R-20
B.E. (AI&DS)
Scheme and Syllabus of
V-VI Semesters
w.e.f. 2022-23

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Scheme of Instruction of V Semester of B.E. – Artificial Intelligence and Data Science as per AICTE Model Curriculum, with effective from 2022-23

SEMESTER - V

S. No	Course Code	Title of the Course	Scheme of Instruction Hours per Week L/T	Scheme of Instruction Hours per Week P/D	Scheme of Examination Duration of SEE in Hours	Scheme of Examination Maximum Marks CIE	Scheme of Examination Maximum Marks SEE	Credits
THEORY								
1	20ADC06	Artificial Intelligence	3	-	3	40	60	3
2	20ITC24	Embedded Systems and IoT	3	-	3	40	60	3
3	20ITC19	Operating Systems	3	-	3	40	60	3
4	20ADC07	Full Stack Development	3	-	3	40	60	3
5	20ITC20	Computer Networks	3	-	3	40	60	3
6		Professional Elective – 2	3	-	3	40	60	3
PRACTICALS								
7	20ADC08	Artificial Intelligence Lab	-	2	3	50	50	1
8	20ITC26	Embedded Systems and IoT Lab	-	3	3	50	50	1.5
9	20ADC09	Minor Project - I (Full Stack Development)	-	3	-	50	-	1.5
10		Industrial / Rural Internship	90 Hours		-	-	-	2
		TOTAL	18	8	24	390	460	24

L: Lecture   T: Tutorial   D: Drawing   P: Practical
CIE – Continuous Internal Evaluation   SEE - Semester End Examination

Professional Elective #2	Natural Language Processing 20ADE03	NoSQL Databases 20ADE04	Computer Vision 20ITE13	Cyber Security 20ITE08	Compiler Design 20ADE05	Augmented Reality and Virtual Reality 20ITE07

20ADC06   **ARTIFICIAL INTELLIGENCE**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Concepts of Semiconductor Physics and Applied Physics.
 Course Objectives:
 1. To understand problem solving through search techniques.
 2. To familiarize with knowledge representation and logical reasoning techniques in AI.
 3. To learn the knowledge representation techniques.
 4. To learn probabilistic reasoning models on uncertain data.
 5. To acquaint with reinforcement learning.

 Course Outcomes:
Students who complete this course should be able to
 1. Solve problems using Exhaustive and Heuristic Search Techniques.
 2. Apply inference methods in propositional logic to prove statements.
 3. Construct knowledge representation models.
 4. Inspect probabilistic reasoning models on uncertain data.
 5. Appraise the learning techniques on data.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	-	-	-	-	2	3	3	3
CO2	3	3	2	2	-	-	-	-	-	-	-	2	3	3	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3	3	3
CO4	3	3	2	2	-	-	-	-	-	-	-	2	3	3	2
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	3	3

UNIT-I

Introduction: The Foundations of AI, History of AI. Intelligent agents – Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.
Solving problems by searching: Problem Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed Search Strategies, Heuristic Functions.

UNIT-II

Adversarial search: Games, Optimal decisions in games, Alpha-Beta Pruning. Constraint Satisfaction Problems-Defining constraint satisfaction Problems.
Logic Concepts and Logic Programming: Introduction, Propositional Calculus, Propositional Logic, Natural Deduction System, Axiomatic System, Semantic Tableau System in Propositional Logic, Resolution Refutation in Propositional Logic, Predicate Logic, Logic Programming.

UNIT-III

Knowledge Representation: Introduction, Approaches to Knowledge Representation, Knowledge Representation using Semantic Network, Extended Semantic Networks for KR, Knowledge Representation using Frames.
Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Independence, Bayes' Rule and its Use.

UNIT-IV

Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Networks.

Probabilistic Reasoning over Time: Time and Uncertainty, Inference in Temporal Models, Hidden Markov Models, Kalman Filters.
UNIT-V

Learning with hidden variables: The EM Algorithm. **Reinforcement Learning:** Introduction, Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, Applications of Reinforcement Learning.

Text Books:
> 1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, 3rd Edition.
> 2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011.

Suggested Reading:
> 1. Nilsson, N., ―Artificial Intelligence: A New Synthesis‖, San Francisco, Morgan Kaufmann, 1998.
> 2. Rich, Knight, Nair: ―Artificial intelligence‖, Tata McGraw Hill, Third Edition, 2009.
> 3. Tom M. Mitchell, ―Machine Learning‖, McGraw Hill, 1997.
> 4. Kulkarni, Parag, Joshi, Prachi, ‖ Artificial Intelligence: Building Intelligent Systems‖, PHI, 2015.
> 5. Peter Jackson, ―Introduction to Expert Systems‖, Third Edition, Pearson Addison Wesley, 1998

Web Resources:
1. https://nptel.ac.in/courses/106106126
2. https://www.coursera.org/learn/ai-for-everyo

20ITC24   **EMBEDDED SYSTEMS AND IOT**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To understand the embedded systems, control-driven Architectures
2. To understand the fundamental of IoT and appreciate the importance of communication between machines with reference to IoT.
3. See the design methodology and mechanism of IoT and acquire knowledge of Raspberry Pi device, its interfaces
4. To understand, appreciate and develop ability to use various contemporary IOT applications.
5. To understand the software systems for Industrial IoT and the utilities of IoT through case studies.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Develop and design for Embedded computing using 8051 Microcontroller.
2. Describe the role of things and Internet in IoT and determine the IoT levels designing an IoT Systems.
3. Learn the methodology for IoT system design and interface with Raspberry Pi.
4. Design and Develop IoT computing and its applications.
5. Implement standard IoT to build large systems for industries.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	0	1	1	1	1	1	3	3	3
CO2	2	1	2	1	2	0	3	0	0	0	2	0	2	0	3
CO3	2	1	2	2	2	3	0	0	0	0	2	0	3	0	3
CO4	2	1	1	1	2	0	3	2	0	0	1	1	2	3	3
CO5	2	1	1	1	1	0	0	2	0	0	0	1	1	0	3

UNIT-I

Embedded Computing: Introduction Embedded System Design Process, Characteristics and Challenges of Embedded Systems. **The 8051 Architecture**: Introduction, 8051 Micro controller Hardware. Data Transfer and Logical Instructions, Arithmetic Operations, Decimal Arithmetic, Jump and Call Instructions Applications: Interfacing with Keyboards, Displays, D/A and A/D Conversions.

UNIT-II

Introduction to Internet of Things: Definitions & Characteristics of IoT, Physical Design of IOT- Things in IoT, IoT Protocols, Logical Design of IOT-IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IOT Enabling Technologies-Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IOT Levels & Deployment Templates.

UNIT-III

IoT Platforms Design Methodology: Introduction, IoT Design Methodology Steps-Purpose and Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device and Component Integration, Application Development, Case Study on IoT System for Weather Monitoring.
IoT Physical Devices and End Points: Basic building blocks of an IoT device, Raspberry Pi About the board, Raspberry Pi interfaces-Serial, SPI, I2C. Python Web Application Framework: Django Framework-Roles of Model, Template and View.

UNIT-IV

Domain Specific IOTs: Various types of IoT Applications in Home Automation- smart lighting, Smart appliance, smoke and gas detectors, Cities, Environment, Energy, Retail, Logistics Agriculture, Industry, Health & Life Style-Wearable Electronics. **IoT and M2M** – Introduction, M2M, Differences between IoT and M2M, Software Defined Networking, Network Function Virtualization.

UNIT-V

Industrial IoT: Introduction to Industrial IoT, IIoT Communication**,** Industry 4.0 Globalization and Emerging Issues, The Fourth Revolution, Security and Fog Computing.
Real case studies:
Case study - I : Milk Processing and Packaging Industries
Case study - II: Manufacturing Industries

Text Books:
1. Wayne Wolf, "Computers as Components", 1st Edition, Academic press, 2001.
2. Kenneth J.Ayala, "The 8051 Microcontroller", 3rd Edition, Thomson, 2014.
3. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
4. Misra, C. Roy, and A. Mukherjee, 2020 "Introduction to Industrial Internet of Things and Industry 4.0". CRC Press.

Suggested Reading:
1. Raj Kamal, "Embedded Systems", 2nd Edition, McGraw Hill, 2015.
2. Samuel Greengard, "The Internet of Things", 1st Edition, MIT Press, 2015.
3. Peter Waher, Pradeeka Seneviratne, Brian Russell, Drew Van Duren, "IoT: Building Arduino-Based Projects", 1st Edition, Packt Publishing Ltd, 2016.
4. Jeeva Jose, "Internet of Things", Khanna Book Publishing Company,

Web resources:
1. http://ee.sharif.edu/~sakhtar3/books/The%208051%20Microcontroller%20Ayala/The%208051%20Microcontroller%20Architecture,%20Programming%20and%20Applications%201991.pdf
2. https://slideplayer.com/slide/3944480/.
3. https://nptel.ac.in/noc/individual_course.php?id=noc17-cs05.
4. https://slideplayer.com/slide/5740917/.
5. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

20ITC19   **OPERATING SYSTEMS**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To familiarize students with various services provided by an operating system.
2. To introduce the concepts of process, process synchronization and process scheduling.
3. To deal with different approaches of memory management.
4. To facilitate understanding of the structure and organization of the file system.
5. To provide understanding of Protection and security aspects of operating systems

Course Outcomes:
Upon successful completion of this course, students will be able to:

1. Demonstrate operating system services, inter process communication and multithreaded Programming.
2. Apply suitable process scheduling, deadlocks handling algorithms and solve process-synchronization.
3. Make use of advanced techniques such as paging, segmentation and virtual memory for memory management.
4. Illustrate file system interfaces and its implementation.
5. Identify the Operating System Security problems and Threats.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO3	PSO2	PSO1
CO1	2	2	3	1	1	-	-	-	1	1	1	1	3	3	3
CO2	2	1	2	1	2	-	-	-	-	-	1	-	3	-	2
CO3	2	1	2	2	1	-	-	-	-	-	-	-	3	-	3
CO4	2	1	1	1	1	-	-	-	-	-	-	1	3	-	1
CO5	2	1	1	1	1	-	-	-	-	-	-	1	3	-	1

UNIT–I

Introduction: Definition of Operating System, Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Computing Environments, Open-Source Operating Systems. **Operating System Structures**: Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure, System Boot. **Process:** Process Concept, Process Scheduling, Operations on Processes, Inter process Communication **Threads:** Overview, Multicore Programming, Multithreading Models, Threading Issues.

UNIT–II

Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling. **Synchronization:** Background, The Critical-Section Problem, Peterson 's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors. **Deadlocks:** System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

UNIT–III

Memory Management Strategies: Background, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table. **Virtual Memory Management:** Background, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory.

UNIT–IV

File-System: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing Protection. **Implementing File Systems:** File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance. **Mass-Storage Structure:** Overview of Mass-Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management.

UNIT–V

System Protection: Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems **System Security:** The Security Problem, Program Threats, System and Network Threats, Cryptography as a Security Tool, User Authentication.

Text Book:
1. Abraham Silberschatz, Peter Galvin, Greg Gagne, ―Operating System Concepts, 10th Edition, John Wiley and Sons Pvt Ltd, 2018.

Suggested Reading:
1. A.Tanenbaum, ―Modern Operation Systems‖, 3rd Edition, Pearson Education, 2008.
2. William Stallings, ―Operating Systems‖, 5th Edition, Pearson Education, 2005.
3. Ida M.Flynn, ―Understanding Operating Systems‖, 6th Edition, Cengage, 2011.
4. D.M.Dhamdhere,‖Operating systems a concept-based approach‖, 2nd Edition, McGraw-Hill, 2007.

Web Resources:
1. https://www.os-book.com/OS10/
2. http://nptel.ac.in/downloads/106108101/
3. http://www2.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/
4. http://www.cs.kent.edu/~farrell/osf03/oldnotes/

20ADC07   **FULL STACK DEVELOPMENT**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To provide knowledge about web pages design and development.
2. To understand how the HTML, CSS and JavaScript components of Bootstrap work.
3. To explore the basic architecture of a React application and develop applications in agile mode
4. To gain the basics of frond-end and back-end application development using Node Js.
5. To understand the basics of MongoDB and its Data Model

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Create web pages with good aesthetic sense of design using HTML and CSS
2. Create real-world React web applications and related tools.
3. Become an agile practitioner with the ability to quickly complete projects
4. Build an end-to-end application from scratch using NODE JS
5. Understand and build logical relationships between documents using MongoDB

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	-	-	-	1	1	1	1	3	2	3
CO2	2	1	2	1	2	-	-	-	-	-	1	-	2	2	3
CO3	2	1	2	2	1	-	-	-	-	-	-	-	3	2	3
CO4	2	1	1	1	1	-	-	-	-	-	-	1	1	2	3
CO5	2	1	1	1	1	-	-	-	-	-	-	1	1	2	3

UNIT-I
Introduction: Web Fundamentals, **HTML 5.0:** basic tags, Images, Tables, Lists, Forms, Layout, Graphics, span and div tags. **Introduction to Cascading Style Sheets:** Types of CSS**, text and font, color,** CSS Selectors, CSS BOX Model, CSS Positioning, and CSS floating.

UNIT-II
Java Script: Data Types & Type Conversion, JSON, Events, String and Date Functions, Object Oriented Programming (OOP) in JS, Document Object Model, JavaScript Regular Expressions. **Bootstrap:** Introduction of Bootstrap, Container and Container-fluid, Connectivity of Bootstrap in page. **Bootstrap Component**: Jumbotron, Button, Grid, Table, Form, Alert, Panels, Image, Progress Bar, Tabs/Pill, Navbar, Modals

UNIT-III
React Js: Basics, State, Props, Components, Lifecycle, Events, Router, Forms, Tables, Portals, ES6, CSS, Hook, and Back End Integration. **Express JS:** The model-view-controller pattern, Defining EJS template Engine Building a front-end controller, defining routes, creating actions, Configuring Express to use EJS, Using REST, Reading POST data Adding middleware

UNIT-IV
Node JS Modules: Functions, Buffer, Module, Modules Types, Core Module, Local Modules and Modules Exports
Node Package Manager: What is NPM? Installing Packages Locally, installing package globally, adding dependency in package Json and Updating packages. **Creating Web Server:** Creating Web Server, Sending Requests and Handling HTTP requests. **File System:** Read File, writing a File, opening a File Deleting a File, Writing a file asynchronously and Other I/O Operations. **Events:** Event Emitter class, Inheriting Events and Returning event emitter

UNIT-V

MongoDB: Introduction, Importance of NoSQL databases, JSON features, Data types and examples. CRUD Operations, Data Modelling & Schema Design, Indexing and Aggregation, Mongo Import/Export and Master/Slave Replication.

Text Books:
1. Vasan Subramanian, "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node", second Edition, Apress Publications, 2019.
2. David Hows, Peter Membrey, EelcoPlugge – "MongoDB Basics", Apress, 2014.

Suggested Reading:
1. Ethan Brown, "Web Development with Node and Express", Oreilly Publishers, First Edition, 2014.

Web Resources:
1. https://web.stanford.edu/class/cs142/index.html
2. https://nodejs.org/en/docs/
3. https://www.mongodb.com/
4. https://reactjs.org/
5. https://getbootstrap.com/docs/5.0/utilities/api/
6. https://edu.anarchocopy.org/Programming%20Languages/Node/Pro%20MERN%20Stack,%202nd%20Edition.pdf

20ITC20   **COMPUTER NETWORKS**

Instruction   3 Hours per Week
Duration of SEE   3 Hours
SEE   60 Marks
CIE   40 Marks
Credits   3

Course Objectives:

1. Familiarize students with the basics of Layering of services, data transmission, transmission media, data Communications System and its components.
2. Provide state-of-the-art knowledge on Network Layer issues including Routing, Addressing.
3. Give an overview of how Networks differ and how they can be interconnected.
4. Introduce IP based transport protocols TCP and UDP.
5. Give an insight into the working principles of popular Internet Applications including Email, Domain Name System, WWW, Streaming audio and video.

Course Outcomes:
Upon successful completion of this course, student will be able to
1. Summarize functions of each layer in the OSI and TCP/IP reference models and demonstrate the systematic understanding of data communication Techniques.
2. Solve problems related to Addressing, Routing, Interoperability among heterogeneous networks.
3. Identify issues in Internetwork Routing issues and Congestion in computer networks.
4. Appraise the functions and performance of Internet Transport Protocols TCP and UDP.
5. Analyze the operating principles of Domain Name System and Electronic Mail, WWW.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	-	-	-	-	2	3	3	3
CO2	3	3	2	1	-	-	-	-	-	-	-	2	3	3	2
CO3	3	3	2	1	-	-	-	-	-	-	-	2	3	3	3
CO4	3	3	2	2	-	-	-	-	-	-	-	2	3	3	2
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	3	3

UNIT-I
Introduction: Concept of layering, Reference models- The OSI Reference Model- the TCP/IP Reference Model - A Comparison of the OSI and TCP/IP Reference Models, **The Data Link Layer**: Framing, Error Control – Flow Control, Error Detection and Correction – Error-Correcting Codes – Error Detecting Codes, Sliding WindowProtocols. **Channel allocation methods:** Assumptions for dynamic channel allocation, Carrier Sense Multiple access protocols, Collision free protocols. **Ethernet:** MAC Sublayer Protocol, Switched Ethernet, Fast Ethernet, Gigabit Ethernet, 10-Gigabit Ethernet

UNIT-II
Network layer Routing Algorithms: Design Issues, Routing Algorithms-Shortest path, Flooding, Flow based Distance vector, Link state Routing. **The Network Layer in The Internet**: The IP Version 4 Protocol, IP Addresses, IP Version 6, Internet Control Protocols, Label Switching and MPLS, Internet Multicasting, **Internetworking:** Different networks, Connection of networks, Tunneling, Packet Fragmentation

UNIT-III
The Transport Layer: Berkeley Sockets, Elements of transport protocols – Addressing, Connection Establishment, Connection Release, Error Control and Flow Control, Multiplexing, Crash Recovery, **Congestion Control**: Desirable Bandwidth Allocation, Regulating the Sending Rate.

UNIT-IV

The Internet Transport Protocols: UDP: Introduction to UDP. **The Internet Transport Protocols: TCP-** Introduction to TCP, The TCP Service Model, The TCP Protocol, The TCP Segment Header, TCP Connection Establishment, TCP Connection Release, TCP Connection Management Modeling, TCP Sliding Window, TCP Timer Management, TCP Congestion Control.

UNIT-V
Application Layer: DNS—The Domain Name System, The DNS Name Space, Domain Resource Records, Name Servers. **Electronic MAIL:** Architecture and Services, The User Agent, Message Formats, Message Transfer, Final Delivery. **The World Wide Web** - Architectural Overview. **Streaming Audio and Video:** Streaming Stored Media, Streaming Live Media. Content Delivery.

Text Books:
1. Andrew S. Tanenbaum, David J. Wetherall, "Computer Networks", 5th Edition, Pearson Education, 2014.
2. W. Richard Stevens, Unix Network Programming, Prentice Hall/Pearson Education, 2009.

Suggested Reading:
1. Chwan-Hwa (John) Wu, J. David Irwin, "Introduction to Computer Networks and Cyber Security", CRC Press, 2013.
2. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", 5th Edition, Addison-Wesley, 2012.

Web Resources:
1. https://nptel.ac.in/courses/117105148
2. https://www.ibm.com/docs/en/i/7.1?topic=communications-socket-programming

20ADE03   **NATURAL LANGUAGE PROCESSING**

(Professional Elective #2)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To understand the steps involved in Natural language processing
2. To learn about the lexical, syntactic and semantic analysis of natural language processing
3. To explore the various parsing techniques for natural languages
4. To understand the statistical models for Natural language processing
5. To learn about the various applications involved in Natural language processing

Course Outcomes:

Upon completing this course, students will be able to:
1. Justify the various steps necessary for processing natural language
2. Suggest appropriate semantic modeling and sequence labeling techniques for a particular application.
3. Apply appropriate neural network-based models for a contextual application
4. Analyze existing encoder-decoder models and information extraction techniques.
5. Identify the significance of word net and analyze the applications of Natural Language Processing such as Question Answering and chatbots.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	-	-	-	1	1	1	1	3	2	3
CO2	2	1	2	1	2	-	-	-	-	-	1	-	2	1	3
CO3	2	1	2	2	1	-	-	-	-	-	-	-	3	2	3
CO4	2	1	1	1	1	-	-	-	-	-	-	1	1	1	3
CO5	2	1	1	1	1	-	-	-	-	-	-	1	1	2	3

UNIT-I

Introduction Regular Expressions, Text Normalization, Edit Distance**, N-gram Language Models:** N-Grams, Evaluating Language Models, Sampling sentences from a language model, Generalization and Zeros, Smoothing, Kneser-Ney Smoothing

UNIT-II

Vector Semantics and Embeddings: Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, **TF-IDF:** Weighing terms in the vector, Pointwise Mutual Information (PMI), Applications of the tf-idf or PPMI vector models, Word2vec, Visualizing Embeddings, Semantic properties of embeddings, Bias and Embeddings, Evaluating Vector Models. **Sequence Labeling for Parts of Speech and Named Entities:** English Word Classes, Part-of-Speech Tagging, Named Entities and Named Entity Tagging, HMM Part-of-Speech Tagging, Conditional Random Fields (CRFs), Evaluation of Named Entity Recognition.

UNIT-III

Deep Learning Architectures for Sequence Processing: Language Models Revisited, Recurrent Neural Networks, RNNs as Language Models, RNNs for other NLP tasks, Stacked and Bidirectional RNN architectures, The LSTM, Self-Attention Networks: Transformers, Transformers as Language Models, Contextual Generation and Summarization. Case study in NLP. **Machine Translation and Encoder-Decoder Models:** Language Divergences and Typology, The Encoder-Decoder Model, Encoder-Decoder with RNNs, Attention, Beam Search, Encoder-Decoder with Transformers, Some practical details on building MT systems, MT Evaluation, Bias and Ethical Issues

UNIT-IV

Constituency Grammars-Constituency, Context-Free Grammars, Some Grammar Rules for English. Some Grammar Rules for English, Grammar Equivalence and Normal, Lexicalized Grammars. **Constituency Parsing-**Ambiguity**,** CKY Parsing: A Dynamic Programming Approach, Span-Based Neural Constituency Parsing, Evaluating Parsers, Partial Parsing, CCG Parsing. **Dependency Parsing**-Dependency Relations, Dependency Formalisms, Dependency Treebanks, Transition-Based Dependency Parsing, Graph-Based Dependency Parsing, Evaluation

UNIT-V

Word Senses and WordNet: Word Senses, Relations Between Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation, Alternate WSD algorithms and Tasks, Using Thesauruses to Improve Embeddings, Word Sense Induction. **Question Answering:** Information Retrieval, IR-based Factoid Question Answering, Entity Linking, Knowledge-based Question Answering, Using Language Models to do QA, Classic QA Models, Evaluation of Factoid Answers. **Introduction to Chatbots-Chatbots, GUS:** Simple Frame-based Dialogue Systems, The Dialogue-State Architecture, Evaluating Dialogue Systems, Dialogue System Design

Text Books:
1. Jurafsky Daniel, Martin James, "Speech and Language Processing", Third Edition, Pearson Education, 2021.
2. Christopher Manning, Schutze Heinrich, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.

Suggested Reading:
1. Allen James, "Natural Language Understanding", Second Edition, Benjamin Cumming, 1995.
2. Charniack Eugene, "Statistical Language Learning", MIT Press, 1993.

Web Resources:
1. http:// archive.nptel.ac.in/courses/106/105/106105158/
2. http://archive.nptel.ac.in/courses/106/106/106106211/

20ADE04   **NO SQL DATABASES**
                              (Professional Elective #2)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. Explore the origins of NoSQL databases and the characteristics that distinguish them from traditional relational database management systems.
2. Understand the architectures and common features of Key Value databases.
3. Understand the architectures and common features of Document databases.
4. Understand the architectures and common features of column-family stores, graph databases
5. Understand the architectures and common features of graph databases and discuss the criteria that decision makers should consider when choosing between different NoSQL databases that best addresses specific use cases.

Course Outcomes:

Upon successful completion of this course, students will be able to:
1. Define, compare and use the four types of NoSQL Databases.
2. Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Key-Value Pair NoSQL databases.
3. Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.
4. Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.
5. Explain the detailed architecture, define objects, load data, query data and performance tune Graph NoSQL databases.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	-	1	-	-	-	1	-	-	1	2	3	-
CO2	2	1	1	-	1	-	-	-	-	-	-	1	1	3	-
CO3	2	2	1	-	-	-	-	-	-	-	2	2	2	3	2
CO4	2	1	-	-	-	-	-	-	-	-	-	2	2	3	3
CO5	2	1	-	-	-	-	-	-	1	-	-	2	2	3	3

UNIT-I

Why NoSQL: The Value of Relational Databases, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Motivations for Not Just/NoSQL Databases. **Variety of NoSQL Databases**: Data Management with Distributed Databases, ACID and BASE, Types of NoSQL Databases.

UNIT–II

Key-Value Databases: Introduction to Key-Value Databases From Arrays to Key-Value Databases, Essential Features of Key-Value Databases,Keys, Values, Key-Value Database Data Modeling Terms, Key-Value Architecture Terms, Key-Value Implementation Terms. **Designing for Key-Value Databases:** Key Design and Partitioning Keys Designing Structured Values, Limitations of Key-Value Databases Comparable to SQL for Relational Databases Design Patterns for Key-Value Databases, Case Study: Key-Value Databases for Mobile Application Configuration.

UNIT–III

Document Databases: Introduction to Document Databases, what is a Document? Avoid Explicit Schema Definitions, Basic Operations on Document Databases, **Document Database Terminology:** Document and Collection Terms, Types of Partitions, Data Modeling and Query Processing. **Designing for Document Databases**:

Normalization, Denormalization, and the Search for Proper Balance Planning for Mutable Documents, The Goldilocks Zone of Indexes, Modeling Common Relations, Case Study: Customer Manifests.

UNIT–IV

Column Family Databases: Introduction to Column Family Databases in the Beginning, There Was Google Big-Table Differences and Similarities to Key-Value and Document Databases, Architectures Used in Column Family Databases, When to Use Column Family Databases, **Column Family Database Terminology:** Basic Components of Column Family Databases, Structures and Processes: Implementing Column Family Databases, Processes and Protocols. **Designing for Column Family Databases:** Guidelines for Designing Tables, Guidelines for Indexing, Tools for Working with Big Data. Case Study: Customer Data Analysis.

UNIT-V

Graph Databases: Introduction to Graph Databases: What Is a Graph, Graphs and Network Modeling, Advantages of Graph Databases. **Graph Database Terminology:** Elements of Graphs Operations on Graphs, Properties of Graphs and Nodes, Types of Graphs. **Designing for Graph Databases** Getting Started with Graph Design, Querying a Graph, Tips and Traps of Graph Database Design. Case Study: Optimizing Transportation Routes. **Choosing your database:** Programmer Productivity, Data-Access Performance, Sticking with the Default.

Text Books:

1. Sullivan. NoSQL for Mere Mortals, 1st ed. Addison-Wesley Professional, 2015.
2. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Wiley Publications,1st Edition ,2012.

Suggested Reading:

1. Meier & Kaufmann. SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management, 1st ed. Springer, 2019

Web Resources:
1. https://www.ibm.com/cloud/learn/nosql-databases
2. https://www.coursera.org/lecture/nosql-databases/introduction-to-nosql-VdRN
3. https://www.geeksforgeeks.org/introduction-to-nosql/
4. https://www.javatpoint.com/nosql-databa

20ITE13   **COMPUTER VISION**
                              (Professional Elective # 2)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites
Image Processing (20ITE01), Data Analysis and Visualization (20ADE01)

Course Objectives:
1. To understand the Fundamental Concepts related to Computer Vision and Image formation
2. To understand Feature Extraction algorithms.
3. To define the structure of an image based on motion.
4. To provide knowledge about object recognition and scene recognition algorithms.
5. To impart the knowledge about 3D Reconstruction techniques.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Summarize the fundamentals of Image formation and describe the Geometric primitives and Transformations.
2. Describe different approaches to recognition of objects.
3. Inspect algorithms for feature detection and feature alignment.
4. Analyze images and videos for problems such as tracking and structure from motion.
5. Design recovered 3D structure for ill-posed scenes.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	-	-	-	-	-	-	2	2	3	3
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	3	2
CO3	3	3	2	2	2	-	-	-	-	-	-	2	3	3	3
CO4	3	3	2	3	2	-	-	-	-	-	-	2	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	2	3	3	3

UNIT-I

Introduction to Computer Vision and Image Formation: Introduction, Photometric image formation, Digital Camera image formation. **Image Processing**: Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations.

UNIT-II

Feature detection and matching: Points and patches, Edges, Lines. Segmentation: Active contours, Split and merge, Mean shift and mode finding, Normalized cuts. **Feature-based alignment:** 2D and 3D feature-based alignment, Pose estimation.

UNIT-III

Structure from motion: Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, Constrained structure and motion. **Dense motion estimation:** Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion.

UNIT-IV

Recognition: Object detection-Face detection,Pedestrian detection, Face recognition : Eigenfaces, Active appearance and 3D shape models,Application: Personal photo collections,   Instance recognition : Geometric alignment, Large

databases,Application: Location recognition,   Category recognition : Bag of words,Part-based models, Recognition with segmentation,Application: Intelligent photo editing, Context and scene understanding : Learning and large image collections, Application: Image search.

UNIT-V

3D Reconstruction: Shape from X: Shape from shading and photometric stereo, Shape from texture,Shape from focus, Active range finding: Range data merging,Application: Digital heritage, Surface representations: Surface interpolation,Surface simplification,Geometry images, Point-based representations, volumetric representations: Implicit surfaces and level sets , Model-based reconstruction: Architecture,Heads and faces,Application: Facial animation, Recovering texture maps: Estimating BRDFs, Application: 3D photography

Text Book:
1. Richard Szeliski "Computer Vision: Algorithms and Applications", Springer-Verlag London Limited, 2011.

Suggested Reading:
1. Robert J. Schallkoff, "Pattern Recognition: Statistical. Structural and Neural Approaches", John Wiley and Sons; 1992+.
2. D. A. Forsyth and J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2003.
3. R. Hartley and A. Zisserman, "Multiple View geometry", Cambridge university Press, 2002.
4. Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", Second Edition, Cambridge University Press, March 2004.
5. K. Fukunaga; "Introduction to Statistical Pattern Recognition", Second Edition, Academic Press, Morgan Kaufmann, 1990.

Web Resources:
1. CV online: http://homepages.inf.ed.ac.uk/rbf/CVonline
2. Computer Vision Homepage: http://www2.cs.cmu.edu/afs/cs/project/cil/ftp/html/vision.html

20ITE08

CYBER SECURITY
(Professional Elective #2)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. To present basic concepts of Cybercrime and Cyberattacks.
2. To impart knowledge on Tools and Methods used in Cybercrime.
3. To familiarize the legal perspectives and Organizational implications of Cyber Security.
4. To present fundamentals concepts in Cyber Forensics.
5. To familiarize about regulatory framework for Cybersecurity.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Describe legal frameworks to handle cybercrimes.
2. Identify the functioning of different kinds of malware used in cybercrimes.
3. Examine the legal perspectives of cybercrimes in Indian and international context.
4. Describe the need of Digital Forensics and the importance of digital evidence in prosecution
5. Interpret the commercial activities in the event of significant information security incidents in the Organization.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	-	-	3	-	3	-	-	2	-	3	3	1
CO2	2	3	1	2	3	3	-	3	-	-	-	-	3	3	1
CO3	2	2	1	-	-	3	-	3	-	-	-	-	3	3	1
CO4	2	3	1	2	3	3	-	3	-	-	-	-	3	3	1
CO5	2	1	1	2	-	-	-	3	-	-	2	-	3	3	1

UNIT–I

Introduction to Cybercrime: Definition and origins of the word, Cybercrime and Information security, Classification of Cybercrimes, Legal Perspectives, Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

UNIT-II

Cyber offenses: Introduction, How Criminals plan the attacks, Social Engineering, CyberStalking, Cybercafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector.
Tools and Methods Used in Cybercrime: Introduction, Proxy servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDos Attacks, SQL Injection, Buffer Overflow,

UNIT-III

Cyber Security: The Legal Perspectives: Cyber Crime and the Legal Landscape around the World, Need of Cyber laws: the Indian Context, The Indian IT Act, Challenges to Indian Law and Cyber Crime Scenario in India, Digital Signatures and the Indian IT Act, Cyber Crime and Punishment, Cyber Law, Technology and Students: The Indian Scenario.

UNIT-IV

Understanding Cyber Forensics: Introduction, Digital Forensics Science, Need for Computer Forensics, Cyber Forensics and Digital Evidence, Forensics Analysis of Email, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Cyber Forensics Investigation, Challenges in Computer Forensics

UNIT-V

Cyber Security: Organizational Implications: Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

Text Books:
1. Nina Godbole, Sunit Belapure, "Cyber Security Understanding Cyber Crimes, Computer forensics and Legal Perspectives", Wiley India Pvt.Ltd., 2013.
2. Harsh Bothra, "Hacking Be A Hacker with Ethics", Khanna Publishers 2017.

Suggested Reading:
1. John R Vaca "Computer Forensics: Computer crime scene Investigation " 2017.
2. Ferrera, Reder, Bird, Darrow, Aresty, Klosek, Lichtenstein " Cyber Laws Text & Cases" 3rd edition.
3. Tony Sammes Brian Jenkinson "Forensic Computing: A practitioner's Guide", Second Edition Springer International Edition.
4. Bill Nelson, Amelia Phillips, Christopher Steuart "Guide to Computer Forensics and Investigations" Fourth Edition.

Web Resources:
1. https://www.nist.gov/
2. https://www.sans.org/
3. https://www.udemy.com/the-complete-cyber-security-course-end-point-protection/

20ADE05

COMPILER DESIGN
(Professional Elective #2)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Data Structures and Algorithms, Theory of Automata.

Course Objectives:

1. To Analyze the basic steps involved in converting a source language to target code.
2. To Design Scanner and Parsers.
3. To Develop Intermediate code and generate code for target machines.
4. To impart knowledge in generation of target code.
5. To apply machine independent optimizations and error recovery strategies.

Course Outcomes:

Upon successful completion of this course, the students should be able to
1. Identify the concepts related to translator, tokens, bootstrapping, porting and phases of the compiler and develop Lexical-Analyzer for Source Language.
2. Construct Top-down parsers and Bottom-up parsers.
3. Develop Syntax Directed Translation scheme and Generate Intermediate code for a language.
4. Translate Intermediate code into Target code.
5. Understand Data flow Analysis and apply the optimization techniques.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	-	1	-	-	-	1	1	3	-	3
CO2	2	3	2	3	3	-	-	-	1	-	-	1	3	-	2
CO3	2	3	2	3	1	-	-	-	-	-	-	1	3	-	2
CO4	2	2	2	2	1	-	1	-	-	-	-	-	2	-	2
CO5	2	2	1	2	1	-	1	-	-	-	-	-	2	-	2

UNIT-I

Introduction: Programs related to compilers, Translation process, Major data structures, Other issues in compiler structure, Bootstrapping and porting. **Lexical analysis**: The role of Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, The Lexical-Analyzer Generator LEX.

UNIT-II

Syntax Analysis: Introduction, Context-Free Grammars, writing a Grammar, Top-Down parsing, Bottom-Up parsing, Introduction to LR Parsing, more powerful LR parsers, Using Ambiguous Grammars, Parser Generators.

UNIT-III

Syntax Directed Translation: Syntax Directed Definitions, Evaluation Orders for SDDs, Applications of Syntax Directed Translation.
Intermediate code generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Translation of Expressions, Type Checking, Control Flow.

UNIT-IV

Runtime Environments: Storage Organization, Stack Allocation of Space, Access to Non local Data on the Stack, Heap Management, Introduction to Garbage Collection.
Code Generation: Issues in the Design of a Code Generator, The Target Language, Addresses in the Target Code, Basic Blocks and Flow Graphs, Optimization of Basic Blocks, Peephole Optimization, Register Allocation and Assignment.

UNIT-V

Machine Independent Optimizations: The Principal Sources of Optimizations, Introduction to data flow analysis, Foundation of data flow analysis.

Text Books:
1. Alfred V Aho, Monica S Lam, Ravi Sethi, Jeffrey D Ullman, "Compilers: Principles, Techniques &Tools", Pearson Education, Second Edition, 2014.
2. Kenneth C Louden, "Compiler Construction: Principles and Practice", Cengage Learning.

Suggested Reading:
1. Keith D Cooper & Linda Torczon, "Engineering a Compiler", Morgan Kafman, Second Edition.
2. Dick Grune, Kees van Reeuwijk, Henri E. Bal , Ceriel J.H. Jacobs, Koen Langendoen ," Modern Compiler Design", Springer, Second Edition.

Web Resources:
1. http://nptel.ac.in/courses/106108113
2. https://web.stanford.edu/class/archive/cs/cs143/cs143.1128/
3. http://en.wikibooks.org/wiki/Compiler_Construction
4. http://dinosaur.compilertools.net/
5. http://epaperpress.com/lexandyacc/

20 ITE07   **AUGMENTED AND VIRTUAL REALITY**
(Professional Elective #2)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To familiarize the students with the fundamentals of Virtual Reality.
2. To impart the knowledge of 3D orientation for understanding the behavior of VR system with the environment.
3. To deal with the Development Tools and Frameworks in Virtual Reality.
4. To introduce the applications of Virtual Reality Systems.
5. To introduce technology and features of augmented reality

Course Outcomes:
After successful completion of the course, student will be able to:
1. Describe the basic concepts of Virtual Reality and 3D Computer Graphics.
2. Apply 3D manipulation techniques in Virtual Reality.
3. Analyze Development Tools and Frameworks in Virtual Reality.
4. Develop a Virtual Reality application.
5. Evaluate Augmented Reality Systems

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	-	2	2	-	-	-	1	-	1	3	-	1
CO2	2	2	1	1	2	2	-	-	-	1	-	1	3	-	2
CO3	2	1	1	-	1	2	-	-	1	1	-	1	3	-	1
CO4	2	2	1	2	3	2	-	-	1	1	-	1	3	-	1
CO5	2	2	1	2	3	-	-	-	1	1	-	1	3	-	1

UNIT-I

Introduction to VR and AR: History of VR and AR, Technology and Features of Augmented Reality, Comparison of AR and VR, Challenges with AR, AR Systems and Functionality, Human factors, Human visual system, Perception of depth, color, contrast, resolution, Stereo Rendering, VR Hardware: Head-coupled displays etc. VR Software, Geometric Modelling: From 2D to 3D, 3D space curves, 3D boundary representation. The Graphics Pipeline and OpenGL, Overview and Transformations, Rotation, translation, scaling, mode view matrix, projection matrix, Lighting and Shading, OpenGL Shading Language (GLSL), GLSL vertex and fragment shaders.

UNIT-II

Visual computation in virtual reality: 3D Interaction Techniques: 3D Manipulation Techniques and Input Devices, 3D Travel Tasks, Travel Techniques, Theoretical Foundations of Wayfinding, Types of Centred-Wayfinding Support, Evaluating Wayfinding Aids, System Control, Classification, Graphical Menus, Voice Commands, Gestrual Commands, Tools, Muti-modal System Control Techniques,Case Study: Mixing System Control Methods, Symbolic Input Tasks.

UNIT-III

Framing using 3D virtual reality: Development Tools and Frameworks in Virtual Reality: VR. X3D Standard; Vega, MultiGen, Virtools etc., World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Graphical User Interface, Control Panel, 2D Controls.

UNIT-IV

VR applications: Pose Tracking I, Tracking with light house, Pose Tracking II, Advanced positional tracking, Panoramic Imaging and Cinematic, VR Spatial Sound and the Vestibular System, VR Engines and Other Aspects of

VR, Latency, eye tracking, post-rendering warp. The Future: Virtual environment, modes of interaction Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games, Demonstration of Digital, Entertainment by VR

UNIT- V

Augmented and Mixed Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Text Books:
1. LaValle "Virtual Reality", Cambridge University Press, 2016.
2. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.

Suggested Reading:
1. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013
3. Ange Anderson, Virtual Reality, Augmented Reality and Artificial Intelligence in Special Education, 2019

Web Resource:
1. https://nptel.ac.in/courses/106/106/106106138/
2. https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ge08/
3. https://www.coursera.org/learn/ar?
4. https://www.coursera.org/specializations/virtual-reality

20ADC08   **ARTIFICIAL INTELLIGENCE LAB**

Instruction	2 Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives:
1. Familiarize with Uninformed and Informed search strategies.
2. Understand the game search to solve real-life problems.
3. Introduce logic programming concepts through Prolog.
4. Learn probabilistic reasoning on uncertain data.
5. Outline the Q-learning algorithm.

Course Outcomes:

Upon successful completion of this course, students will be able to:
1. Understand the types of informed and uninformed problems and apply search strategies to solve them.
2. Demonstrate Basic Prolog programming
3. Solve real-life problems using AI techniques like game search.
4. Apply probabilistic reasoning on data.
5. Analyze the Q-learning Algorithm.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	-	-	-	-	-	-	-	2	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	-	2	3	3	2
CO3	3	2	3	3	-	-	-	-	-	-	-	2	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	3	2
CO5	3	3	2	2	-	-	-	-	-	-	-	2	3	3	3

List of Programs

1. Implementation of Breadth First Search uninformed search technique.
2. Implementation of Depth First Search technique.
3. Implementation of Uniform Cost Search technique.
4. Implementation of Iterative Deepening DFS Search technique.
5. Implementation of Bidirectional Search technique.
6. Implementation of Best First Search technique.
7. Implementation of A* Search technique.
8. Implementation of Hill Climbing Algorithm.
9. Implementation of game search Algorithm.
   a. Mini-Max Algorithm
   b. Alpha-beta pruning
10. Installation of prolog and implementation of the basic programs in Prolog.
11. Design of a Bayesian network from given data.
   a. Monty Hall Problem
   b. Burglary and earthquake alarm program
12. Implementation of Q-learning Algorithm.

Text Books:

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011.
2. Russell, Norvig, ―Artificial intelligence - A Modern Approach‖, Pearson Education, 3rd Edition, 2015.

Suggested Reading:

1. Rich, Knight, Nair: ―Artificial intelligence‖, Tata McGraw Hill, 3rd Edition, 2009.
2. Nicole Bauerle, Ulrich Rieder, ―Markov Decision Process with Applications to Finance‖, Springer, 2011.
3. Nilsson, N., ―Artificial Intelligence: A New Synthesis‖, Morgan Kaufmann, 1st Edition, 1998.

Web Resources:

1. https://ai.berkeley.edu/project_overview.html
2. http://aima.cs.berkeley.edu

20ITC26   **EMBEDDED SYSTEMS AND IoT LAB**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives:

1. Understanding Raspberry Pi / Arduino fundamentals.
2. On-Boarding Raspberry Pi / Arduino.
3. Programming with Raspberry Pi Pins / Arduino Pins.
4. Make students to do simple Applications.
5. Understand about IoT Applications using smart sensors.

Course Outcomes:

Upon completing this course, students will be able to:
1. Program using Raspberry Pi.
2. Develop python programs that run on Raspberry Pi/Arduino
3. Write basic IoT Programs using Raspberry Pi/Arduino.
4. Implement Applications using Raspberry Pi / Arduino.
6. Develop simple IoT systems of different Case studies.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	3	3	-	-	-	-	-	-	2	3	2
CO2	2	1	1	2	3	3	-	-	-	-	-	-	2	3	3
CO3	2	1	-	2	3	3	-	-	-	-	-	-	2	3	3
CO4	2	1	-	2	3	3	2	1	1	1	2	1	2	3	3
CO5	2	1	1	2	3	3	2	1	1	1	1	1	-	-	3

LIST OF PROGRAMS

1. Interface Input-Output and other units such as: Relays, LEDs, Switches, Stepper Motors using 8051 Micro controllers.
2. Study and Configure Raspberry Pi.
3. Write programs using Raspberry Pi to blink LED.
   a. using loops   b. using conditional & control statements
4. Write program using Raspberry Pi to interface LEDs, Switch and Buzzer.
5. Interface different Sensors using Raspberry Pi.
   a. Temperature & Humidity   b. PIR   c. GAS   d. LDR   d. Rain
   e. Soil moisture.
6. Write a program to monitor temperature and humidity using DHT (Digital Humidity and Temperature) sensor using Raspberry Pi / Arduino.
7. Uploading and reading the Cloud data using Thingspeak platform.
8. Study the Use Cases:
   a. Home Automation (e.g., Smart Lighting),
   b. City Applications (e.g., Smart Parking, Traffic Lighting)
   c. Environment (e.g., Pollution Monitoring, Weather Monitoring)
   d. Agriculture (e.g., Smart Irrigation) etc.

Text Books:
1. Kenneth J.Ayala, "The 8051 Microcontroller", 3 rd Edition, Thomson, 2014.
2. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
3. Misra, C. Roy, and A. Mukherjee, 2020 "Introduction to Industrial Internet of Things and Industry 4.0". CRC Press.

Suggested Reading:
1. Raj Kamal, "Embedded Systems", 2 nd Edition, McGraw Hill, 2015.
2. Samuel Greengard, "The Internet of Things", 1st Edition, MIT Press, 2015.
3. Peter Waher, Pradeeka Seneviratne, Brian Russell, Drew Van Duren, "IoT: Building Arduino-Based Projects", 1st Edition, Packt Publishing Ltd, 2016.
4. Jeeva Jose, "Internet of Things", Khanna Book Publishing Company

20ADC09
        MINOR PROJECT-I
        (Full Stack Development)

Instruction	3 Hours per Week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1.5

Course Objectives:

1. To enable students to learn by doing.
2. To develop capability to analyze and solve real world problems.
3. To inculcate innovative ideas of the students.
4. To impart team building and management skills among students.
5. To instill writing and presentation skills for completing the project.

Course Outcomes:

Upon successful completion of this course, students will be able to:
1. Interpret Literature with the purpose of formulating a project proposal.
2. Plan, analyze, Design and implement a project.
3. Find the solution of identified problem with the help of modern Technology and give priority to real time scenarios.
4. Plan to work as a team and to focus on getting a working project done and submit a report within a stipulated period of time.
5. Prepare and submit the Report and deliver a presentation before the departmental Committee.

Minor Project is aimed to enable the students to develop a product/application based on the course **FULL STACK DEVELOPMENT** with course code- **20ADC07**. The student has to implement and present the project as per the given schedule. During the implementation of the project, Personnel Software Process (PSP) has to be followed. Report of the project work has to be submitted for evaluation.

SCHEDULE

S No	Description	Duration
1.	Problem Identification / Selection	1 week
2.	Preparation of Abstract	1 week
3.	Design the Web Pages using advanced HTML Form tags input–date, time, number, email, HTML5 Header and Footer, spell check and editable areas.	1 week
4.	Demonstrate the CSS tags Inline, Internal and External Style sheets using advanced CSS in web pages	1 week
5.	Demonstrate JavaScript to perform validation and Bootstrap in Front-End Design.	1 week
6.	Implement React JS, MVC Pattern and Node JS Features in the application.	2 weeks
7.	Implement CRUD operations/DB Replication in MongoDB.	2 weeks
8.	Implementation and inferences	2 weeks
9.	Documentation and Project Presentation	2 weeks

Guidelines for the Award of marks

S No	Description	Max. Marks
	Final Assessment	
1.	PPT Preparation	10
2.	Technical Content	10
3.	Question and Answers	5
4.	Report Preparation	5
	Total	**30**

Final Minor Project demonstration and PPT presentation is to be evaluated for the entire class together by the entire faculty handling Minor Project for that class.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Scheme of Instruction of VI Semester of B.E. – Artificial Intelligence and Data Science
as per AICTE Model Curriculum, with effective from 2022-23

SEMESTER – VI

S.No	Course code	Title of the Course	Scheme of Instruction		Scheme of Examination				Credits
			Hours per week		Duration of SEE in Hours	Maximum Marks			
			L/T	P/D		CIE	SEE		
THEORY									
1.	20ITC13	Software Engineering	3	-	3	40	60		3
2.	20ADC10	Deep Learning	3/1		3	40	60		4
3.	20ADC11	Data Science with R	3	-	3	40	60		3
4.	20ITC25	Cloud Computing	3		3	40	60		3
5.		Professional Elective – 3	3	-	3	40	60		3
PRACTICALS									
6.	20ITC16	Software Engineering Lab	-	3	3	50	50		1.5
7.	20ADC12	Deep Learning Lab	-	3	3	50	50		1.5
8.	20ADC13	Minor Project -II (Data Science)	-	3	-	50	-		1.5
9.	20EGC03	Employability Skills	-	2	-	50	50		1
TOTAL			**16**	**11**	**21**	**400**	**450**		**21.5**

L: Lecture   T: Tutorial   D: Drawing   P: Practical
CIE – Continuous Internal Evaluation   SEE - Semester End Examination

Professional Elective #3	Micro Services with Springboot 20ADE06	Explainable AI 20ADE07	Applied Predictive Analytics 20ITE14	Fundamentals of Block Chain Technology 20ITE16	Agile Project Management 20ADE08	Social Network Analytics 20ADE09

20ITC13   **SOFTWARE ENGINEERING**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. Describe the various software life cycle models.
2. Explain the concepts of Agile software development concepts.
3. Define the basic structural modeling concepts in UML.
4. Enable the students with UML notations.
5. Acquaint the students with Risk management and Product metrics.

Course Outcomes:
Upon completing this course, students will be able to:

1. Identify the minimum requirements for the development of application.
2. Build a system, component, or process to meet desired needs of a customer.
3. Involve in analysis and design of UML models for various case studies.
4. Acquire thorough knowledge of standard UML notations.
5. Know the risks, formulate and implement software projects.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	-	1	-	-	-	1	-	-	1	1	-	-
CO2	2	1	1	-	1	-	-	-	-	-	-	1	-	2	-
CO3	1	1	1	-	-	-	-	-	-	-	2	1	1	-	-
CO4	2	1	0	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	1	-	-	-	1		1	-	-	1	-	-	2

UNIT-I

Software and Software Engineering: The Nature of Software, Software Engineering. The Software Process, Software Engineering Practice. **A Generic view of Process:** Software Engineering -A Layered Technology, A Process framework, Process Models- Waterfall model, spiral model, The Unified Process, Product and Process, Process Assessment and Improvement, The CMMI, Introduction to Agile Development-Extreme programming. **Understanding Requirements:** Requirements Engineering, Establishing the Groundwork, Eliciting Requirements, Building the Requirements Model, Negotiating Requirements, Validating Requirements. **Requirements Modeling:** Requirements Analysis, Scenario-Based Modelling, Problem Analysis, Software Requirement and specifications.

UNIT-II

UML Introduction: Why we Model, Introducing the UML, Elements of UML-Things Relationships and Diagrams. **Basic Behavioural Modelling**: Interactions, Use Cases, Use Case Diagrams, Interaction Diagrams-Sequence diagrams-components of Sequence diagrams, collaboration diagrams-Components of Collaboration diagrams, Activity Diagrams-components of activity diagrams, swim lane diagrams, Case studies on Use Case diagrams, Interaction diagrams. **Advanced Behavioural Modelling**: State Chart Diagrams-components of statechart diagrams, Case studies on State chart diagrams.

UNIT-III

Basic Structural Modelling: Classes, Relationships, Diagrams, Class Diagrams. **Advanced Structural Modelling**: Advanced Classes, Advanced Relationships, Interfaces, Components, Case studies on class diagrams. **Quality Concepts:** Software Quality, Achieving Software Quality. **Software Quality Assurance:** Background Issues, Elements of Software Quality Assurance, SQA Tasks, The ISO 9000 Quality Standards.

UNIT-IV

Software Testing Strategies: A Strategic Approach to Software Testing, Strategic Issues, Validation Testing, System Testing. Testing Tools–Rational functional tester, Selenium software testing tool. **Testing Conventional Applications:** Software Testing Fundamentals, White-Box Testing, Basis Path Testing, Black– Box Testing, Alpha testing, Beta testing.

UNIT-V

Product Metrics: A Framework for Product Metrics, Size Metrics like LOC, Function points, **Risk Management:** Software Risks, Reactive versus Proactive Risk Strategies, Risk Mitigation, Monitoring, and Management, The RMMM Plan.

Text Books:
1. Roger S.Pressman, "Software Engineering: A Practitioner's Approach", 7th edition, McGrawHill, 2017.
2. Grady Booch, James Rumbaugh, Ivor Jacobson, "The Unified Modelling Language-User Guide (Covering UML 2.0)", Third Edition, Pearson Education, India, 2017.
3. Pankaj Jalote "An Integrated Approach to Software Engineering ", 3rd edition, Narosa Publishing house, 2008.

Suggested Reading:
1. Martin Fowler, Kendall Scott , "UML Distilled: A Brief Guide to the Standard Object Modelling Language" Addison Wesley, 4th Edition, 2011.
2. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, "Fundamentals of Software Engineering", PHI, 2nd edition.
3. James F.Peters, WitoldPedrycz, "Software Engineering-An engineering Approach".

Web Resources:
1. SEweb - Software Engineering Education Home Page: http://tuvalu.cs.flinders.edu.au/seweb/se-ed/
2. IBM Rational http://www-306.ibm.com/software/rational/uml/
3. Practical UML - A Hands-On Introduction for Developers, http://www.togethersoft.com/services/practical_guides/umlonlinecou rse

20ADC10 **DEEP LEARNING**

Instruction	4 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives:
1. To impart knowledge on the basic concepts of Neural Networks and Deep learning.
2. To familiarize various neural network architectures
3. To learn usage of neural networks for problem solving.
4. To familiarize various deep learning models.
5. To facilitate usage of deep learning applications in societal context.

Course Outcomes:
Upon completing this course, students will be able to:
1. Explain the basic principles of neural networks and deep learning.
2. Implement simple neural network algorithms.
3. Compare modeling aspects of various neural network architectures.
4. Evaluate Convolutional Neural Network models on real data sets.
5. Analyze and optimize Recurrent Neural Network models for various applications.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	-	-	-	-	-	-	1	1	2	3	2
CO2	2	2	2	2	1	-	-	-	-	-	1	1	2	3	2
CO3	2	2	1	1	1	-	-	-	-	-	1	-	2	-	2
CO4	2	2	2	2	1	-	-	-	-	-	1	1	2	3	2
CO5	-	1	1	1	1	-	-	-	-	-	-	-	2	-	2

UNIT-I

Introduction to Artificial Neural Networks: From Biological to Artificial Neurons, Implementing MLP, Fine-Tuning Neural Network Hyper parameters, Training Deep Neural Networks: The Vanishing/Exploding Gradients Problems, Reusing Pre trained Layers, Faster Optimizers and Avoiding Overfitting through Regularization.

UNIT-II

Linear Neural Networks: Linear Regression, Linear Regression Implementation from Scratch, Concise Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset, Implementation of Softmax Regression from Scratch, Concise Implementation of Softmax Regression.

UNIT-III

Deep Learning Computation: Layers and Blocks, Parameter Management, Deferred Initialization, Custom Layers, File I/O, GPUs Convolutional Neural Networks: From Fully-Connected Layers to Convolutions, Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, Convolutional Neural Networks (LeNet).

UNIT-IV

Modern Convolutional Neural Networks: Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet), **Recurrent Neural Networks:** Sequence Models, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks.

UNIT-V

Modern Recurrent Neural Networks: Gated Recurrent UNITs (GRU), Long Short-Term Memory (LSTM), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence Learning. **Optimization Algorithms:** Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent.

Text Books:
1. Aurélien Géron , "Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow", Orielly, 2nd edition,2019.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "Dive into Deep Learning", d2l.ai, 2021

Suggested Reading:
1. Levitin A, "Introduction to the Design And Analysis of Algorithms", Pearson Education, 2008.
2. Ian Goodfellow,Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016
3. Indra den Bakker, "Python Deep Learning Cookbook", PACKT publisher, 2017
4. Wei Di, Anurag Bhardwaj, Jianing Wei, "Deep Learning Essentials" , Packt publishers, 2018

Web Resources:
1. http://nptel.ac.in/courses

20ADC11   **DATA SCIENCE WITH 'R'**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To introduce Data Science with R.
2. To impart knowledge on the concepts of Exploring and Cleaning data.
3. To familiarize Supervised and Unsupervised Techniques.
4. To introduce documentation and deployment using R
5. To familiarize text mining with R.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Explore data operations on files and databases using R programming.
2. Understand deployment of models on different datasets.
3. Apply supervised, unsupervised, ensembling and NLP models on different datasets.
4. Perform Sentiment analysis.
6. Build and evaluate the models.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	1	-	-	-	-	1	3	-	-
CO2	3	3	2	3	2	-	1	-	-	-	-	1	3	-	-
CO3	3	3	2	3	3	-	1	-	-	-	1	1	3	3	2
CO4	3	3	2	3	3	-	1	1	-	-	1	1	3	3	2
CO5	3	3	2	3	3	-	1	-	-	-	1	1	3	3	2

UNIT-I:
Introduction to data science: The Data Science Process: Roles in a data science project, Stages of a data science project, Setting expectations. **Starting with R and data:** Starting with R, working with data from files, Working with relational databases. **Exploring data:** Using Summary Statistics to spot problems, Spotting problems with graphics and visualization.

UNIT-II
Managing data: cleaning data, Data transformations, Sampling for modeling and validation. **Choosing and evaluating models:** Mapping problems to machine learning tasks, evaluating models, Local interpretable model-agnostic explanations (LIME) for explaining model predictions.

UNIT-III
Supervised Learning: Using Linear Regression, Using Logistic Regression. **Unsupervised methods:** Cluster Analysis, Association rules. **Exploring Advanced Methods**: Using bagging and random forest, using generalized additive models, using kernel methods to increase data separation.

UNIT-IV
Documentation and Deployment: Predicting buzz, Using R markdown to produce milestone documentation, Using comments and version control for running documentation, Deploying models. **Text Mining with R: The tidy text format:** Contrasting tidy text with other data structures, the unnest_tokens function, tidying the works of Jane Austen, Word Frequencies.

UNIT-V

Sentiment analysis with Tidy data: The sentiments datasets, Comparing the three sentiment dictionaries, Most common positive and negative words, Word clouds, Looking at units beyond just words, **Analyzing word and document frequency:** tf-idf, Term frequency in Jane Austen's novels, Zipf's law, The bind_tf_idf() function.

Text Books:
1. Zumel, N., Mount, J., &Porzak, J., "Practical data science with R", 2nd edition. Shelter Island, NY: Manning, 2019.
2. Julia Silge and David Robinson. "Text Mining with R: A Tidy Approach", 1st. edition. O'Reilly Media, Inc., 2017

Suggested Reading:
1. Garrett Grolemund and Hadley Wickham,"R for data science: import, tidy, transform, visualize, and model data" O'Reilly Media, Inc., 2016.
2. Roger D. Peng, "R programming for data science*" (pp. 86-181). Lean pub, 2016.

Web Resources:
1. https://blog.rstudio.com/
2. https://r4ds.had.co.nz/index.html
2. https://www.dataquest.io/blog/learn-r-for-data-science/

20ITC25   **CLOUD COMPUTING**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. Learn the fundamentals of cloud computing paradigm.
2. Learn various deployment and development models.
3. Learn various security concerns related to cloud.
4. Learn about various offerings of cloud service providers.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Understand the basic ideas of Cloud Computing and its services.
2. Analyze the architecture, deployment models, and infrastructure models of Cloud Computing.
3. Realize distributed storage and performance for implementing virtualization.
4. Analyze cloud computing security, federation, presence, identity, and privacy.
5. Use IaaS / PaaS service offered by cloud service providers

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3													
CO2	3	3	3											3	
CO3	3	3	3	3	3						3			3	3
CO4	3	3	3	3		3				3				3	
CO5	3	3	3	3	3				3	3	3			3	3

UNIT-I

Introduction to Cloud Computing: Cloud Computing in a Nutshell, Roots of Cloud Computing, Layers and Types of Cloud, Features of a cloud, Software-as-a-Service, Platform-as-a-Service, Infrastructure-as-a- Service, Challenges and Risks. **Cloud Computing Platforms:** Infrastructure as service: Amazon EC2, Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.

UNIT-II

Service and Deployment Models: The promise of the cloud, the cloud service offerings and Deployment model, Challenges in the cloud, **Broad Approaches to Migrating into Cloud:** Why Migrate? Deciding on cloud migration. **The Seven Step Model of Migration into Cloud:** Migration Risks and Mitigation. **Managing Cloud Services:** Organizational Issues **Administering Cloud Services:** Service Level Agreements (SLA) and Monitoring Support, Billing and Accounting, Technical Interface, Managing Cloud Resources, Maintaining Connections.

UNIT-III

Web Services: SOAP/WSDL web services, REST web services, SOAP v/s REST **AJAX:** Asynchronous 'rich' interfaces **Mashups:** user interface services **Cloud Technologies:** Study of Hypervisor **Virtualization Technology:** Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization **Multitenant Software:** Multi-entity support, multi-schema approach, multi-tenance using cloud data stores, Data access control for enterprise applications.

UNIT-IV

Cloud Security Fundamentals: Vulnerability assessment tool for cloud, Privacy and Security in cloud **Cloud Computing Security Architecture:** Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access control Identity management, Access control, Autonomic Security **Cloud Computing Security Challenges:** Virtualization security management virtual threats, VM Security Recommendations, VM-Specific Security techniques.

UNIT-V

Enterprise Cloud Computing Ecosystem: Introduction, Public Cloud Providers, Cloud Management Platforms and Tools, Tools for **Building** Private Cloud: IaaS using Eucalyptus, PaaS on IaaS –AppScale. **Roadmap for Enterprise Cloud Computing:** Introduction, Quick wins using Public Clouds, Future of Enterprise Cloud Computing: Commoditization of the data center, Inter-operating Virtualized Data Centers, Convergence of private and public clouds, Generalized 'cloud' services.

Text Books:

1. RajkumarBuyya, "Cloud Computing: Principles and Paradigms", John Wiley & Sons, First Edition
2. Gautam Shroff, "Enterprise Cloud Computing: Technology, Architecture, Applications", Cambridge University Press, First Edition

Suggested Reading:
1. Barrie Sosinsky, "Cloud Computing Bible", Wiley India, First Edition
2. Tim Malhar, S.Kumaraswammy, S.Latif, "Cloud Security & Privacy", O'Really Publications, First Edition

20ADE06   **MICROSERVICES WITH SPRING BOOT**
                                      (Professional Elective –3)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have a good understanding of the Java programming language and SQL

Course Objectives:
1. To Understand the basic concepts of the Spring Framework
2. To provide basic knowledge of Web Application Development with Spring Boot and Restful APIs
3. To explore data access with Spring's DAO Module
4. To acquire Knowledge of Spring transaction management
5. To study Spring's unit testing framework and Introduce Spring Security with Rest API

Course Outcomes:
Upon completing this course, students will be able to:
1. Gain the basic concepts of the Spring Framework
2. Interact with databases using Spring's support for JDBC and JPA.
3. Build spring boot applications using Dependency Injection concept
4. Apply Transaction Management concepts of spring in Enterprise Application Development and develop the Spring-MVC based Applications to solve the real-world problems.
5. Use Spring Unit testing framework and configure security on Spring MVC Applications

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	-	-	-	1	1	1	1	3	-	3
CO2	2	1	2	1	2	-	-	-	-	-	1	-	2	-	3
CO3	2	1	2	2	1	-	-	-	-	-	-	-	3	-	3
CO4	2	1	1	1	1	-	-	-	-	-	-	1	1	-	3
CO5	2	1	1	1	1	-	-	-	-	-	-	1	1	-	3

UNIT-I

Spring Overview: Introduction to Spring Framework, The DI Container, Evolution of Spring Framework
Java Configuration: Java configuration and the Spring application context, @Configuration and @Bean annotations, @Import: working with multiple configuration files, defining bean scopes, launching a Spring Application and obtaining Beans, External properties & Property sources, Environment abstraction, Using bean profiles, Spring Expression Language (SpEL) **Annotation and Component Scanning:** Component scanning, Autowiring using @Autowired, Java configuration versus annotations mixing Lifecycle annotations: @PostConstruct and @PreDestroy, Stereotypes and meta-annotations

UNIT-II

Web Applications with Spring Boot: Introduction to Spring MVC and request processing, Controller method signatures, Using @Controller, @RestController and @GetMapping annotations and Configuring Spring MVC with Spring Boot. **RESful Application with Spring Boot:** An introduction to the REST architectural style, Controlling HTTP response codes with @ResponseStatus, Implementing REST with Spring MVC, @RequestMapping, @RequestBody and @ResponseBody, Spring MVC's HttpMessageConverters and automatic content negotiation and Jakson library

UNIT-III

Spring Boot Feature Introduction: Introduction to Spring Boot Features, Value Proposition of Spring Boot and Creating a simple Boot application using Spring Initializer website **Spring Boot – Dependency Management:**

Dependency management using Spring Boot starters, how auto-configuration works, Configuration properties, overriding auto-configuration and Using CommandLineRunner

UNIT-IV

JDBC Simplification with JdbcTemplate: How Spring integrates with existing data access technologies, Spring's JdbcTemplate and DataAccessException hierarchy **Spring Boot – Spring Data JPA:** Quick introduction to ORM with JPA, Benefits of using Spring with JPA, JPA configuration in Spring, Configuring Spring JPA using Spring Boot, Spring Data JPA dynamic repositories **Transaction Management with Spring:** Transaction overview, Transaction management with Spring, Transaction propagation and rollback rules and Transactions and integration testing

UNIT-V

Testing a Spring-based Application: Spring and Test-Driven Development, Spring 5 integration testing with JUnit 5, Application context caching and the @DirtiesContext annotation, Profile selection with @ActiveProfiles, Easy test data setup with @Sql **Securing REST Application with Spring Security:** What problems does Spring Security solve? , Configuring authentication, implementing authorization by intercepting URLs, Authorization at the Java method level, Understanding the Spring Security filter chain and Spring security testing. **Actuators, Metrics and Health Indicators:** Exposing Spring Boot Actuator endpoints, Custom Metrics, Health Indicators, Creating custom Health Indicators and External monitoring systems

Text Books:
1. Mark Heckler, "Spring Boot Up and Running, 1ˢᵗ Edition", Oreilly, 2021.
2. Iuliana Cosmina, Rob Harrop, Chris Schaefer, Clarence Ho " Pro String 5", Fifth Edition, Apress, 2019

Suggested Reading:
1. Raja CSP Raman, Ludovic Dewailly, "Building A RESTful Web Service with Spring 5", Packt Publishing, 2018.

Web Resources:
1. https://spring.io/guides/gs/spring-boot/
2. https://docs.spring.io/spring-framework/docs/current/reference/html/index.html

20ADE07   **EXPLAINABLE ARTIFICIAL INTELLIGENCE**
                                    (Professional Elective #3)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To Understand the concepts within Explainable AI and interpretable machine learning
2. To Demonstrate comprehension of current techniques for generating explanations from black-box machine learning methods
3. To Demonstrate the ability to select and assess Explainable AI methods
4. To Demonstrate comprehension of current ethical, social and legal challenges related to Explainable AI

Course Outcomes:
Upon completing this course, students will be able to:
1. Describe the context of the machine learning application and why explainability would help, but also scrutinize which kind of explainability technique is necessary.
2. Understand the concepts that are important in model validation, evaluation, and performance visualization for both supervised and unsupervised learning.
3. Install and set up one or more post hoc explain ability techniques through a self-chosen set of programming platforms.
4. Critically reflect on the results from Explainable deep learning techniques and suggest how it helps the problem context.
5. Demonstrate comprehension of challenges and future related to Explainable AI

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO2	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO4	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO5	2	2	2	2	1	1	1	1	1	1	1	2	2	2	2

UNIT-I

Introduction: Black-Box problem, Goals, Brief History, Purpose, Societal Impact, Types of Explanations, Trade-offs, Taxonomy, Flowchart for Interpretable and Explainable Techniques. **Pre-model Interpretability and Explainability:** Data Science Process and EDA, Exploratory Data Analysis, Feature Engineering

UNIT-II

Model Visualization Techniques and Traditional Interpretable Algorithms: Model Validation, Evaluation, and Hyperparameters, Model Selection and Visualization, Classification Model Visualization, Regression Model Visualization, Clustering Model Visualization, Interpretable Machine Learning Properties, Traditional Interpretable Algorithms

UNIT-III

Model Interpretability: Advances in Interpretable Machine Learning: Interpretable vs. Explainable Algorithms, Tools and Libraries, Ensemble-Based, Decision Tree-Based, Rule-Based Techniques, Scoring System. **Post-Hoc Interpretability and Explanations:** Tools and Libraries, Visual Explanation, Feature Importance, Example-Based

UNIT-IV

Explainable Deep Learning: Applications, Tools and Libraries, Intrinsic, Perturbation, Gradient / Backpropagation

UNIT-V

Explainability: Time Series Forecasting, Natural Language Processing, and Computer Vision **XAI: Challenges:** Properties of Explanation, Categories of Explanation, Taxonomy of Explanation Evaluation. **XAI: Future:** Formalization of Explanation Techniques and Evaluations, Adoption of Interpretable Techniques, Human-Machine Collaboration, Collective Intelligence from Multiple Disciplines, Responsible AI (RAI), XAI and Security, Causality and XAI

Text Books:
1. Uday Kamath and John Liu "Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning", Springer Cham, First Edition, 2021.

Suggested Reading:
1. Leonida Gianfagna and Antonio Di Cecco, "Explainable AI with Python", Springer International Publishing, First Edition, 2021.
2. Denis Rothman, "Hands-On Explainable AI (XAI) with Python", Packt Publishing, First Edition, 2020

Web Resources:
1. https://www.ibm.com/in-en/watson/explainable-ai
2. https://sites.google.com/view/explainable-ai-tutorial
3. https://cloud.google.com/explainable-ai

20ITE14   **APPLIED PREDICTIVE ANALYTICS**

(**Professional Elective #3**)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To introduce Predictive Modeling.
2. To familiarize Regression and Classification Techniques.
3. To impart knowledge on the concepts of Support vector machines and Neural Networks.
4. To explore tree-based classifiers and ensemble methods
5. To introduce Topic modeling.

Course Outcomes:
Upon completing this course, students will be able to:
1. Comprehend predictive modeling and assess the performance
2. Apply regression techniques and analyze the performance
3. Demonstrate Support Vector Machines and build an efficient networking model
4. Analyze ensemble methods by choosing Tree based classifiers
5. Select appropriate probabilistic Graphical models and identify topics through topic modeling

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO2	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO4	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO5	2	2	2	2	1	1	1	1	1	1	1	2	2	2	2

UNIT-I

Gearing Up for Predictive Modeling: Models**, Types of models :** Supervised, unsupervised, semi-supervised, and reinforcement learning models, Parametric and nonparametric models, Regression and classification models, Real-time and batch machine learning models, **The process of Predictive Modeling:** Defining the model's objective, Collecting the data, Picking a model, Preprocessing the data, Exploratory data analysis, Feature transformations, Encoding categorical features, Missing data, Outliers, Removing problematic features, Feature engineering and dimensionality reduction, Training and assessing the model, Repeating with different models and final model selection, Deploying the model, **Performance metrics:** Assessing regression models, Assessing classification models, Assessing binary classification models.

UNIT-II

Linear Regression: Introduction to linear regression, Simple linear regression, Multiple linear regression, Assessing linear regression models, Problems with linear regression, Feature selection, Regularization, Ridge regression**.**
Logistic Regression: Classifying with linear regression, Assessing logistic regression models, Regularization with the lasso, Classification metrics, Extensions of the binary and Multinomial logistic classifier

UNIT-III

Support Vector Machines: Maximal margin classification, Support vector classification, Inner products**,** Kernels and support vector machines, Cross-validation.

Neural Networks: Stochastic gradient descent**:** Gradient descent and local minima, The perceptron algorithm, Linear separation, The logistic neuron, **Multilayer perceptron networks:** Training multilayer perceptron networks.

UNIT-IV

Tree-based Methods: The intuition for tree models, Algorithms for training decision trees-
Classification and regression trees, CART regression trees, Tree pruning, Missing data, Regression model trees CART classification trees, C5.0, Predicting complex skill learning, Variable importance in tree models, **Ensemble Methods: Bagging -** Margins and out-of-bag observations, Predicting heart disease with bagging, Limitations of bagging, **Boosting –** AdaBoost, Limitations of boosting, **Random forests-** The importance of variables in random forests

UNIT-V

Probabilistic Graphical Models: A little graph theory, Bayes' Theorem, Conditional independence, Bayesian networks, The Naïve Bayes classifier. Hidden Markov models- Predicting letter patterns in English words.**Topic Modeling:** An overview of topic modeling, Latent Dirichlet Allocation, The Dirichlet distribution, The generative process, Fitting an LDA model, Modeling the topics of online news stories, Model stability, Finding the number of topics, Topic distributions, Word distributions, LDA extensions.

Text Books:
1. Rui Miguel Forte, "Mastering Predictive Analytics with R", Packt Publishing Ltd, 2015.
2. Roger D. Peng, "R Programming for Data Science", Lean Publishing, 2015.

Suggested Reading:
1. Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst, Dean Abbott, 2014, Wiley.
2. Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Tom Fawcett, O′Reilly, 1st edition, 2013.

Web Resources:
1. https://data-flair.training/blogs/r-predictive-and-descriptive-analytics/
2. https://www.littlemissdata.com/blog/predictive-analytics-tutorial-part-1
3. http://uc-r.github.io/mars
4. https://www.coursera.org/learn/design-thinking-predictive-analytics-data-products
5. https://www.coursera.org/learn/meaningful-predictive-modeling

20ITE16   **FUNDAMENTALS OF BLOCK CHAIN TECHNOLOGY**
                          (Professional Elective #3)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To Familiarize the basic concepts of blockchain.
2. To provide the significance of the bitcoin ecosystem.
3. To Explore the consensus mechanisms and technologies that support ethereum.
4. To introduce Hyperledger Fabric and its architecture.
5. To familiarize blockchain use cases in various domains.

Course outcomes:
Upon completing this course, students will be able to
1. Describe the concepts of distributed systems and blockchain properties.
2. Identify the significance of the bitcoin ecosystem.
3. Examine the consensus mechanisms and technologies that support ethereum.
4. Inspect Hyperledger Fabric and its architecture.
5. Analyze blockchain use cases in various domains.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	-	1	3	3	3
CO2	3	3	2	2	3	-	-	-	-	-	1	1	3	3	2
CO3	3	2	2	3	2	2	1	-	-	-	-	-	3	3	3
CO4	2	2	2	3	2	1	1	-	-	-	1	-	3	3	2
CO5	3	2	2	3	3	3	1	-	-	-	-	-	3	3	3

UNIT I

Introduction: Overview of distributed systems, Introduction to Blockchain, Generic elements of a blockchain, Features of Blockchain, Applications of Blockchain.
Cryptocurrency And Blockchain : Hash Functions and Merkle Trees, Components of Blockchain Ecosystem, Cryptography and Consensus Algorithms; Types of Blockchain, Blockchain Platforms.

UNIT II

Bitcoin Platform: Bitcoin definition, Keys and addresses , Public keys and Private keys in bitcoin, The transaction life cycle, The transaction structure, Bitcoin payments, Bitcoin investment and buying and selling bitcoins. Consensus mechanism in bitcoin
Wallets: Wallet types, Non-deterministic wallets, Deterministic wallets, Alternative Coins- Namecoin, Litecoin, Zcash
.
UNIT III

Smart contracts and Ethereum: Introducing Smart Contracts, Ethereum blockchain , The Ethereum stack, Ethereum virtual machine (EVM), Consensus mechanism in Ethereum, The Ethereum network, Ethereum Development, Setting up a development environment, Development tools and clients, Applications developed on Ethereum

UNIT IV

Hyperledger Fabric: Introduction to Hyperledger Fabric, Hyperledger Fabric architecture, Membership services Blockchain services, Hyperledger Projects- Fabric, Sawtooth lake, Iroha , Components of the Fabric, Peers or nodes, Applications on Blockchain, Alternate Blockchains- Ripple, Corda

UNIT V

Applications of Blockchain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade — Trade Finance Network, Supply Chain Financing, Identity on Block chain

Text Books:
1. Imran Bashir "Mastering Blockchain" 2nd Edition Packt Publishers, 2018.
2. Melanie Swan, "Block Chain: Blueprint for a New Economy", 1st Edition O'Reilly, 2018.

Suggested Reading:
1. Andreas Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", 1st Edition, Apress, 2017.
2. Ritesh Modi, "Solidity Programming Essentials: A Beginner's Guide to BuildSmart Contracts for Ethereum and BlockChain", Packt Publishing, 2019.

Web Resources:
1. https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html
2. https://www.hyperledger.org/projects/fabric
3. https://www.packtpub.com/big-data-and-business-intelligence/hands-blockchain-hyperledger
4. https://www.amazon.com/Hands-Blockchain-Hyperledger-decentralized-applications/dp/1788994523
5. https://github.com/HyperledgerHandsOn/trade-finance-logistics

20ADE08   **AGILE PROJECT MANAGEMENT**
                                        (Professional Elective #3)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course objectives:
1. To familiarize with Agile Life cycle models.
2. To provide insight into the Agile waterfall model and develop scope for requirements.
3. To explore the planning and scheduling mechanisms for Agile project development.
4. To introduce Quality principles in Agile space.
5. To familiarize with matrix management in Agile development.

Course outcomes:
Upon completing this course, students will be able to
1. Describe the Agile Life cycle models.
2. Identify the scope and requirements for Agile project development
3. Appraise the Agile Planning and scheduling mechanisms for an enterprise Agile project.
4. Describe the Quality Principles in the Agile space.
5. Analyze Matrix Management in the Agile Space

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	1	-	1	1	1	1	3	3	3
CO2	3	3	2	1	3	-	2	-	1	2	2	1	3	3	2
CO3	3	3	2	1	3	-	2	-	2	1	2	2	2	3	3
CO4	3	3	2	2	2	-	1	-	1	2	1	2	1	2	2
CO5	3	3	2	2	3	-	2	-	1	2	2	1	3	1	3

UNIT I

Agile Manifesto: Agile Principles,Traditional Lifecycle, Agile Lifecycle,Scaling for Enterprise Agile,Four Agile Methodologies-Representative Agile Methods,Advantages and Disadvantages of Agile Methods.
The Agile Business Case-Adding Value with the Business Case,Business Value Models Models for the Business Case,Building the Business Case by Levels

UNIT II

Agile in the Waterfall-First Principles and Requisite Conditions,The Black Box, Interfaces, and Connectivity,Milestone Planning, Monitoring, and Controlling, Change Management, Risk Management. **Developing the Scope and Requirements-**Agile Scope ,Evolving, Emerging, and Adaptive,Scope as a Best Value,Envisioning , Process for Requirements.

UNIT III

Planning and Scheduling-Planning in the Enterprise Context,Agile Planning Portfolio, Scheduling-Rhythm of the Schedule,Time Box Timelines and Calendars, Other Plans in the Enterprise Agile Project -Planning for Architecture and Nonfunctional Deliverables,Planning for Uncertainty.

UNIT IV

Quality in the Agile Space-Quality Values and Principles,Quality: Values, Principles, and Practices,Quality Values and Principles Are Planned into Agile Methods. **Sampling for Quality Validation**-Sampling, Process Limits and Benchmarks,Quality Measures from Users

UNIT V

Groups as the Genesis of Teams-Teams from Groups ,Principles of Successful Teams, Operating Model of the Agile Team,Managing the Team Network ,Team-of-Teams. **Matrix Management in the Agile Space-**Matrix Attributes,Matrix as an Agile Management Tool,Agile Teams Recruit Their Members

Text Books:

1. John C. Goodpasture, "Project Management the Agile Way -Making it Work in the Enterprise" **,** 2ⁿᵈ edition , JRoss Publishers 2016.
2. Alistair Cockburn, Agile Software Development: The Cooperative Game, Addison Wesley 2017.

Suggested Readings:
1. Robert C. Martin, "Agile Software Development, Principles, Patterns and Practices", Prentice Hall,2015.
2. Mike Cohn, "User Stories Applied: For Agile Software", Addison Wesley,2015.

Web Resources:

1. https://www.scrum.org/
2. https://www.udemy.com/course/agile-with-scrum-from-beginner-to-advanced-project-management-agile
3. https://www.coursera.org/learn/agile-project-management
4. https://www.coursera.org/learn/agile-atlassian-jira

20ADE09 SOCIAL NETWORK ANALYSIS
(Professional Elective #3)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
1. To Describe about the current web development and emergence of social web
2. To Design modeling, aggregating and knowledge representation of semantic web
3. To Describe Association rule mining algorithms
4. To Summarize knowledge on extraction and analyzing of social web
5. To know the application in real time systems.

Course Outcomes:
Upon completing this course, student will be able to:
1. Understand the basics of social network analysis.
2. Analyze Ontology representation of social network data.
3. Apply supervised and unsupervised algorithms on social networks.
4. Interpret the semantic content of social media data.
5. Build social network model for real time applications.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	-	-	-	-	-	-	1	1	2	3	2
CO2	2	2	2	2	1	-	-	-	-	-	1	1	2	3	2
CO3	2	2	1	1	1	-	-	-	-	-	1	-	2	-	2
CO4	2	2	2	2	1	-	-	-	-	-	1	1	2	3	2
CO5	2	1	1	1	1	-	-	-	-	-	-	-	2	-	2

UNIT-I

INTRODUCTION: Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

UNIT-II

MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modeling and aggregating social network data: State-of-the-art in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.

UNIT-III

ALGORITHMS AND TECHNIQUES: Association Rule Mining, Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Markov models, K-Nearest Neighboring, Content-based Recommendation, Collaborative Filtering Recommendation, Social Network Analysis, Detecting Community Structure in Networks, the Evolution of Social Networks.

UNIT-IV

EXTRACTING AND ANALYZING WEB SOCIAL NETWORKS: Extracting Evolution of Web Community from a Series of Web Archive, Temporal Analysis on Semantic Graph using Three-Way Tensor, Decomposition, Analysis of Communities and their Evolutions in Dynamic Networks.

UNIT- V

APPLICATIONS:A Learning Based Approach for Real Time Emotion Classification of Tweets, A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments, Explaining Scientific and Technical Emergence Forecasting, Social Network Analysis for Biometric Template Protection.

Text Books:
1. Peter Mika, "Social Networks and the Semantic Web", Springer, 1st edition, 2007.
2. Guandong Xu , Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", Springer, 1st edition, 2012.
3. Przemyslaw Kazienko, Nitesh Chawla,"Applications of Social Media and Social Network Analysis", Springer,2015.

Suggested Reading:
1. Ajith Abraham, Aboul Ella Hassanien, Václav Snášel, "Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2012
2. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1 st edition, 2011
3. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2014
4. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.

Web Resource:
1. https://swayam.gov.in/nd1_noc19_cs66/preview

20ITC16   **SOFTWARE ENGINEERING LAB**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives:
1. Describe use case models that capture requirements of a software system.
2. Illustrate Dynamic models of a software system.
3. Build class diagrams that model a software system.
4. Acquaint with Activity and swimlane models.
5. Familiarize with analysis and design models.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Interpret user requirements using the UML notation.
2. Illustrate Dynamic models of a software system.
3. Analyze and develop class diagrams that model a software system.
4. Develop Activity and swimlane models.
5. Outline analysis and design models.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	-	-	-	-	-	-	1	1	2	3	2
CO2	2	2	2	2	1	-	-	-	-	-	1	1	2	3	2
CO3	2	2	1	1	1	-	-	-	-	-	1	-	2	-	2
CO4	2	2	2	2	1	-	-	-	-	-	1	1	2	3	2
CO5	2	1	1	1	1	-	-	-	-	-	-	-	2	-	2

List of Programs

1. Construct Use case diagrams for the following
   a. Diagram editor.
   b. Library information system.
   c. Banking system.
2. Construct Sequence diagrams for the following.
   a. Mobile phone.
   b. Use case student register for a course.
   c. Diagram editor.
3. Construct Collaboration diagrams for the following
   a. Use case librarians issue books to students.
   b. Mobile phone.
   c Diagram editor.

4. Construct class diagrams for the following
   a. Diagram editor.
   b. Library information system.
   c. Banking system
5. Construct Activity diagrams for the following.
   a. ATM transaction.
   b. Ticket machine.
   c. Sales order processing.
6. Construct Swim lane diagrams for the following.
   d. Account.
   e. CD player.
   c. ATM machine
7 Case Studies**:**
   Prepare SRS, develop Analysis and design models for
   f. Passport automation system

g. Credit card processing
h. BPO management system
i. E-book management system
j. Recruitment system
8   Study of selenium web testing tools.
k. Selenium IDE
l. Selenium RC
9   Creating test cases for GUI based desktop applications.

Text Books:
1. Grady Booch, RobertA. Maksimchuk, "Object - Oriented Analysis and Design with Applications", Addision-Wesley, 3 rd Edition, ISBN No: 9780201895513, 2007.
2. Martina Seidl , Marion Scholz , Christian Huemer, GertiKappel "UML @ Classroom: An Introduction to Object-Oriented Modeling", Springer; 2015th edition, ISBN-10: 3319127411, (March 9, 2015)

Suggested Reading:
1. Martin Fowler, Kendall Scott, "UML Distilled**:** A Brief Guide to the Standard Object Modeling Language" Addison Wesley, 4th Edition, 2011.
2. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli,"Fundamentals of Software Engineering", PHI,2nd Edition.
3. Unmesh Gundecha , Carl Cocchiaro ," Learn Selenium: Build data-driven test frameworks for mobile and web applications with Selenium Web Driver 3", ISBN : 183898304X, Packt Publishing (July 18, 2019)

Web Resources:
1. SEweb - Software Engineering Education Home Page:http://tuvalu.cs.flinders.edu.au/seweb/se-ed/
2. IBM Rationalhttp://www-306.ibm.com/software/rational/uml/
3. Practical UML - A Hands-On Introduction for Developers http://www.togethersoft.com/services/practical_guides/umlonlinec ourse
4. https://www.udemy.com/course/selenium-automation-testing-for-beginner

20ADC12   **DEEP LEARNING LAB**

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives:
1. To impart knowledge on image data representation techniques.
2. To introduce the concept of Regression.
3. To familiarize with MLP and CNNs.
4. To familiarize with various CNN architectures.
5. To introduce the concept of RNNs.

Course Outcomes:
Upon successful completion of the course the students will be able to:
1. Preprocess the data to train on Neural Networks
2. Design and Implement Multilayer Perceptron Networks.
3. Identify suitable Neural Network topology to solve a problem.
4. Evaluate and Tune the Convolutional Neural Network models on real dataset(s)
5. Analyze and Tune the Recurrent Neural Network models on real dataset(s)

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	-	-	-	-	1	-	2
CO2	1	1	1	1	1	-	-	-	-	-	-	-	1	-	2
CO3	-	2	2	2	1	-	-	-	-	-	-	1	3	3	2
CO4	2	3	3	3	2	-	-	-	-	-	-	1	3	3	2
CO5	2	3	3	3	2	-	-	-	-	-	-	1	3	3	2

List of Programs

1. Implement Linear Regression, Softmax Regression
2. Implement Multilayer Perceptron Networks
3. Train and Model the Deep Convolutional Neural Networks (AlexNet)
4. Use Networks - Blocks in Networks(VGG)
5. Use Networks with Parallel Concatenations in GoogLeNet
6. Apply Batch Normalization in LeNet.
7. Implement Residual Networks (ResNet)
8. Model the Densely Connected Networks (DenseNet)
9. Use LSTM on document dataset
10. Use Encoder-Decoder on speech recognition dataset

Text Books:

1. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "Dive into Deep Learning", d2l.ai, 2021
2. Aurelien Geron, "Hands-on Machine Learning with Scikit-Learn, Keras, and Tensor Flow", O'Reilly Media, 2nd Edition, 2019.

Suggested Reading:
1. Ian Goodfellow, Yoshua Bengio, Aaron , Courville, "Deep Learning", MIT Press, 2016
2. Indra den Bakker, "Python Deep Learning Cookbook", PACKT publisher, 2017
3. Wei Di, Anurag Bhardwaj, Jianing Wei, "Deep Learning Essentials", Packt publishers, 2018

Datasets:
1. https://www.kaggle.com/datasets
2. https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/multilabel.html#siam-competition2007

Web Resources:
1. https://www.coursera.org/specializations/machine-learning
2. http://nptel.ac.in/courses

20ADC13
MINOR PROJECT-II
(Data Science)

Instruction	3 Hours per Week
Duration of SEE	--
SEE	--
CIE	50 Marks
Credits	1.5

Course Objectives:
1. To enable students learning by doing.
2. To develop capability to analyse and solve real world problems.
3. To apply innovative ideas of the students.
4. To learn the ability to build a data science project
5. To impart team building and management skills among students and instill writing and presentation skills for completing the project.

Course Outcomes:
Upon completing this course, students will be able to:

1. Interpret Literature with the purpose of formulating a project proposal.
2. Develop the ability to identify and formulate problems by applying diverse technical knowledge skills.
3. Apply the fundamental knowledge gained in the curriculum to model, design and implement a Data Science project.
4. Build a prototype by choosing appropriate technologies to meet the identified requirements.
5. Plan to work as a team and to focus on getting a working project done and submit a report within a stipulated period of time to the departmental Committee.

Minor Project is aimed to enable the students to develop a product/application based on the course Data Science with R, Course code - 20ADC11. The student has to implement and present the project as per the given schedule. During the implementation of the project, Personnel Software Process (PSP) has to be followed. Report of the project work has to be submitted for evaluation.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	3	3	3	2	2	2	3	3	2	-	3
CO2	3	3	3	3	3	3	3	2	2	2	3	3	3	3	3
CO3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	3
CO4	3	3	2	3	3	3	3	2	3	3	3	3	3	3	3
CO5	1	2	2	2	3	3	-	-	3	3	-	2	1	-	-

Schedule

S No	Description	Duration
1.	Problem Identification / Selection	2 weeks
2.	Preparation of Abstract	1 week
3.	Data Collection and exploratory data analysis	2 weeks
4.	Data Modeling Techniques	3 weeks
5.	Implementation and inferences	2 weeks
6.	Documentation and Project Presentation	3 weeks

Guidelines for the Award of marks

S. No.	Description	Max. Marks
Final Assessment		30
1.	PPT Preparation	10
2.	Technical Content	10
3.	Question and Answers	5
4.	Report Preparation	5

- The CIE evaluation is based on the rubrics for evaluation on weekly basis.
- Final Minor Project demonstration and PPT presentation is to be evaluated for the entire class together by the entire faculty handling Minor Project for that class.

20EGC03   **EMPLOYABILITY SKILLS**

Instruction	2 Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives:

1. To Learn the art of communication, participate in group discussions and case studies with confidence and to make effective presentations.
2. To With- resume packaging, preparing them to face interviews.
3. To Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. To Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

Course Outcomes:

Upon completing this course, students will be able to
1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	2	2	2	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	2	-	-	-	-	-	2		-	2	-	-	-	-
CO5	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-

UNIT 1
Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences-Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT 2
Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT

UNIT 3
Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management-**Corporate Culture** – Grooming and etiquette-Statement of Purpose (SOP).

UNIT 4
Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT 5
Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

Suggested Reading:
1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005
2. Dr. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006
3. Edgar Thorpe and ShowickThorpe , "Objective English", 2nd edition, Pearson Education, 2007
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010
5. Gulati and Sarvesh, " Corporate Soft Skills", New Delhi: Rupa and Co. , 2006
6. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004
7. A Modern Approach to Verbal & Non-Verbal Reasoning by R S Aggarwal, 2018
8. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989