). For practical subjects, Mini Project and Major Project, the CIA is carried out for 50% marks and the External Assessment (Final Lab Exam, Record, Viva-Voce for Practical Subjects and Project Presentation, Project Report, Viva-Voce for Mini Project and Major Project) is for 50% marks. Semester examination will be conducted for all subjects of study, at the end of each Semester. If a Student wants to carry out the final Major project work in 4th semester in an IT company, the student can get permission from the concerned Project Supervisor and Head of the Department after submitting the Acceptance Letter from the IT Company.

PRACTICAL

Practical examinations will be conducted at the end of each semester. The scheme of valuation is to be decided by the respective board of Question setters.

Passing Minimum for Practical Examination:

Assessment Components (External: Internal – 50 : 50)

There is no Passing Minimum for the CIA component. But overall (CIA+ External), the student should get 50% or more to get a pass.

PROJECT AND VIVA-VOCE

Project report evaluation and Viva-Voce will be conducted by the external examiner and the Project Supervisor. The break-up for the project work is as follows:

Components	Marks
Project Report	20
Project Presentation & Viva-Voce	30
Total	50

Passing Minimum for Mini/Major Project:

There is no Passing Minimum for the CIA component. But overall (CIA+ External), the student should score 50% or more to get a pass.

Scheme of Examination / Question Paper Pattern - Theory Subjects:

(Total Marks: 100 (Internal: 25 Marks, External: 75 Marks)

<table>
<tr><td colspan="2">There is no Passing Minimum for the CIA component.
But overall (CIA+ External), the student should get 50% or more to get a pass</td></tr>
<tr><td>CIA- Internal Marks</td><td>End semester Examination - External Marks</td></tr>
<tr><td>i. Average of best two tests from three: 15 Marks
ii. Assignment: 05 Marks
iii. Seminar: 05 Marks</td><td rowspan="2">Total : 75 Marks</td></tr>
<tr><td>Total : 25 Marks</td></tr>
<tr><td></td><td>Passing minimum 50% i. e. 38 marks</td></tr>
</table>

External (End Semester) Examination Question pattern:

Time: 3 hours Max. Marks: 75

Part – A

(10 x 1 = 10)

Answer all the questions

Ten Questions - Two objective type questions from each unit.

Part – B

(5 x 5 = 25)

Answer all the questions

Five Questions, two short answer type questions from each unit with internal choice (Either . . . Or. . . type)

Part – C

(5 x 8 = 40)

Answer all the questions

Five Questions, two descriptive/Analytical type questions from each unit with internal choice (Either . . . Or . . . type)

Model Question Paper: Sub. Code : **ZAIM11**

M. Sc. (CBCS) DEGREE EXAMINATION

First Semester

Artificial Intelligence — Core

ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer:

1. Which of the following is the language meant for Artificial Intelligence?
   (a) C (b) Java (c) LISP (d) Perl

2. Which of the following is not an application of artificial intelligence?
(a) Computer Vision (b) Natural Language Processing (c) Database Management System (d) Digital Assistants

3. Procedural Domain Knowledge in a rule-based system, is in the form of ..... .

(a) Meta Rules (b) Production rules (c) control rules (d) protocols

4. By which algorithm decisions of Victory/Defeat made in Game trees?
(a) DFS (b) BFS (c) Heuristic Search (d) MiniMax Search

5. Inference engines work on the principle of ..... .
(a) Backward Chaining (b) Forward Chaining (c) Both Forward and Backward chaining (d) Neither Forward nor Backward chaining

6. Which of the following is not the required property of Knowledge representation?
(a) Inferential Efficiency (b) Inferential Adequacy (c) Representational Verification (d) Representational Adequacy

7. What does the Bayesian network provide?
(a) Partial description of the domain (b) Complete description of the problem (c) Partial description of the problem (d) Complete description of the domain

8. Machines that try to imitate human intuition while handling vague information lie in the field of AI are called ..... .
(a) Functional Logic (b) Fuzzy Logic (c) Boolean Logic (d) Human Logic

9. Which represents facts and rules?
(a) Knowledge base (b) Inference engine (c) Operating system (d) DBMS

10. Experts make decisions based on ..... information.
(a) Numerical data (b) Qualitative & quantitative (c) graphs and charts (d) Experimental information

PART B — (5 x 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) What is Artificial Intelligence? What are the different types of agents?
Or
(b) What does production system consist of?

12. (a) Compare Breadth First Search and Depth First Search.
Or
(b) Write a note on Waiting for Quiescence

13. (a) Compare Forward and Backward Chaining
Or
(b) Write a note on Backtracking

14. (a) What is fuzzy logic? What is a fuzzy set?
Or
(b) Write a note on Certainty factor.

15. (a) What is an Expert system?
Or
(b) Write a note on PROSPECTOR.

PART C — (5 x 8 = 40 marks)

Answer ALL questions by choosing either (a) or (b).

16. (a) Explain State Space Search.
Or

(b) Briefly explain Problem Characteristics

17. (a) Write A* algorithm.
Or
(b) Explain Minimax search.

18. (a) What is Propositional Logic? Write algorithms for propositional resolution and Unification.
Or
(b) Describe the basics of PROLOG

19. (a) Discuss briefly about Bayesian probability.
Or
(b) Briefly explain Semantic nets.

20. (a) Briefly explain the phases in Expert system development.
Or
(b) Describe the Expert System - MYCIN.

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PG COURSES – AFFILIATED COLLEGES

M. Sc ARTIFICIAL INTELLIGENCE

(Choice Based Credit System)

(with effect from the academic year 2021-2022 onwards)

SEMESTER WISE COURSE LIST

Sem	Course No	Course status	Course Title	Contact Hrs	Credits
I	1	Core 1	Artificial Intelligence & Expert Systems	5	4
	2	Core 2	Design & Analysis of Algorithms	5	4
	3	Core 3	Python Programming	4	4
	4	Core 4	Big Data Analytics	4	4
	5	Core 5	Mathematical Foundation for Computer Science	4	4
	6	Core 6 Practical 1	Algorithm Lab using C++	4	2
	7	Core 7 Practical 2	Python Programming Lab	4	2
			Sub Total	30	24
II	8	Core 8	Machine Learning	5	4
	9	Core 9	Artificial Neural Networks & Fuzzy Systems	5	4
	10	Core 10	Advanced Web Technology	4	4
	11	Core 11	Compiler Design	4	4
	12	Elective 1	Distributed Operating Systems / Virtual Reality/ Pattern Recognition & Image Analysis	4	3
	13	Core 12 Practical 3	Machine Learning Lab with Python/ R & Hadoop	4	2
	14	Core 13 Practical 4	Advanced Web Technology Lab	4	2
			Sub Total	30	23
III	15	Core 14	Natural Language Processing	4	4
	16	Core 15	Internet of Things	4	4
	17	Core 16	Optimization Techniques	4	4
	18	Core 17	Research Methodology	4	4
	19	Elective 2	Deep Learning/Robotics / Cryptography & Network Security	4	3
	20	Core 18 Practical 5	Natural Language Processing Lab	4	2
	21	Core 19	Mini Project	6	6
			Sub Total	30	27
IV	22	Core 20	Major Project	30	16
			Sub Total	30	16
			Total	120	90

Semester I

Course No.	Course status	Course Title	Contact Hrs	Credits
1	Core 1	Artificial Intelligence & Expert Systems	5	4
2	Core 2	Design & Analysis of algorithms	5	4
3	Core 3	Python Programming	4	4
4	Core 4	Big Data Analytics	4	4
5	Core 5	Mathematical Foundation for Computer Science	4	4
6	Core 6 Practical 1	Algorithms Lab using C++	4	2
7	Core 7 Practical 2	Python Programming Lab	4	2
		Sub Total	30	24

Core 1

ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS

L	T	P	C
4	1	0	4

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

Course Outcome:

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

CO1. Delineate Artificial intelligence.
CO2. Build knowledge about Expert systems.
CO3. Understand the basics of knowledge representations
CO4. Develop Expert Systems
CO5. Design a Fuzzy set for a given application

Unit-I Fundamentals of Artificial Intelligence 15 hours

Introduction, A. I. Representation, Non-AI & AI Techniques, Representation of Knowledge, Knowledge Base Systems, State Space Search, Production Systems, Problem Characteristics, types of production systems, Intelligent Agents and Environments, concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation

Unit-II Search Strategies 15 hours

Uninformed Search: Formulation of real world problems, Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Depth First Search, Bidirectional Search, Comparison of Uninformed search Strategies

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

Unit-III Knowledge Representation 15 hours

Knowledge based agents, Wumpus world. Propositional Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. First order Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. Basics of PROLOG: Representation, Structure, Backtracking.

Unit-IV Non Monotonic Reasoning 15 hours

Logics for Non Monotonic Reasoning, Semantic Nets, Statistical Reasoning, Fuzzy logic: fuzzy set definition and types, membership function, designing a fuzzy set for a given application. Probability and Bayes' theorem - Bayesian Networks.

Unit-V Expert systems 15 hours

Architecture of expert systems, Role of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, PROSPECTOR

CO - PO - PSO Mapping

ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K - 4
CO 3	S	S	M	S	S	S	S	S	S	S	K - 2
CO 4	S	S	M	S	S	S	S	S	S	S	K - 3
CO 5	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

Reference Books:

1. Ivan Bratko, "Prolog Programming For Artificial Intelligence", 2nd Edition Addison Wesley
2. Eugene, Charniak, Drew McDermott, "Introduction to Artificial Intelligence", Addison Wesley
3. Patterson, "Introduction to AI and Expert Systems", PHI
4. Nilsson, "Principles of Artificial Intelligence", Morgan Kaufmann.
5. Carl Townsend, "Introduction to Turbo Prolog"

Core 2

DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	C
4	1	0	4

Course Objectives:

1. To understand fundamental concepts of Algorithm
2. To impart knowledge about Basic Traversal And Search Techniques and Problematic Design
3. To implement the linear and non-linear data structures

Course Outcome:

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

CO1. Understand and solve complex problems

CO2. Select an appropriate algorithm for the problem

CO3. Evolve as a competent programmer capable of designing and analyzing algorithms and data structures for different kinds of problems

CO4. Classify problems into complexity classes like P and NP.

CO5. Analyze graphs and determine shortest path

UNIT-1 **15 hours**

Introduction: Algorithm-Specification - Performance Analysis. Divide And Conquer - General Method - Binary Search - Find the Maximum and Minimum - Quick sort - Strassen's Matrix Multiplication.

Unit –II **15 hours**

Representing rooted trees – Hash Tables: Direct-address tables, Hash tables, Hash functions - Open addressing, Perfect hashing – Binary Search Trees: Querying a binary search tree, Insertion and deletion, Randomly built binary search trees – Red-Black Trees: Properties of red-black trees, Rotations, Insertion, Deletion – B-Trees: Definition of B-trees, Basic operations, Deleting a key from a B-tree.

UNIT – III **15 hours**

The Greedy Method: General Method - Knapsack Problem - Job Sequencing with Deadlines- Minimum Cost Spanning Tree - Single Source Shortest Path. Dynamic Programming: General Method-Multistage Graph-All Pairs Shortest Path - Optimal Binary Search Tree - 0/1 Knapsack- Travelling Salesperson Problem.

UNIT – IV **15 hours**

Basic Traversal And Search Techniques: Techniques for Binary Trees –Techniques for Graphs-Connected Components and Spanning Trees-Bi-connected Components and DFS. Backtracking: General Method-8-Queen Problem, Sum of Subsets Graph Coloring: Hamiltonian Cycle.

UNIT – V **15 hours**

Graph Algorithms: Representation of Graphs, Breadth first search, Depth first search, Topological sort. Minimum Spanning Trees: Algorithms of Kruskal and Prim – Single Source Shortest Path: The Bellman-Ford Algorithm, Single source shortest path in directed acyclic graphs, Dijkstra's algorithm All pairs Shortest

Path: Shortest path and Matrix Multiplication, The Floyd-Warshall algorithm – Johnson's algorithm for sparse graphs.

CO - PO - PSO Mapping

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

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

Text and Reference books

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", 2nd Edition, Universities Press(India) Private Ltd., 2018.
2. Aho, Hoporoft and Ullman, "The Design and Analysis of Computer Algorithm", Pearson Education, Delhi, 2001.
3. Basu S. K., "Design Methods and Analysis of Algorithms", PHI, 2006.
4. M. A. Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education, Asia, 2013.
5. Sandeep Sen and Amit Kumar, "Design and Analysis of Algorithms: A contemporary perspective", Cambridge University Press, 2019.
6. Thomas S. Cormen, Charles E. Liersorson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, The MIT Press, Cambridge, Massachusetts, London, England.
7. Eric Bach and Jeffrey Shallit, "Algorithmic Number Theory: Efficient Algorithms", Vol I: The MIT Press, Cambridge, Massachusetts, London, England.

Core 3

PYTHON PROGRAMMING

L	T	P	C
4	0	0	4

Course Objectives:

1. To understand different datatypes in Python
2. To learn the different concepts in Python
3. To analyze Database Connectivity and Data Visualization

Course Outcome:

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

CO1. Create Arrays, Strings, Lists and Tuples

CO2. Examine Dictionaries & Object Oriented Programming concepts in Python.

CO3. Understand Database Connectivity and Data Visualization

CO4. Access Database with Python

CO5. Use MySQL from Python

UNIT I INTRODUCTION 12 hours

Introduction to Python: Features of Python – Writing the First Python Program – Executing a Python Program – Datatypes in Python – Literals – Operators – Input and Output – Control Statements.

UNIT II ARRAYS, STRINGS, FUNCTIONS AND TUPLES 12 hours

Creating an Array – Indexing and Slicing on Arrays – Types of Arrays – Working with arrays using numpy - Slicing and Indexing in numpy Arrays – Working with Multi-dimensional Arrays – Indexing and Slicing the Multi-dimensional Arrays – Creating Strings – Indexing, Slicing and Comparing Strings – Finding and Counting Substrings – Splitting and Joining Strings – Defining and Calling a Function – Pass by Object Reference – Anonymous Functions or Lambdas – Lists – Creating and Updating the Elements of a List – Methods to Process Lists – Creating Tuples – Functions to process Tuples – Inserting, Modifying and Deleting Elements from a Tuple.

UNIT III DICTIONARIES AND INTRODUCTION TO OOPS 12 hours

Operations on Dictionaries – Dictionary Methods – Creating a Class – Types of Variables – Types of Methods – Constructors in Inheritance – Types of Inheritance – Operator Overloading – Method Overloading and Overriding – Interfaces in Python – Regular Expressions in Python.

UNIT IV DATA STUCTURES & GUI 12 hours

Linked Lists – Stacks – Queues – **Graphical User Interface:** The Root Window – Working with Containers – Canvas – Frame – Widgets – Button Widget – Label Widget – Message Widget – Text Widget – Scrollbar Widget – Checkbutton Widget – Radiobutton Widget – Entry Widget – Listbox Widget – Menu Widget – Creating Tables – Sending a Simple Mail.

UNIT V DATABASE CONNECTIVITY & DATA SCIENCE 12 hours

Database Connectivity: Types of Databases used with Python – Using MySQL from Python – Retrieving all rows from a Table – Inserting, Deleting and Updating rows in a Table – Creating Database Tables using Python

Data Science using Python**:** Data Frame and Data Visualization.

CO - PO - PSO Mapping

PYTHON PROGRAMMING											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K - 4
CO 3	S	S	M	S	S	S	S	S	S	S	K - 5
CO 4	S	S	M	S	S	S	S	S	S	S	K - 3
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

TEXT BOOK

Dr. R. Nageswara Rao, “Core Python Programming”, Second Edition, Dreamtech Press, 2019.

REFERENCE BOOKS

1. Martin C. Brown, “The Complete Reference Python”, Indian Edition, Mc Graw Hill Education, 2018.
2. Yashavant Kanetkar, Aditya Kanetkar, “Let us Python”, Second Edition, BPB Publications, 2019.

Core 4 **BIG DATA ANALYTICS**

L	T	P	C
4	0	0	4

Course Objectives:

1. To understand the fundamental concepts of big data and analytics.
2. To explore tools and practices for working with big data
3. To know about the research with the integration of large amounts of data.

Course Outcome:

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

CO1. Acquire the knowledge on the basics of Big Data
CO2. Work with big data tools
CO3. Design efficient algorithms for mining the data from large volumes
CO4. Explore the cutting-edge tools and technologies to analyze Big Data
CO5. Appreciate Big Data Processing concepts and Data visualization techniques

UNIT-1 INTRODUCTION **12 hours**

Introduction to Big Data Analytics : Big Data Overview – Data Structures – Analyst Perspective on Data Repositories - State of the Practice in Analytics – BI Versus Data Science - Current Analytical Architecture – Drivers of Big Data – Big Data Ecosystem - Data Analytics Lifecycle – Data Discovery – Data Preparation – Model Planning – Model Building – Communicate Results – Operationalize.

UNIT – II DATA ANALYTIC METHODS **12 hours**

Basic Data Analytic Methods Using R : Introduction to R programming – R Graphical User Interfaces – Data Import and Export Attribute and Data Types – Descriptive Statistics Exploratory Data Analysis : Visualization Before Analysis – Dirty Data – Visualizing a Single Variable – Examining Multiple Variables Data Exploration Versus Presentation -– Statistical Methods of Evaluation: Hypothesis Testing – Difference of Means – Wilcoxon Rank-Sum Test – Type I and Type II Errors – Power and Sample Size – ANOVA.

UNIT – III ADVANCED METHODS **12 hours**

Advanced Analytical Theory and Methods: Clustering – K Means – Use Cases – Overview – Determining number of clusters – Diagnostics Reasons to choose and cautions – Additional Algorithms - Association Rules: A Priori Algorithm – Evaluation of Candidate Rules Applications of Association Rules – Validation and Testing – Diagnostics. Regression: Linear Regression and Logistic Regression: – Use cases – Model Description – Diagnostics - Additional Regression Models.

UNIT – IV CLASSIFICATION **12 hours**

Classification : Decision Trees – Overview – Genetic Algorithm – Decision Tree Algorithms – Evaluating Decision Tree – Decision Trees in R - Naive Bayes – Bayes Theorem – Naïve Bayes Classifier – Smoothing – Diagnostics – Naïve Bayes in R – Diagnostics of Classifiers – Additional Classification Methods - Time Series Analysis : Overview – Box – Jenkins Methodology – ARIMA Model – Autocorrelation Function – Autoregressive Models – Moving Average Models – ARMA and ARIMA Models – Building and Evaluating and ARIMA Model - Text Analysis :Text Analysis

Steps – Example – Collecting – Representing Term Frequency – Categorizing – Determining Sentiments – Gaining Insights.

UNIT – V TECHNOLOGY **12 hours**

Advanced Analytics-Technology and Tools: MapReduce and Hadoop: Analytics for Unstructured Data . - Use Cases - MapReduce - Apache Hadoop – The Hadoop Ecosystem – pig – Hive – Hbase – Mahout – NoSQL - Tools in Database Analytics : SQL Essentials – Joins – Set operations – Grouping Extensions – In Database Text Analysis - Advanced SQL – Windows Functions – User Defined Functions and Aggregates – ordered aggregates- MADLib – Analytics Reports Consolidation – Communicating and operationalizing and Analytics Project – Creating the Final Deliverables : Developing Core Material for Multiple Audiences – Project Goals – Main Findings – Approach Model Description – Key points support with Data - Model details – Recommendations – Data Visualization

CO - PO - PSO Mapping

BIG DATA ANALYTICS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	M	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	S	S	S	S	S	S	S	S	K - 2
CO 3	S	S	M	S	M	S	S	S	S	S	K - 4
CO 4	S	S	M	S	S	S	S	S	S	S	K - 3
CO 5	M	S	M	S	S	S	S	S	S	S	K – 6

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

Text books

1. Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", EMC Education Services Published by John Wiley & Sons,
2. Noreen Burlingame, "The little book on Big Data", New Street publishers, 2012.
3. Anil Maheshwari, "Data Analytics", McGraw Hill Education, 2017.

Reference books

1. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
2. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
3. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, 2010.
4. Kim S. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press, 2015.

Core 5 MATHEMATICAL FOUNDATION FOR COMPUTER SCIENCE

L	T	P	C
4	0	0	4

Course Objectives:

1. To understand the basic concepts of Set Theory and Graph Theory
2. To analyse using correlation and regression
3. To work with matrices

Course Outcome:

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

CO1. Acquire knowledge of relations, functions and mathematical logic
CO2. Statistically analyse data
CO3. Analyze correlation between data
CO4. Compute solutions of linear equations and system of equations
CO5. Understand the basic concepts of Graph Theory

UNIT I SET THEORY 12 hours

Basic concepts of set theory: Notation – Inclusion of equality of sets – Power set – Operation on sets – Venn diagrams

Relations and ordering: Cartesian products - Relations – Properties of Binary Relation in a set – Relation matrix and graph – Equivalence relations – Composition of Binary Relations.

Functions: Definition and Introduction – Composition of functions – Inverse function.

UNIT II MATRICES 12 hours

Introduction – Vectors – Methods of Testing Linear Dependence – Consistency of a System of Linear Algebraic Equation – Rank of the Matrix – Inverse of the Matrix - Eigen Values and Eigen Vectors – Cayley Hamilton Theorem.

UNIT III GRAPH THEORY 12 hours

Basic terminology: Different types of graphs – Directed and Undirected – Simple – Pseudo – Complete – Regular – Bipartite – Incidence and Degree – Pendant and Isolated Vertex – Null Graph – Isomorphism – Sub Graphs – Walk – Path and Circuit – Connected and Disconnected Graphs and Components - Planar graphs, Euler's formula - Operations on Graphs – Matrix representation of Graphs – Incidence Matrix – Path matrix - Adjacency Matrix

UNIT IV STATISTICS 12 hours

Measure of Central Tendency (Arithmetic Mean, Median, Mode); Measure of Dispersion (Absolute and Relative Measures Range, Quartile Deviation, Mean Deviation, Standard Deviation and Coefficient of Variation)

Correlation: Definition, Scatter diagram, Karl Pearson's coefficient of correlation, Numerical problems for determination of Correlation Coefficients.

UNIT V NUMERICAL METHODS 12 hours

Basics – Errors - Significant Digits – Solving Simultaneous Linear Equations – Bisection Method - Regula Falsi Method – Newton Raphson Method – Gauss Elimination Method – Gauss Jordan Method – Jacobi Iteration Method – Gauss Seidal Method

CO - PO - PSO Mapping

MATHEMATICAL FOUNDATION FOR COMPUTER SCIENCE											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	M	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	M	S	S	S	K - 3
CO 3	M	S	M	S	S	S	S	S	S	S	K - 4
CO 4	S	S	M	S	S	S	S	S	S	S	K - 5
CO 5	S	S	M	S	S	S	S	S	S	S	K – 4

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

TEXT BOOKS

1. J. P Trembley, R. Manohar, “Discrete Mathematical structures with applications to Computer Science”, Tata McGrawHill publications, 2017.
2. Seymour Lipschutz, Marc Lipson, “Discrete Mathematics”, Revised Third Edition, Schaum’s Outline Series, Tata McGraw Hill Publications, 2002.
3. B. S. Grewal, "Numerical methods in Engineering & Science", Khanna Publishers, Fifth Edition, April 2018.

Note: Excluding algorithms and theorems.

REFERENCE BOOKS

1. S. Santha, “Discrete Mathematics with Combinatory and Graph Theory”, Third Edition, Cengage Publications, 2015.
2. S. Arumugam, A. Thangapandi Isaac, "Statistics", New Gamma Publishing House, 2018.
3. S C Gupta, “Fundamentals of Statistics”, Himalaya Publishing House

Core 6 Practical 1

ALGORITHM LAB USING C++

L	T	P	C
0	0	4	2

Course Outcome:

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

CO1. Understand and solve complex problems

CO2. Select an appropriate algorithm for the problem

CO3. Evolve as a competent programmer capable of designing and analyzing algorithms and data structures for different kinds of problems

CO4. Evaluate Postfix expressions

CO5. Analyze and find shortest path in a graph

Practical List

1. Implement Merge Sort, Heap Sort and Quick Sort algorithms.
2. Implement the knapsack problem (0/1).
3. Obtain the topological ordering of vertices in a given digraph
4. Greedy algorithm to find minimum number of coins to make change for a given value of Indian currency. Assume that we have infinite supply of denominations in Indian currency.
5. Implement Breadth First Search and Depth First search
6. Use Prim's Algorithm to find a minimum spanning tree.
7. Find shortest path using Dijkstra's algorithm.
8. Multiply two matrices recursively.
9. Find whether a string is a permutation of another given string.
10. Postfix evaluation
11. Binary tree traversal
12. Binary Search Tree
13. N queen problem
14. Hash table
15. Divide and conquer algorithm for binary search

CO - PO - PSO Mapping

ALGORITHM LAB USING C++											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K - 2
CO 3	S	S	M	S	S	S	S	S	S	S	K - 4
CO 4	S	S	M	S	S	S	S	S	S	S	K - 3
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

Core 7 Practical 2

PYTHON PROGRAMMING LAB

L	T	P	C
0	0	4	2

Course Outcome:

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

CO1. Appreciate programming concepts in Python

CO2. Work with Widgets.

CO3. Insert, Delete and Update in Database.

CO4. Create and perform operations using Data Frames.

CO5. Implement Data Visualization

Practical List

1. Program to generate the Fibonacci Series.
2. Program to check whether the given number is prime or not.
3. Program to find the factorial of a given number using function.
4. Program using Arrays - Python program to sort the elements of an array in ascending order
5. Program using Strings - Program to Sort Words in Alphabetic Order
6. Program to perform various list operations, such as:
   - Append an element
   - Insert an element
   - Append a list to the given list
   - Modify an existing element
   - Delete an existing element from its position
   - Delete an existing element with a given value
   - Sort the list
   - Display the list.
7. Program using Tuples - Write a program to swap two numbers without using a temporary variable.
8. Program using Dictionaries - Write a program to count the number of times a character appears in a given string

9. 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'.
10. Program using Inheritance.
11. Program using Interfaces.
12. Program using Regular Expressions.
13. Program to perform Stack Operations.
14. Program to perform Queue Operations.
15. Working with Widgets.
16. Program to Insert, Delete and Update in Database.
17. Program to create and perform operations using Data Frames.
18. Program to 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	S	S	S	M	S	S	S	M	S	S	K - 2
CO 2	S	S	M	S	S	S	S	S	S	S	K - 3
CO 3	S	S	M	S	S	S	S	S	S	S	K - 2
CO 4	S	S	M	S	S	S	S	S	S	S	K - 6
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

Semester II

Course No.	Course status	Course Title	Contact Hrs	Credits
8	Core 8	Machine Learning	5	4
9	Core 9	Artificial Neural Networks & Fuzzy Systems	5	4
10	Core 10	Advanced Web Technology	4	4
11	Core 11	Compiler Design	4	4
12	Elective 1	Distributed Operating Systems / Virtual Reality/ Pattern Recognition & Image Analysis	4	3
13	Core 12 Practical 3	Machine Learning lab with Python/ R & Hadoop	4	2
14	Core 13 Practical 4	Advanced Web Technology Lab	4	2
		Sub Total	30	23

Core 8

L	T	P	C
4	1	0	4

MACHINE LEARNING

Course Objectives:

1. To understand the concept of Machine Intelligence
2. To implement and apply machine learning algorithms to real- world applications.
3. To identify and apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems.

Course Outcomes

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

CO1. Have a good understanding of the fundamental issues and challenges of Machine learning

CO2. Appreciate the underlying mathematical relationships within and across Machine Learningalgorithms

CO3. Understand the paradigms of supervised and un-supervised learning.

CO4. Design and implement various machine learning applications

CO5. Analyze different machine learning models

UNIT -1 INTRODUCTION **15 hours**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Linear Discriminants – Perceptron – Linear Separability– Linear Regression.

UNIT - II LINEAR MODELS **15 hours**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi- layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back- Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Course of Dimensionality – Interpolations and Basis Functions – Support Vector Machines

UNIT– III TREE AND PROBABILISTIC MODELS **15 hours**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

UNIT- IV DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS 15 hours

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process

UNIT – V GRAPHICAL MODELS 15 hours

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods

CO - PO - PSO Mapping

MACHINE LEARNING											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	M	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	M	S	S	S	S	S	K - 3
CO 3	S	S	S	S	S	S	M	S	S	N	K - 4
CO 4	S	S	M	S	S	S	S	S	S	S	K - 6
CO 5	M	S	M	S	S	S	M	S	S	S	K – 5

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

Text books

1. Stephen Marsland, —Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, —Machine Learning, First Edition, McGraw Hill Education, 2013.

Core 9 FUZZY LOGIC AND NEURAL NETWORK

L	T	P	C
4	1	0	4

Course Objectives:

1. To understand the concept of Fuzzy Logic
2. To analyze the architecture and working of neural network

Course Outcome:

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

CO1. Gain sound knowledge of Fuzzy Logic and Neural Networks
CO2. Apply fuzzy logic and reasoning to handle uncertainty
CO3. Apply Neural Network based algorithms to real world problems
CO4. Analyze Neuro-fuzzy system
CO5. Understand Fuzzy System Architecture

UNIT I FUNDAMENTALS OF FUZZY LOGIC 15 hours

Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets-complements- union intersection- combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy set and systems

UNIT II ARCHITECTURE OF NEURAL NETWORKS 15 hours

Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functions Basic learning rules- Mcculloch-Pitts neuron- Architecture, algorithm, applications-single layer net for pattern classification- Biases and thresholds, linear separability - Hebb's rule- algorithm - perceptron - Convergence theorem-Delta rule

UNIT III BASIC NEURAL NETWORK TECHNIQUES 15 hours

Back propagation neural net: standard back propagation-architecture algorithm-derivation of learning rules number of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine

UNIT IV COMPETITIVE NEURAL NETWORKS 15 hours

Neural network based on competition: fixed weight competitive nets- Kohonen self-organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2

UNIT V SPECIAL NEURAL NETWORKS 15 hours

Cognitron and Neocognitron - Architecture, training algorithm and application- fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

CO - PO - PSO Mapping

FUZZY LOGIC AND NEURAL NETWORK											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 2
CO 2	S	S	M	S	S	S	S	S	S	S	K - 3
CO 3	S	S	M	S	S	S	S	S	S	S	K - 1
CO 4	S	S	M	S	S	S	S	S	S	S	K - 5
CO 5	M	S	M	S	S	S	S	M	S	S	K – 4

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

Text books:

1. T. Kliryvan- Fuzzy System & Fuzzy logic Prentice Hall of India, First Edition.

2. Lawrence Fussett- Fundamental of Neural Network Prentice Hall, First Edition.

Reference Books:

1. Bart Kosko, ―Neural network and Fuzzy System‖ - Prentice Hall-1994.

2. J. Klin and T. A. Folger, ―Fuzzy sets‖ University and information- Prentice Hall -1996.

3. J. M. Zurada, ―Introduction to artificial neural systems‖-Jaico Publication house,Delhi 1994.

4. VallusuRao and HayagvnaRao, ―C++ Neural network and fuzzy logic‖-BPB and Publication, New Delhi,1996.

5. Intelligent Systems and Control-http://nptel. ac. in/courses/108104049/16

Core 10

ADVANCED WEB TECHNOLOGY

L	T	P	C
4	0	0	4

Course Objectives:

1. Explore the backbone of web page creation
2. Enrich knowledge about HTML control and web control classes
3. Provide depth knowledge about Java Scrit, PHP, MySQL and AJAX
4. Understand the need of usability, evaluation methods for web services

Course Outcome

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

CO1. Design a web page with Web form fundamentals and web control classes

CO2. Recognize the importance of validation control, cookies and session

CO3. Apply the knowledge of Java Script object, data access and SQL to develop a client servermodel.

CO4. Gain in- depth knowledge of Java Script, PHP, MySQL and AJAX

CO5. Analyze the need of usability, evaluation methods for web services

UNIT 1: Web Technologies and HTML **12 hours**

Internet and web Technologies - Client/Server model - Web Search Engine - Web Crawling - Web Indexing - Search Engine Optimization and Limitations - Web Services –Collective Intelligence –Mobile Web –Features of Web 3. 0 - HTML vs HTML5 - Exploring Editors and Browsers Supported by HTML5 - New Elements - HTML5 Semantics - Migration from HTML to HTML5 - Canvas - HTML Media - HTML Geolocation - Introduction to CSS3 - CSS2 vs CSS3 - Rounded Corner - Border Images - Multi Background - Gradients - iframe - 2d and 3d transform - Animation.

UNIT 2: XML and AJAX **12 hours**

XML - Documents and Vocabularies-Versions and Declaration -Namespaces JavaScript and XML: Ajax - DOM based XML processing Event - oriented Parsing: SAX - Transforming XML Documents-Selecting XML Data : XPATH-Template based Transformations: XSLT-Displaying XML Documents in Browsers - Evolution of AJAX -Web applications with AJAX -AJAX Framework.

UNIT 3: Client Side Scripting with Java Script **12 hours**

JavaScript Implementation - Use Javascript to interact with some of the new HTML5 apis -Create and modify Javascript objects - JS Forms - Events and Event handling - JS Navigator - JS Cookies - Introduction to JSON - JSON vs XML - JSON Parse - JSON Objects - jQuery Selectors - jQuery HTML&CSS - jQuery DOM - Importance of Angular JS in web - Angular Expression and Directives - AngularJS Data Binding and Controllers - Filters.

UNIT 4: Server side Scripting with PHP **12 hours**

Essentials of PHP - Installation of Web Server, XAMPP Configurations - PHP Forms - GET and POST method - URL encoding - HTML Encoding - Regular Expressions

- Cookies - Sessions - Usage of Include and require statements - File:read and write from the file - PHP Filters - PHP XML Parser - Introduction to Node. js - Node. js Modules and filesystem - Node. js Events.

UNIT 5: MySQL and MEAN STACK **12 hours**

PHP with MySQL - Performing basic database operation(DML) (Insert, Delete, Update, Select) - Prepared Statement - Uploading Image or File to MySQL - Retrieve Image or File from MySQL

Uploading Multiple Files to MySQL – SQL Injection - Introduction to MEAN and Express. JS -Real time example for modern web applications using MEAN

CO - PO - PSO Mapping

ADVANCED WEB TECHNOLOGY											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K – 1
CO 2	S	S	M	S	S	S	S	S	S	S	K – 2
CO 3	S	S	M	S	S	S	S	S	S	S	K – 4
CO 4	S	S	M	S	S	S	S	S	S	S	K – 6
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

Text Books

1. Paul Deitel, Harvey Deitel & Abbey Deitel, Internet and World Wide Web: How to Program, Pearson Education, Fifth edition, 2018
2. Amos Q. Haviv, MEAN Web Development, Packt Publishing, Second Edition, 2016

Reference Books

1. Laura Lemay, Rafe Colburn & Jennifer Kyrnin, Mastering HTML, CSS & Javascript Web Publishing, BPB Publications, First edition, 2016
2. Alex Giamas, Mastering Mongo DB 3. x, Packt Publishing Limited, First Edition, 2017

Core 11 **COMPILER DESIGN**

L	T	P	C
4	0	0	4

Course Objectives:

1. To understand the principles used to construct various phases of a compiler.
2. To explore knowledge about parsers

Course Outcome:

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

CO1. Understand various phases of a compiler
CO2. Appreciate the working of a parser
CO3. Explore the features of code generation and optimization techniques
CO4. Use Optimization Techniques
CO5. Design a compiler

UNIT-I LEXICAL ANALYSIS **12 hours**

Introduction to Compiling: Language Processors, The Structure of a Compiler. Lexical Analysis: The role of the lexical analyzer - Input buffering Specification of tokens - Recognition of tokens – The Lexical Analyzer Generator Lex - Finite automata - Regular expression to finite automata – Design of Lexical Analyzer Generator - Optimization of DFA - based pattern matchers.

UNIT – II SYNTAX ANALYSIS **12 hours**

Syntax Analysis: The role of the parser - Context-free grammars - Writing a grammar - Top down Parsing - Bottom-up Parsing - LR parsers- Parser Generators. Run time environment: Storage Organization – Static Allocation of space.

UNIT – III INTERMEDIATE CODE GENERATION **12 hours**

Intermediate Code Generation : Variants of Syntax trees – Three Address code – Types and Declarations - Translation of Expressions – Type checking - Control flow - Back patching - Switch Statements – Intermediate Code for Procedure

UNIT – IV CODE GENERATION **12 hours**

Code Generation : Issues in the design of a code generator - The target language – Address in the Target Code – Basic Block and Flow graphs – Optimization of Basic Blocks - A simple code generator – Peephole Optimization.

UNIT – V OPTIMIZATION TECHNIQUES **12 hours**

Machine Independent Optimizations: The Principal Sources of Optimization - Introduction to Data Flow analysis – Foundations of data flow analysis – Partial Redundancy Elimination - Loops in flow graph

CO - PO - PSO Mapping

COMPILER DESIGN											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K – 1
CO 2	S	S	M	S	S	S	S	S	S	S	K – 2
CO 3	S	S	M	S	S	S	S	S	S	S	K – 3
CO 4	S	S	M	S	S	S	S	S	S	S	K – 4
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

Text Book

Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, “Compilers-Principles, Techniques,and Tools”, Second Edition, Pearson Education Asia, 2014.

Reference Books

1. Kennath C. Louden, Compiler Construction Principles and Practice, Vikas publishing House, 2004.
2. Terence Halsey, Compiler Design Principles, Techniques and Tools, Larsen andKeller Education, 2018
3. Sudha Rani S, Karthi M., Raj Kumar Y - Compiler Design, Wiley 2019.
4. Adesh K Pandey, “Concepts of Compiler Design”, Katson, 2013.

Elective 1 A

DISTRIBUTED OPERATING SYSTEMS

L	T	P	C
4	0	0	3

Course Objectives:

1. To get a clear understanding about networks and operating systems
2. To apply basic networking concepts in projects
3. To get clear understanding about file systems

Course Outcome:

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

CO1. Get an insight about networking concepts

CO2. Gain knowledge about operating system concepts

CO3. Understand file system concepts

CO4. Analyze Deadlock

CO5. Explore Process management

UNIT-1 **12 hours**

Fundamentals: What is Distributed Operating System – Evolution of Distributed ComputingSystem – Distributed Computing System Models – Why are Distributed Computing Systems gaining popularity – What is a Distributed Computing System – Issues in Designing Distributed Computing System – Introduction to Distributed Computing Environment. Introduction to Computer Networks – Network types – LAN –WAN – Communication protocols – Internetworking – ATM Technology

UNIT – II **12 hours**

Message Passing: Introduction Desirable features – Issues in PC Message Passing – Synchronization – Buffering – Multi datagram Messages – Encoding and Decoding – Process Addressing – Failure Handling – Group Communication

UNIT – III **12 hours**

Remote Procedure Calls : RPC models – Transparency of RPC–Stub generation– RPC messages– Marshaling arguments and results–Exception Handling–Light weight RPC; Distributed Shared Memory: Introduction – General Architecture of DSM system – Design and Implementation Issues of DSM – Granularity – Structure of Shared Memory – Consistency Models – Replacement Strategy – Thrashing.

UNIT – IV **12 hours**

Synchronization: Introduction – Clock Synchronization – Event Ordering – Mutual Exclusion – Deadlock – Election Algorithm– Process Management: Introduction-Process Migration– Threads.

UNIT – V **12 hours**

Distributed File System: Introduction – Desirable features – File Models – File Accessing Models – File Sharing Semantics – File Caching Schemes – File Replication – Fault Tolerance – AtomicTransactions – Design Principles.

CO - PO - PSO Mapping

DISTRIBUTED OPERATING SYSTEMS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 3
CO 2	S	S	M	S	S	S	S	S	S	S	K - 2
CO 3	S	S	M	S	S	S	S	S	S	S	K - 1
CO 4	S	S	M	S	S	S	S	S	S	S	K - 4
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

Text books

1. Pradeep K Sinha, ―Distributed Operating Systems – Concepts and Design‖, PHI, 2016

2. Andrew S Tanenbaum, ―Distributed Operating Systems, First Edition, PHI. 2017

Reference Books

1. Abraham Silberschatz, Peter B. Galvin G. Gagne, Operating Systems Concepts, Ninth edition, Addision Wesley Publishing Co., 2018.
2. Coulouris George, Dollimore Jean, Blair Gordon–Distributed systems-concepts and design Pearson 2017.

Elective 1 B **VIRTUAL REALITY**

L	T	P	C
4	0	0	3

Course Objectives:

1. To understand the basics of typography, grids in layout design, color modes
2. To conceive the design concepts of Virtual Reality

Course Outcome:

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

CO1. Work with typography and grids in layout design
CO2. Efficiently use various color modes
CO3. Able to record an action and create rollover states
CO4. Explore the issues in Virtual Reality
CO5. Analyze the role and importance of Virtual Reality in the modern world.

UNIT I **12 hours**

Basic elements of visual design - Principles of visual design - Creating - Headlines and Body content - Pre-press technology and Post-press technology Grids in layout design: Anatomy of a grid - Types of layout design - Mixed design - Design process - Brand Management - Branding - Brand identity design - Design thinking process

UNIT II **12 hours**

Introduction – A generic VR system: Virtual environment – Technology – Modes of Interaction – VR Hardware: Sensor Hardware, Head Coupled displays – Acoustic hardware – Integrated VR – VR Software: Modeling Virtual worlds – Physical simulations – VR Applications

UNIT III **12 hours**

Designing for VR -Visual aid - UI depth and eye strain - Constant velocity - Maintaining head tracking - Guiding with light - Leveraging scale - Spatial audio - Gaze Cues Image Size and resolution - Pixel density - Eye buffers - Optimal resolution- Creating Panoramic Images

UNIT IV **12 hours**

Color Modes: Changing color mode - Type tool options - Work path from type - Layers panel - Types of layers - Features of layers - Shape tools and Painting Tools - Brush tools - Gradient tools - Effects panel - Graphics panel - Photo effects

UNIT V **12 hours**

Filter Gallery: Applying filters - Smart filters - Channels panel - Actions panel - Change settings - Exclude commands - Inserting a non-recordable menu command - Batch command - Rollovers - Creating buttons - Make layer duplicates - Create rollover states 360-degree illustrations for VR - Panorama - Planning and drawing 360-degree illustration - Exporting for VR 23

CO - PO - PSO Mapping

VIRTUAL REALITY											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 2
CO 2	S	S	M	S	S	S	S	S	S	S	K - 2
CO 3	S	S	M	S	S	S	S	S	S	S	K - 1
CO 4	S	S	M	S	S	S	S	S	S	S	K - 6
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

Text Books:

1. John Vince, “Virtual Reality Systems” Addison Wesley 1995

2. Karl Aspelund, “The Design Process”, 3rd Edition, 2014

3. Brian Wood, “Adobe Illustrator CC Classroom”, 1st Edition, 2019

4. Joseph A. Gatto, “Exploring Visual Design: The Elements and Principles”, 2010

Reference Books:

1. Erin Pangilinan, Steve Lukas, et al. ‘Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing’, Apr 14, 2019

2. Steve Aukstakalnis, ‘Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability)

Elective 1 C

L	T	P	C
4	0	0	3

PATTERN RECOGNITION AND IMAGE ANALYSIS

Course Objective:

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

Course Outcome:

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

CO1. Get acquainted with natural language processing
CO2. Apply basic algorithms in NLP
CO3. Understand the algorithmic description of the main language levels
CO4. Grasp basics of knowledge representation
CO5. Recognize patterns

Unit I **12 hours**

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 **12 hours**

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 **12 hours**

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

Unit IV **12 hours**

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 squared test.

Unit V **12 hours**

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.

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	S	S	S	M	S	S	S	M	S	S	K – 1
CO 2	S	S	M	S	S	S	S	S	S	S	K – 2
CO 3	S	S	M	S	S	S	S	S	S	S	K – 3
CO 4	S	S	M	S	S	S	S	S	S	S	K – 4
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

Strongly Correlated – S, 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

Core 12 Practical 3

L	T	P	C
0	0	4	2

MACHINE LEARNING LAB WITH PYTHON/ R & HADOOP

Course Objectives:

1. To apply the concepts of Machine Learning to solve real-world problems
2. To implement basic algorithms in clustering & classification applied to text & numeric data
3. To implement algorithms emphasizing the importance of bagging & boosting in classification & regression
4. To implement algorithms related to dimensionality reduction
5. To apply machine learning algorithms for Natural Language Processing applications

Course Outcome:

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

CO1. Implement machine learning algorithms related to numeric data

CO2. Apply machine learning algorithms for text data

CO3. Use dimensionality reduction algorithms for image processing applications

CO4. Distinguish Clustering and Classification

CO5. Apply CRFs in Natural Language Processing

LIST OF EXERCISES

1. Solving Regression & Classification using Decision Trees
2. Root Node Attribute Selection for Decision Trees using Information Gain
3. Bayesian Inference in Gene Expression Analysis
4. Pattern Recognition Application using Bayesian Inference
5. Bagging in Classification
6. Bagging, Boosting applications using Regression Trees
7. Data & Text Classification using Neural Networks

8. Using Weka tool for SVM classification for chosen domain application
9. Data & Text Clustering using K-means algorithm
10. Data & Text Clustering using Gaussian Mixture Models
11. Dimensionality Reduction Algorithms in Image Processing applications
12. Application of CRFs in Natural Language Processing

CO - PO - PSO Mapping

MACHINE LEARNING LAB WITH PYTHON/ R & HADOOP											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 2
CO 2	S	S	M	S	S	S	S	S	S	S	K - 1
CO 3	S	S	M	S	S	S	S	S	S	S	K - 4
CO 4	S	S	M	S	S	S	S	S	S	S	K - 3
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

Core 13 Practical 4

ADVANCED WEB TECHNOLOGY LAB	**L**	**T**	**P**	**C**
	0	**0**	**4**	**2**

Course Objectives:

1. Explore the backbone of web page creation by developing HTML 5 and XML, Java Scripting, PHP and MySQL skill.
2. Provide in-depth knowledge about JS, PHP, MySQL and AJAX

Course Outcome:

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

CO1. Recognize the importance of validation control

CO2. Analyze cookies and session

CO3. Apply the knowledge of Java Script object, data access and SQL to develop a client servermodel.

CO4. Design Web applications using various technologies such as Java, XML, AJAX, Servlets,PHP, JSP, MySQL and MEAN STACK

CO5. Implement Database connectivity

LIST OF EXERCISES

1. Display five different images. Skip two lines between each image. Each image shouldhave a title.
2. Print two addresses in the same format used on the front of envelopes (senders address intop left corner, receivers address in the center)
3. Create a page with a link at the top of it that when clicked will jump all the way to the bottom of the page. At the bottom of the page there should be a link to jump back to thetop of the page.
4. Create Web Animation with audio using HTML5 & CSS3
5. Demonstrate Geolocation and Canvas using HTML5
6. Write an XML file and validate using Document Type Definition (DTD)
7. Demonstrate DOM and SAX parser
8. Write a JavaScript program to demonstrate Form Validation and Event Handling
9. Design a simple online test web page in PHP

10. Write a JavaScript to implement a web application that lists all cookies stored in the browser on clicking List Cookies button. Add cookies if necessary
11. Create an application using AngularJS
12. Demonstrate AngularJS forms and directives
13. Demonstrate to fetch the information from an XML file with AJAX
14. Implement web application using AJAX with JSON
15. Demonstrate Node. js file system module
16. Write a PHP program to keep track of the number of visitors visiting the web page and todisplay this count of visitors, with proper headings
17. Implement Database connectivity MySql with PHP

CO - PO - PSO Mapping

ADVANCED WEB TECHNOLOGY LAB											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K - 3
CO 3	S	S	M	S	S	S	S	S	S	S	K - 5
CO 4	S	S	M	S	S	S	S	S	S	S	K - 2
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

Semester III & IV

Course No.	Course status	Course Title	Contact Hrs	Credits
15	Core 14	Natural Language Processing	4	4
16	Core 15	Internet of Things	4	4
17	Core 16	Optimization Techniques	4	4
18	Core 17	Research Methodology	4	4
19	Elective 2	Deep Learning/Robotics / Cryptography & Network Security	4	3
20	Core 18 Practical 5	Natural Language Processing Lab	4	2
21	Core 19	Mini Project	6	6
		Sub Total	30	27
22	Core 20	Major Project	30	16

Core 14

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. Discover various linguistics relevant to NLP tasks

CO3. Identify statistical features relevant to NLP tasks

CO4. Analyze parsing in NLP

CO5. Develop systems for various NLP problems with moderate complexity.

UNIT-I **12 hours**

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 **12 hours**

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 **12 hours**

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 **12 hours**

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 **12 hours**

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	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K - 3
CO 3	S	S	M	S	S	S	S	S	S	S	K - 5
CO 4	S	S	M	S	S	S	S	S	S	S	K - 2
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

Text book:

Jurafsky Dan and Martin James S. "Speech and Language Processing",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".

Core 15	INTERNET OF THINGS	L	T	P	C
		4	0	0	4

Course Objectives:

1. To gain knowledge on Internet of Things (IoT), IoT Architecture, and the Protocols
2. To understand the concept of Web of Things and the relationship between IoT & WoT

Course Outcome:

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

CO1. Gain the basic knowledge about IoT

CO2. Use IoT related products inreal life.

CO3. Rely less on physical resources and start to do work smarter.

CO4. Analyze opportunities and challenges in IoT

CO5. Understand the need of Sensors and actuators

UNIT-1 **12 hours**

The Internet of Things: An Overview - The Flavor of the Internet of Things, The "Internet" of "Things"- The Technology of the Internet of Things - Enchanted Objects, Who is Making the Internet of Things? Design Principles for Connected Devices - Calm and Ambient Technology, Magic as Metaphor, Privacy, Keeping Secrets, Whose Data Is It Anyway?, Web Thinking for Connected Devices, Small Pieces, Loosely Joined, First-Class Citizens On The Internet, GracefulDegradation, Affordances.

UNIT – II **12 hours**

Prototyping Embedded Devices – Electronics, Sensors, Actuators, Scaling Up the Electronics, Embedded Computing Basics, Microcontrollers, System-on-Chips, Choosing Your Platform, Arduino, Developing on the Arduino, Some Notes on the Hardware, Openness, Raspberry Pi, Cases and Extension Boards, Developing on the Raspberry Pi, Some Notes on the Hardware, Openness What Are Smart Objects? - Where Do Smart Objects Come From? Challenges for Smart Objects

UNIT – III **12 hours**

Why IP for Smart Objects? – Interoperability, An Evolving and Versatile Architecture, Stability and Universality of the Architecture Scalability,

Configuration and Management, Small Footprint, What Are the Alternatives? Why Are Gateways Bad? Security for Smart Objects - The Three Properties of Security - "Security" by Obscurity, Encryption, Security Mechanisms for Smart Objects - Security Mechanisms in the IP Architecture, IPSec, TLS - Web Services for Smart Objects - Web Service Concepts - The Performance of Web Services for Smart Objects. - Connectivity Models for Smart Object Networks - Introduction, Autonomous Smart Object Networks, IOT - Extended Internet.

UNIT – IV **12 hours**

Smart Object Hardware and Software – Hardware - Software for Smart Objects – Energy Management - THE APPLICATIONS - Smart Grid – Introduction – Terminology - Core Grid Network Monitoring and - Control - Smart Metering (NAN) – HAN

UNIT – V **12 hours**

Industrial Automation – Opportunities, Challenges, Use Cases Smart Cities and Urban Networks– Introduction - Urban Environmental Monitoring - Social Networks - Intelligent Transport Systems - Home Automation – Introduction - Main Applications and Use Cases - Technical Challenges and Network Characteristics- Building Automation – Emerging Application in Building automation - Health Monitoring – Introduction - Main Applications and Use Case - Technical Challenges in Health Monitoring.

CO - PO - PSO Mapping

INTERNET OF THINGS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 2
CO 2	S	S	M	S	S	S	S	S	S	S	K - 1
CO 3	S	S	M	S	S	S	S	S	S	S	K - 3
CO 4	S	S	M	S	S	S	S	S	S	S	K - 5
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

Text Books

1. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, JohnWiley and Sons, Ltd 2014 (Unit I & II)
2. Jean-Philippe Vasseur and Adam Dunkels, Interconnecting Smart Objects with IP -The Next Internet, Morgan Kaufmann Publishers 2010(Unit III to V)
3. Cuno Pfister, Getting Started with the Internet of Things, Published by O'Reilly

Reference books

1. Brian Underdah, The Internet of Things For Dummies, KORE Wireless Edition,
2. Ovidiu Vermesan and Peter Friess, Internet of Things Applications: From Research to Market Deployment, River Publishers
3. Francis daCosta, Rethinking the Internet of Things – A Scalable Approach to Connecting Everything, Apress

Core 16 **OPTIMIZATION TECHNIQUES**

L	T	P	C
4	0	0	4

Course objectives:

1. To apply various optimization techniques for decision making.
2. To introduce the use of variables for formulating complex mathematical models in management, science and industrial applications

Course Outcome:

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

CO1. Formulate and solve Linear Programming Problems.
CO2. Examine the Two Phase method
CO3. Analyze the usage of Integer Programming Problem.
CO4. Evaluate the Sequencing Problems and Queueing Models.
CO5. Apply PERT and CPM techniques to find the optimal solution.

UNIT I **12 hours**

INTRODUCTION- LINEAR PROGRAMMING PROBLEM

The Nature and Meaning of OR – Management – Applications of OR – Modeling in OR – General methods for solving OR models – Scope of OR.

Linear Programming Problem: Formulation of LP problems – Graphical solution of LP problems – General formulation of LPP – Slack and Surplus variables – Standard form of LPP – Some important forms of LPP – Simplex Method and its special cases.

UNIT II **12 hours**

ARIFICIAL VARIABLE TECHNIQUES AND IPP

Artificial Variable Techniques: Two Phase method and special cases.

Integer Programming Problem: Importance – Definitions – Gomory's Pure Integer Programming Problem – Mixed Integer Programming Problem.

UNIT III **12 hours**

ASSIGNMENT AND TRANSPORTATION PROBLEMS

Assignment Problem: Mathematical formulation – Hungarian method – Unbalanced assignment problem – Various types

Transportation Model: Mathematical formulation – Matrix form – Methods for finding Initial Basic Feasible solution and Optimal solution – Degeneracy in Transportation Problems – Unbalanced Transportation Problem.

UNIT IV **12 hours**

SEQUENCING PROBLEMS AND QUEUING MODELS

Sequencing Problems: Assumptions – Solutions to Sequencing Problems: Processing n jobs through 2 machines – Processing n jobs through 3 machines – Processing n jobs on m machines.

Queuing Models: Queuing System – Transient and Steady States – Kendal's Notation for representing Queuing Models – Various Models in Queuing System – Birth and Death Model.

UNIT V **12 hours**

PERT AND CPM TECHNIQUES

PERT and CPM Techniques: Basic Steps – Network Diagram representation – Rules for drawing Network Diagram – Labeling Fulkerson's I–J Rule – Time Estimates and Critical Path in Network Analysis – Examples on optimum duration and minimum duration cost – PERT.

CO - PO - PSO Mapping

OPTIMIZATION TECHNIQUES											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 2
CO 2	S	S	M	S	S	S	S	S	S	S	K - 1
CO 3	S	S	M	S	S	S	S	S	S	S	K - 3
CO 4	S	S	M	S	S	S	S	S	S	S	K - 5
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

TEXT BOOK

S. D. Sharma, "Operations Research", Tenth Edition, Pearson, 2017.

REFERENCE BOOKS

1. Hamdy A Taha, "Operations Research", Ninth Edition, 2016.
2. V. Sundaresan, K. S. Ganapathy Subramanian, K. Ganesan, "Resource Management Techniques", Ninth Edition, A. R. Publications, 2015.

Core 17 **RESEARCH METHODOLOGY**

L	T	P	C
4	0	0	4

Course objectives:

1. To understand the importance of Research Methodology
2. To apply statistical testing to prove hypothesis
3. To provide the inference using quantitative data analysis
4. To make use of computer aids to analyze the data, prepare reports and presentations
5. To evaluate methodology of teaching

Course Outcome:

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

CO1. Develop data collection according to the underlying theoretical framework.

CO2. Analyze quantitative data and qualitative data using software packages

CO3. Construct and document an appropriate research design

CO4. Understand the ill-effects of Plagiarism

CO5. Become a good teacher using ICT based Teaching Methods

UNIT-1 **12 hours**

INTRODUCTION OF RESEARCH AND FORMULATION: Motivation and Objectives – Research methods vs Methodology. Types of research –Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – Reviews, treatise, monographs, patents –Critical literature review. RESEARCH DESIGN AND METHODS Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design.

UNIT – II **12 hours**

Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models - Developing a research plan - Exploration, Description, Diagnosis, Experimentation - Determining experimental and sample design. DATA COLLECTION: Execution of the research - Observation and Collection of data - Methods of data collection.

UNIT – III **12 hours**

DATA ANALYSIS Quantitative Methods: Online Quantitative Design and Survey – Descriptive Measures – Probability – Random Variables and Distribution

Functions – Discrete Probability Distributions – Continuous Probability Distribution – Sampling Distributions – Theory of Estimation – Hypothesis Testing – Correlation – Regression – Principles of Sample Survey – Types of Sampling – Design of Experiments – CRD-RBD-LSD-Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation

Application of Statistical Software Packages - REPORTING AND THESIS WRITING Reporting and thesis writing – Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes – Use of Oral presentation – Software Packages for thesis Preparation– Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication.

UNIT – IV **12 hours**

APPLICATION OF RESULTS AND ETHICS Application of results and ethics - Environmental impacts - Ethical issues - ethical committees - Commercialization – Copy right – royalty – Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights

Reproduction of published material – Plagiarism – Application of Plagiarism detection tools - Citation and acknowledgment - Reproducibility and accountability.

UNIT – V **12 hours**

METHODOLOGY OF TEACHING: Teaching – Objectives of Teaching, Phases of Teaching – Teaching Methods: Lecture Method, Discussion Method, Discovery Learning, Inquiry, Problem Solving Method, Project method, Seminar – Integrating ICT in Teaching: Individualised Instruction, Ways for Effective Presentation with PowerPoint – Documentation – Evaluation: Formative, Summative & Continuous and Comprehensive Evaluation – Later Adolescent Psychology: Meaning, Physical, Cognitive, Emotional, Social and Moral Development – Teaching Later Adolescents.

CO - PO - PSO Mapping

RESEARCH METHODOLOGY											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K -2
CO 3	S	S	M	S	S	S	S	S	S	S	K - 3
CO 4	S	S	M	S	S	S	S	S	S	S	K – 4
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

Text Books

1. C R Kothari, “Research Methodology: Methods and Techniques”, 2014
2. Modern Language Association Handbook, Eight Edition, 2016
3. R. Paneerselvam, “Research Methodology” 2nd Edition, PHI, 2014

Reference books

1. John W Creswel, Research Design: Qualitative, Quantitative, and Mixed MethodsApproaches, 3rd Edition, 2014
2. S. C. Gupta & V. K. Kapoor, Fundamentals of Mathematical Statistics, SultanChand & Sons, New Delhi, 2014 Edition.
3. S. C. Gupta & V. K. Kapoor, Fundamentals of Applied Statistics, Sultan Chand &Sons. 2014 Edition.
4. Sampath. K, Panneerselvam. A & Santhanam. S (1984), Introduction to EducationalTechnology (2nd Revised Ed.) New Delhi: Sterling Publishers.
5. Sharma. S. R(2003). Effective Classroom teaching modern methods, tools & techniques, Jaipur: Mangal Deep.
6. Vedanayagam. E. G (1989). Teaching Technology for College Teachers, Newyork:Sterling Publishers.

DEEP LEARNING

Elective 2 A

L	T	P	C
4	0	0	3

Course Objective

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

Course Outcome

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

CO1. Become familiar with the fundamental concepts in Deep Learning

CO2. Explore the use of Deep Learning technology in computer vision, speech analysis, healthcare, agriculture, and understanding climate change.

CO3. Apply Deep Learning technology in computer vision, speech analysis, Health care, agriculture, and understanding climate change

CO4. Analyze Deep Reinforcement Learning

CO5. Evaluate the Practical Challenges in Deep Learning

Unit I **12 hours**

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 II **12 hours**

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 III **12 hours**

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 IV **12 hours**

Recurrent Neural Networks: Introduction – Architecture of Recurrent Neural Networks – The challenges of training recurrent Networks – Echo-State Networks –

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 Covolutional networks.

Unit V **12 hours**

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.

CO - PO - PSO Mapping

DEEP LEARNING											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 2
CO 2	S	S	M	S	S	S	S	S	S	S	K - 1
CO 3	S	S	M	S	S	S	S	S	S	S	K - 3
CO 4	S	S	M	S	S	S	S	S	S	S	K - 5
CO 5	S	S	M	S	S	S	S	S	S	S	K – 4

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

Textbook

Charu C. Aggarwal, Neural Netwoks 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.

Elective 2 B

L	T	P	C
4	0	0	3

ROBOTICS

Course Objectives:

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

Course Outcome:

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

CO1. Understand the functions of the basic components of a Robot
CO2. Analyze the use of various types of End Effectors and Sensors
CO3. Gain knowledge in Robot Kinematics and Programming
CO4. Ascertain Safety Considerations for Robot Operations
CO5. Determine the feasibility of implementing a Robot

UNIT I **12 hours**

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 II **12 hours**

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 III **12 hours**

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 IV **12 hours**

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 2 Dimension), 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 V **12 hours**

Implementation and Robot Economics: RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

CO - PO - PSO Mapping

ROBOTICS											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K - 2
CO 3	S	S	M	S	S	S	S	S	S	S	K - 4
CO 4	S	S	M	S	S	S	S	S	S	S	K - 3
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

TEXT BOOKS:

1. Klafter R. D., Chmielewski T. A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2019.
2. Groover M. P., “Industrial Robotics -Technology Programming and Applications”, McGrawHill, 2018.

REFERENCE BOOKS:

1. Craig J. J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2017.
2. Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 2019.
3. Fu. K. S., Gonzalez R. C. and Lee C. S. G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 2017
4. Janakiraman P. A., “Robotics and Image Processing”, Tata McGraw Hill, 2015.

Elective 2 C

CRYPTOGRAPHY AND NETWORK SECURITY

L	T	P	C
4	0	0	3

Course Objectives:

1. To understand security design principles and mathematics behind cryptography
2. To understand the security requirements in OS, databases and networking

Course Outcome:

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

CO1. Illustrate the approaches, trade-offs in security design principles.

CO2. Apply number theory in public key encryption techniques

CO3. Understand the security requirements

CO4. Analyze Virus – counter measures

CO5. Design a secure system

UNIT-1 **12**

Introduction-Security trends–The OSI security architecture– Security attacks, services and mechanisms– A Model of network security-Security Goals-Cryptographic Attacks—Classical encryption techniques: Symmetric cipher Model-substitution-transposition - steganography- Block cipher and the DES: Block cipher Principles – DES - The strength of DES- Differential and Linear Crypt Analysis-Block Cipher Design Principles.

UNIT – II **12 hours**

Advanced Encryption Standard- AES Cipher-More on Symmetric Ciphers: Block Cipher modes of operation-Stream Cipher and RC4. Public-Key Encryption and Hash Function: Prime Numbers- Testing for Primality - The Chinese remainder theorem-Public-Key Cryptography and RSA: Principles of Public Key Cryptosystem- The RSA Algorithm-Key Management -Diffie-Hellman Key Exchange- Message Authentication and Hash Function: Authentication Function – Message Authentication Codes-Hash function – HMAC – CMAC - Digital Signature-Authentication Protocol.

UNIT – III **12 hours**

Authentication Applications – Kerberos-x. 509 Authentication Service-Public-KeyInfrastructure- Secret Key Algorithm-Security at the Application Layer: Electronic Mail Security-Pretty Good Privacy (PGP)- S/MIME.

UNIT – IV **12 hours**

IPSecurity- IPSecurity – Overview - IPSecurity - Architecture,-Authentication-Header- Encapsulating Security Payload- Combining Security Associations. Web Security: Web Security Considerations-Secure Socket Layer (SSL) and Transport Layer Security (TLS)- Secure Electronic Transaction (SET). Network Management Security :Basic Concepts of SNMP, SNMPv1, SNMPv3, VPN.

UNIT – V **12 hours**

System Security: Intruders - Intruders, Intrusion Detection- Password Management-Malware. Malicious Software: Viruses and Related Threats, Virus Countermeasures, Distributed Denial of Service Attacks. Firewalls: Firewall Design Principles, Trusted Systems, Common Criteria for information technology Security Evaluation. Legal and Ethical Issues in Computer Security: Protecting Programs Data-Information and the Law-Redress for Software failures-Selling Correct Software Flaws.

CO - PO - PSO Mapping

CRYPTOGRAPHY AND NETWORK SECURITY											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K – 2
CO 2	S	S	M	S	S	S	S	S	S	S	K – 3
CO 3	S	S	M	S	S	S	S	S	S	S	K – 4
CO 4	S	S	M	S	S	S	S	S	S	S	K – 6
CO 5	S	S	M	S	S	S	S	S	S	S	K – 5

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

Text Books:

1. Stallings William, “Cryptography & Network Security, Principles & Practice”, 2017.
2. Behrouz A. Ferouzan, “Cryptography & Network Security”, Tata McGraw Hill, 2007, Reprint 2015.
3. Charless P. Pfleeger, Shari Lawrence Pfleeger, “ Security in Computing”, Fourth Edition, 2007

Reference Books:

1. Young Man Rhee, “Internet Security: Cryptographic Principles, Algorithms & Protocols”, Wiley Publications, 2003.
2. Ulysses Black, “Internet Security Protocols”, Pearson Education Asia, 2000.
3. Charlie Kaufman, Radia Perlman, Mike Speciner, “Network Security: Private Communication In Public World”, PHI, 2002.
4. Bruce Schneier, Neils Ferguson, “Practical Cryptography”, First Edition,Wiley Dreamtech India Pvt Ltd, 2003.
5. Douglas R Simson “Cryptography – Theory and Practice”, First Edition, CRC Press, 1995.

Core 18 Practical 5

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

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. Implement common NLP tasks using Python and Natural Language Toolkit, NLTK

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

CO3. Discover various linguistics relevant to NLP tasks

CO4. Analyze parsing in NLP

CO5. Develop systems for various NLP problems with moderate 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 Babelfish, 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 lxml, Cleaning and stripping HTML, 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	
CO 1	S	S	S	M	S	S	S	M	S	S	K – 1
CO 2	S	S	M	S	S	S	S	S	S	S	K – 3
CO 3	S	S	M	S	S	S	S	S	S	S	K – 5
CO 4	S	S	M	S	S	S	S	S	S	S	K – 4
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

References

1. Python Text processing with NLTK 2. 0 Cookbook, Jacob Perkins, PACKT Publishing

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

Core 19 **MINI PROJECT**

L	T	P	C
0	0	6	6

1. Each student has to undergo an individual project in the Institution
2. Internal Project Supervisor shall be allocated for each student.

Course Outcome:

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

CO1. Develop a model to achieve the project's goal

CO2. Demonstrate sound technical knowledge of the selected project topic.

CO3. Undertake problem identification, formulation and solution.

CO4. Design solutions to complex problems utilising a systematic approach

CO5. Appreciate the steps involved in Software development process

CO - PO - PSO Mapping

MINI PROJECT											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 1
CO 2	S	S	M	S	S	S	S	S	S	S	K - 2
CO 3	S	S	M	S	S	S	S	S	S	S	K - 3
CO 4	S	S	M	S	S	S	S	S	S	S	K - 5
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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

SEMESTER VI

Core 20

L	T	P	C
0	0	30	16

MAJOR PROJECT

1. Each student has to undergo an individual project either in the Institution or in a reputed industry

2. Internal Project Supervisor shall be allocated for each student.

Course Outcome:

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

CO1. Develop a model to achieve the project's goal

CO2. Demonstrate sound technical knowledge of the selected project topic.

CO3. Undertake problem identification, formulation and solution.

CO4. Design solutions to complex problems utilising a systematic approach

CO5. Appreciate the steps involved in Software development process

CO - PO - PSO Mapping

MAJOR PROJECT											
CO	PO					PSO					COGNITIVE LEVEL
	1	2	3	4	5	1	2	3	4	5	
CO 1	S	S	S	M	S	S	S	M	S	S	K - 4
CO 2	S	S	M	S	S	S	S	S	S	S	K - 5
CO 3	S	S	M	S	S	S	S	S	S	S	K - 6
CO 4	S	S	M	S	S	S	S	S	S	S	K - 1
CO 5	S	S	M	S	S	S	S	S	S	S	K – 6

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