SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)

(Approved by AICTE, New Delhi, Affiliated to JNTUK, Kakinada)

Accredited by NAAC with 'A+' Grade.

Recognised as Scientific and Industrial Research Organisation

SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA

Regulation: R23	**III / IV - B.Tech. I – Semester**

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

COURSE STRUCTURE
(With effect from 2023-24 admitted Batch onwards)

Course Code	Course Name	Category	L	T	P	Cr	C.I.E.	S.E.E.	Total Marks
B23AM3101	Deep Learning	PC	3	0	0	3	30	70	100
B23AM3102	Computer Networks	PC	3	0	0	3	30	70	100
B23AM3103	Natural Language Processing	PC	3	0	0	3	30	70	100
#PE-I	Professional Elective-I	PE	3	0	0	3	30	70	100
#OE-I	Open Elective-I	OE	3	0	0	3	30	70	100
B23AM3110	Deep Learning Lab	PC	0	0	3	1.5	30	70	100
B23AM3111	Natural Language Processing Lab	PC	0	0	3	1.5	30	70	100
B23AM3112	Full Stack Development -2	SEC	0	1	2	2	30	70	100
B23AM3113	Tinkering Lab *(User Interface Design using Flutter)* / SWAYAM Plus - Android Application Development (with Flutter)	ES	0	0	2	1	30	70	100
B23AM3114	Evaluation of Community Service Internship	PR	--	--	--	2	--	50	50
B23MC3101	Employability Skills	MC	2	--	--	--	30	--	30
		TOTAL	**17**	**1**	**10**	**23**	**300**	**680**	**980**

	Course Code	Course
#PE-I	B23AM3104	Automata Theory & Compiler Design
	B23AM3105	NoSQL databases
	B23AM3106	Exploratory Data Analysis
	B23AM3107	Object Oriented Analysis and Design
	B23AM3108	Internet of Things (IoT)
	B23AM3109	MOOCS-I
#OE-I	Student has to study one Open Elective offered by CE or ECE or EEE or ME or S&H from the list enclosed.	

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3101	**PC**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

DEEP LEARNING

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	To introduce the fundamental concepts of neural networks and deep learning architectures
2.	To enable learners to apply deep learning techniques to vision, language, and generative tasks
3.	To develop practical skills in training, regularizing, and optimizing deep neural network models

Course Outcomes: At the end of the course, students will be able to

S. No.	Outcome	Knowledge Level
1.	**Apply** perceptron learning algorithms and threshold logic to solve linearly separable problems	K3
2.	**Analyze** the structure and learning process of deep neural networks and the effectiveness of regularization techniques in improving model performance.	K4
3.	**Use** Convolutional Neural Network and Recurrent Neural Network architectures to solve image and sequence learning tasks	K3
4.	**Apply** auto encoder variants and optimization algorithms in deep learning tasks.	K3
5.	**Use** Deep learning models like AlexNet, GANs, and RBMs in real-world applications	K3

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SYLLABUS

UNIT-I (8 Hrs)	Historical Trends in Deep Learning, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm
UNIT-II (10 Hrs)	**Deep Feed Forward Neural Networks:** Multilayer Perceptron, Gradient Descent, Back propagation computation in Fully-Connected MLP, Various Activation Functions, error functions **Regularization in Deep Learning:** L1, L2 Regularization, Data Augmentation, Noise Robustness, Semi supervised learning, Dropout, Early Stopping, Parameter Tying and Parameter Sharing
UNIT-III (10 Hrs)	**Convolutional Neural Networks:** Convolutional operation- Pooling- Batch Normalization **Recurrent Neural Networks:** RNN, Bidirectional RNN, LSTM, GRU**,** Backpropagation through time

UNIT-IV (10 Hrs)	**Auto Encoders and Optimization Algorithms** **Auto Encoders:** Under Complete Autoencoder, Regularized Autoencoder, Sparse Autoencoder, Denoising Autoencoder **Optimization for Deep Learning**: gradient descent, stochastic gradient descent, mini batch gradient descent, Adagrad, RMSProp, Adam
UNIT-V (10 Hrs)	**Interactive Applications of Deep Learning: Machine Vision**: AlexNet, VGGNet, ResNet, Transfer Learning, Object Detection, **Natural Language processing**: Natural Language Classification, Generative Adversarial Networks **Deep Generative Models:** Boltzmann Machines Restricted Boltzmann Machines, Transformer Architecture

Textbooks:	
1.	Ian Good fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016 (available at http://www.deeplearningbook.org)
2.	Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence - Jon Krohn, Grant Beyleveld, Aglaé Bassens, Released September 2019, Publisher(s): Addison-Wesley Professional, ISBN: 9780135116821
Reference Books:	
1.	Charu C Agarwal, "Neural Networks and Deep Learning", IBM T. J. Watson Research Center, International Business Machines, Springer, 2018
2.	Michael Nielsen, "Neural Networks and Deep Learning", Online book, 2016 (http://neuralnetworksanddeeplearning.com/)
3.	Deep Learning with Python - Francois Chollet, Released December 2017, Publisher(s): Manning Publications, ISBN: 9781617294433
4.	Artificial Neural Networks, Yegnanarayana, B., PHI Learning Pvt. Ltd, 2009.
e-Resources	
1.	https://www.cse.iitm.ac.in/~miteshk/CS7015/Slides/Handout/Lecture1.pdf
2.	https://www.cse.iitm.ac.in/~miteshk/CS7015/Slides/Handout/Lecture2.pdf
3.	https://www.cse.iitm.ac.in/~miteshk/CS6910.html

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3102	**PC**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

COMPUTER NETWORKS

(For AI & ML)

Course Objectives: This course aims to equip students with the following**:**

1.	To understanding the principles of computer networks.
2.	To familiarize with Reference model OSI and TCP/IP
3.	To explore Datalink, Transport and Network layer protocols
4.	To study application layer applications

Course Outcomes: At the end of the course, students will be able to

S. No	Outcome	Knowledge Level
1.	**Illustrate** the OSI reference model, TCP/IP, and Digital transmission techniques	K2
2.	**Apply** error detection and correction, flow control with respect to data link layer	K3
3.	**Summarize** MAC layer protocols and LAN technologies	K2
4.	**Demonstrate** various network layer services and Routing algorithms	K3
5.	**Explain** Transport layer and application layer protocols	K2

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** Types of Computer Networks, Network Topologies Reference Models- The OSI Reference Model, The TCP/IP Reference Model, A Comparison of the OSI and TCP/IP Reference Models. **Physical Layer**: Introduction to physical layer, Guided Media- Twisted-pair cable, Coaxial cable and Fiber optic cable and unguided media
UNIT-II (10 Hrs)	**The Data Link Layer:** Data Link Layer Design Issues, Services Provided To the Network Layer, Error detecting and Error Correcting codes, Elementary Data Link Protocols, Sliding Window Protocols, HDLC. Multiple Access Protocols in Wired Lans, Ethernet, Fast Ethernet, Gigabit Ethernet
UNIT-III (10 Hrs)	**The Network Layer**: Network Layer Design Issues, Routing Algorithms, Congestion, Congestion control algorithms. The Network Layer in the Internet, The IP Version 4 Protocol, IP Addresses- Classful, CIDR, NAT, IP Version 6 Protocol, Transition from IPV4 to IPV6
UNIT-IV (10 Hrs)	**The Transport Layer:** The Transport Layer Services, Connection Establishment and Termination, Congestion Control, Sliding Window Protocol, Transport Layer Protocols: UDP, TCP and SCTP

UNIT-V (10 Hrs)	**The Application Layer: S**ervices And Protocols, The World Wide Web, HTTP, Domain Name Space, Remote Loging, Electronic Mail and File Transfer
Textbooks:	
1.	"Computer Networks", Andrew S Tanenbaum, David J Wetherall, 5th Edition, Pearson
2.	"Data Communications and Networking", Behrouz A Forouzan, 4th Edition, Tata McGraw Hill Education
Reference Books:	
1.	"Data and Computer Communication", William Stallings, Pearson
2.	"TCP/IP Protocol Suite", Behrouz Forouzan, McGraw Hill.
e-Resources	
1.	https://nptel.ac.in/courses/106105183/25
2.	http://ww25.nptelvideos.in/2012/11/computer-networks.html?subid1=20250723-1924-11d3-a203-6de09d1a95d2
3	https://www.youtube.com/playlist?list=PLBlnK6fEyqRiw-GZRqfnlVIBz9dxrqHJS

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3103	**PC**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

NATURAL LANGUAGE PROCESSING

(For AI & ML)

Course Objectives: This course aims to equip students with the following**:**

1.	To gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information.
2.	The course examines NLP models and algorithms using both the traditional symbolic and the more recent statistical approaches.
3.	Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** NLP concepts to process languages and build basic models	K3
2.	**Apply** word and syntactic level analysis techniques to process text using automata, parsing methods, and POS tagging for NLP task	K3
3.	**Apply** semantic and discourse analysis techniques to interpret meaning, resolve ambiguity, and ensure coherence in texts.	K3
4.	**Use** natural language generation and machine translation techniques to build simple NLG systems and translate texts, including those in Indian languages.	K3
5.	**Apply** NLP tools and resources to develop applications like information extraction, text summarization, and question-answering systems.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** What is Natural Language Processing (NLP), Origins of NLP, Language and Knowledge, The challenges of NLP, Language and Grammar, Processing Indian Languages, NLP Applications, Some successful Early NLP Systems, Information Retrieval, Tokenization. **Language Modelling:** Introduction, Various Grammar-based Language Models, Statistical Language Model.
UNIT-II (10 Hrs)	**Word Level Analysis:** Introduction, Regular Expressions, Finite State Automata, Morphological Parsing, Spelling Error Detection and Correction, Minimum Edit Distance, Words and Word Classes, Part-of-Speech Tagging, **Syntactic Analysis:** Introduction, Context- Free Grammar, Constituency, Parsing, Probabilistic Parsing.
UNIT-III (10 Hrs)	**Semantic Analysis:** Introduction, Meaning Representation, Lexical Semantics, Ambiguity, Word Sense Disambiguation, **Discourse Processing:** Introduction, Cohesion, Reference Resolution, Discourse Coherence and Structure

UNIT-IV (10 Hrs)	**Natural Language Generation:** Introduction, Architectures of NLG Systems, Generation task and Representations, Applications of NLG, **Machine Translation:** Introduction, Problems in Machine Translation, Characteristics of Indian Languages, Machine Translation Approaches, Direct Machine Translation, Rule-based Machine Translation, Corpus-based Machine Translation, Semantic or Knowledge-based MT Systems, Translation involving Indian Languages.
UNIT-V (10 Hrs)	**NLP Applications:** Introduction, Information Extraction, Automatic Text Summarization, Question-Answering System, Lexical Resources: Porter Stemmer, Lemmatizer,Penn Treebank, Word Net, Frame Net, Stemmers, Part-of-Speech Tagger, PropBank, Brown Corpus, British National Corpus (BNC).
Textbooks:	
1.	Tanveer Siddiqui, U.S. Tiwary, ―Natural Language Processing and Information Retrieval, Oxford University Press, 2008
2.	Daniel Jurafsky, James H. Martin―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
Reference Books:	
1.	Natural Language Processing with Python, First Edition, Steven Bird, Ewan Klein and Edward Loper, OReilly Media,2009.
2.	Language Processing with Java and Ling Pipe Cookbook, 1st Edition, Breck Baldwin, Atlantic Publisher, 2015.
3.	Natural Language Processing with Java, 2nd Edition, Richard M Reese, OReilly Media,2015.
e-Resources	
1.	https://medium.com/nlplanet/awesome-nlp-18-high-quality-resources-for-studying-nlp-1b4f7fd87322

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3104	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

AUTOMATA THEORY AND COMPILER DESIGN

(For AI & ML)

Course Objectives: This course aims to equip students with the following**:**

1.	To learn design of Automatas as Acceptors
2.	To learn fundamentals of Regular and Context Free Grammars and Languages
3.	To study the various phases in the design of a compiler
4.	To study the design of top-down, bottom-up parsers
5	To learn to develop algorithms for code optimization and machine code for a target machine.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Model** DFA, NFA, NFA with Є-Transitions and output generating machines, regular expressions	K3
2.	**Demonstrate** grammars and CFG, derive strings	K3
3.	**Demonstrate** different phases of compilation process	K3
4.	**Demonstrate** LR parsers for CFG and summarize Syntax directed translation schemes, intermediated code	K3
5.	**Apply** different code optimization and code generation techniques	K3

SYLLABUS

UNIT-I (10Hrs)	**Finite Automata and Regular expressions:** Introduction to DFA and NFA, Acceptance of a Strings by DFA, Acceptance of a Strings by NFA, Design of DFAs, Design of NFAs, Conversion of NFA to DFA (Theorem and problems) Introduction to NFA with Є-Transitions, Conversion of NFA with Є-Transitions to DFA, Minimization of DFA algorithm and state minimization of DFA problems, Design of Mealy and Moore machines, Applications and Limitations of Finite Automata. Introduction to Regular Expressions, Regular Sets, Identity Rules, Conversion of Regular Expression to NFA with Є-Transitions, Applications of Regular Expressions.
UNIT-II (10 Hrs)	**Grammars and Formal languages:** Chomsky Hierarchy, Regular Grammar, Left-Linear Grammar, Right-Linear Grammar, Conversion of Finite Automata to Regular Grammars and Regular Grammars to Finite Automata, Context Free Grammar, Construction of CFGs for Languages, Determining language of the grammar. Leftmost and Rightmost Derivations, Parse Trees, Ambiguous Grammars, Elimination of left recursion and left factoring, Pumping Lemma of Regular Languages (Statement and problems), Applications of pumping lemma, Closure Properties of regular languages, Pumping Lemma for CFL (Statement and Problems), Page 35 of 49 Applications of pumping lemma for CFL, Closure Properties of CFL, Applications of Context Free Grammars.

UNIT-III (10 Hrs)	**Lexical analysis and Syntax analysis:** Introduction to Language Processing, Structure of a Compiler, Compiler-Construction Tools. Lexical Analysis: The Role of Lexical Analysis, Specification of Tokens, Recognitions of Tokens, The Lexical Analyzer Generator LEX. Syntax Analysis: The Role of a Parser, Top down and Bottom-up Parsing, Shift Reduce Parser. Predictive Parser.
UNIT-IV (10 Hrs)	**Powerful parsers and Intermediate code:** Simple LR Parser, Canonical LR parser and LALR Parser, The Parser Generator YACC. Syntax-Directed Translation: Syntax Directed Definitions Inherited and Synthesized Attributes, Evaluating an SDD at Nodes of Parse Tree. Intermediate Code Generation: Three-Address Code, Quadruples, Triples, DAG, Type Checking (Rules for Type Checking and Type Conversion).
UNIT-V (10 Hrs)	**Code Optimization and Code Generation:** Code Optimization: The Principal Sources of Optimization, Introduction to Basic Blocks and Flow Graphs, Optimization of Basic Blocks, Dead code elimination, constant propagation, Global Data-Flow Analysis. Code Generation: A Simple Code Generator, Code Generation from DAG, Peephole Optimization, Symbol Table and error detection in different phases. Storage Organization, Stack Allocation of Space.
Textbooks:	
1.	Introduction to Automata Theory, Languages and Computation, J. E. Hopcroft, R. Motwani and J. D. Ullman, 3rd Edition, Pearson, 2008
2.	Theory of Computer Science-Automata, Languages and Computation, K. L. P. Mishra and N. Chandra sekharan, 3 rd Edition, PHI, 2007
Reference Books:	
1.	Elements of Theory of Computation, Lewis H.P. & Papadimition C.H., Pearson /PHI, 2nd Edition, 2006
2.	Modern compiler implementation in C, Andrew W Appel, Revised edition, Cambridge University Press, 1998
3.	Compilers: Principles, Techniques and Tools, Second Edition, Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffry D. Ullman, Pearson, Pearson Education India; 2nd edition, 2013
e-Resources	
1.	https://nptel.ac.in/courses/106/104/106104028/
2.	https://nptel.ac.in/courses/106/104/106104123/

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Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23AM3105	PE	3	--	--	3	30	70	3 Hrs.

NOSQL DATABASES

(For AI & ML)

Course Objectives: This course aims to equip students with the following**:**

1.	Define, compare and use the four types of NoSQL Databases (Document-oriented, Key-Value Pairs, Column-oriented and Graph).
2.	Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.
3.	Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** aggregate data models to design suitable NoSQL database solutions for various data scenarios.	K3
2.	**Use** data distribution models to handle replication and consistency in distributed database environments.	K3
3.	**Apply** key-value database features by selecting appropriate use cases for real-world applications.	K3
4.	**Use** document-based and column-family database features for structured and semi-structured data storage.	K3
5.	**Analyze** the structure and application of graph and schema-less databases for modeling complex relationships and unstructured data.	K4

SYLLABUS

UNIT-I (10Hrs)	Why NoSQL, The Value of Relational Databases, Impedance Mismatch, Application and Integration Databases, Aggregate Data Models; Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation, Key-Value and Document Data Models, Column-Family Stores, Summarizing Aggregate-Oriented Databases.
UNIT-II (10Hrs)	Distribution Models: Single Server, Shading, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. Consistency, Update Consistency, Read Consistency, Relaxing Consistency, The CAP Theorem, Relaxing Durability, Quorums.
UNIT-III (10Hrs)	What Is a Key-Value Store, Key-Value Store Features, Suitable Use Cases, Storing Session Information, User Profiles, Preference, Shopping Cart Data, When Not to Use, Relationships among Data, Multi operation Transactions, Query by Data, Operations by Sets

UNIT-IV (10Hrs)	Document Databases, What Is a Document Database, Features, Suitable Use Cases, When Not to Use, what is Column-Family Data Store, Features, Suitable use cases, when not to use
UNIT-V (10Hrs)	Graph Databases, What Is a Graph Database, Features, Suitable Use Cases, Connected Data, Routing, Dispatch and Location-Based Services, Recommendation Engines, When Not to Use**,** Schema changes in RDBMS, Schema changes in a NOSQL Data Store
Textbooks:	
1.	Sadalage, P. & Fowler, No SQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addision Wesley, 2012
Reference Books:	
1.	Dan Sullivan, "NoSQL For Mere Mortals", 1st Edition, Pearson Education India, 2015. (ISBN13: 978-9332557338)
2.	Dan McCreary and Ann Kelly, "Making Sense of NoSQL: A guide for Managers and the Rest of us", 1st Edition, Manning Publication/Dreamtech Press, 2013. (ISBN-13: 978-9351192022)
3.	Kristina Chodorow, "Mongodb: The Definitive Guide- Powerful and Scalable Data Storage", 2nd Edition, O'Reilly Publications, 2013. (ISBN-13: 978-9351102694)
e-Resources	
1.	https://www.coursera.org/learn/introduction-to-nosql-databases

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3106	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

EXPLORATORY DATA ANALYSIS

(For AI & ML)

Course Objectives: This course aims to equip students with the following**:**

1.	Introduce the fundamentals of Exploratory Data Analysis
2.	Cover essential exploratory techniques for understanding multivariate data by visualization
3.	Learning the concepts of Data Transformation methods.
4.	Evaluate the Models and select the best model

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** EDA techniques to clean data, analyze patterns, and draw insights using statistical and visualization tools	K3
2.	**Apply** visualizations and EDA techniques to preprocess, analyze, and interpret personal email data using Python.	K3
3.	**Apply** data transformation techniques to prepare and analyze datasets.	K3
4.	**Analyze** datasets using descriptive statistics techniques such as central tendency, dispersion, correlation, and time series analysis.	K4
5.	**Apply** machine learning workflows to preprocess data, train models, evaluate performance, and deploy models using a case study.	K3

SYLLABUS

UNIT-I (10Hrs)	**Exploratory Data Analysis Fundamentals:** Understanding data science, The significance of EDA, Steps in EDA, Making sense of data, Numerical data, Categorical data, Measurement scales, Comparing EDA with classical and Bayesian analysis, Software tools available for EDA, Getting started with EDA
UNIT-II (10 Hrs)	**Visual Aids for EDA:** Technical requirements, Line chart, Bar charts, Scatter plot using seaborn, Polar chart, Histogram, Choosing the best chart **Case Study:** EDA with Personal Email, Technical requirements, Loading the dataset, Data transformation, Data cleansing, Applying descriptive statistics, Data refactoring, Data analysis.
UNIT-III (10 Hrs)	**Data Transformation**: Merging database-style dataframes, Concatenating along with an axis, Merging on index, Reshaping and pivoting, Transformation techniques, Handling missing data, Mathematical operations with NaN, Filling missing values, Discretization and binning, Outlier detection and filtering, Permutation and random sampling, Benefits of data transformation, Challenges.

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UNIT-IV (10 Hrs)	**Descriptive Statistics**: Distribution function, Measures of central tendency, Measures of dispersion, Types of kurtosis, Calculating percentiles, Quartiles, Grouping Datasets, Correlation, Understanding univariate, bivariate, multivariate analysis, Time Series Analysis
UNIT-V (10 Hrs)	**Model Development and Evaluation:** Unified machine learning workflow, Data pre-processing, Data preparation, Training sets and corpus creation, Model creation and training, Model evaluation, Best model selection and evaluation, Model deployment Case Study: EDA on Wine Quality Data Analysis
Textbooks:	
1.	Suresh Kumar Mukhiya, Usman Ahmed, Hands-On Exploratory Data Analysis with Python, Packt Publishing, 2020.
Reference Books:	
1.	Ronald K. Pearson, Exploratory Data Analysis Using R, CRC Press, 2020
2.	RadhikaDatar, Harish Garg, Hands-On Exploratory Data Analysis with R: Become an expert in exploratory data analysis using R packages, 1st Edition, Packt Publishing, 2019
e-Resources	
1.	https://github.com/PacktPublishing/Hands-on-Exploratory-Data-Analysis-with-Python
2.	https://www.analyticsvidhya.com/blog/2022/07/step-by-step-exploratory-dataanalysis-eda-using-python/#h-conclusion
3.	https://github.com/PacktPublishing/Exploratory-Data-Analysis-with-Python-Cookbook

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3107	PE	3	--	--	3	30	70	3 Hrs.

OBJECT ORIENTED ANALYSIS AND DESIGN

(For AI & ML)

Course Objectives:

1.	Demonstrate all phases of OOAD and basic features of UML
2.	Demonstrate Structural modeling
3.	Use advanced structural modeling for Software applications
4.	Demonstrate behavioral modeling
5.	Apply advanced behavioral modeling to real time systems

Course Outcomes

S.No.	Outcome	Knowledge Level
1.	**Demonstrate** basics of modeling for object oriented analysis and design using UML	K3
2.	**Apply** structural modeling for Software applications	K3
3.	**Apply** advanced structural modeling for Software applications	K3
4.	**Demonstrate** basic behavior of a software system with Use Case, Interaction and Activity Diagrams	K3
5.	**Apply** UML for modeling advanced behavioral aspects and Runtime environment of Software Systems	K3

SYLLABUS

UNIT-I (10Hrs)	Structure of Complex systems, Complexity of Software systems, Software development life cycle, Analysis and design process, Introduction to UML: Importance of modeling, principles of modeling, Object Oriented modeling, conceptual model of the UML, Architecture of UML. Case study: Simple Hello World Application
UNIT-II (10 Hrs)	Basic Structural Modeling: Classes, Relationships, Common Mechanisms and diagrams, Class Diagrams: Terms, concepts and modeling techniques. Case study: Student information system
UNIT-III (10 Hrs)	Advanced Structural Modeling: Advanced classes, advanced relationships, Interfaces, Types and Roles, Packages, instances and Object diagrams. Case study: Human Resource management system
UNIT-IV (10 Hrs)	Basic Behavioral Modeling-I: Interactions, Interaction diagrams, Use cases, Use case Diagrams, Activity Diagrams. Case study: Order Management System

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UNIT-V (10 Hrs)	Advanced Behavioral Modeling: Events and signals, state machines, processes and Threads, time and space, state chart diagrams, Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams. Case study: Web Application: Vacation Tracking System
Textbooks:	
1.	Grady Booch, Robert A. Maksimchuk, Michael W. Engle, Bobbi J. Young, Jim Conallen, Kellia Houston ,"Object- Oriented Analysis and Design with Applications", 3rd edition, 2013, Pearson.
2.	Grady Booch, James Rumbaugh, Ivar Jacobson," The Unified Modeling Language User Guide", 2nd edition, 2005, Addison Wesley.
Reference Books:	
1.	Ali Bahrami, "Object oriented systems development using the unified modeling language", 6th edition, 2019, TMH.
2.	Meilir Page-Jones, "Fundamentals of Object Oriented Design in UML",1st Edition, 1999, Addison-Wesley.
3.	Pascal Roques, "UML in Practice: The Art of Modeling Software Systems Demonstrated through Worked Examples and Solutions", 1st Edition, 2004, Wiley.
4.	Atul Kahate, "Object Oriented Analysis & Design", 2004, McGraw-Hill Education (India) Pvt Limited.
5.	Craig Larman, "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development", 3rd Edition, 2004, PHI.
e-Resources	
1.	OOAD, NPTEL course, " https://onlinecourses.nptel.ac.in/noc22_cs99/preview"
2.	UML standards, "https://www.omg.org/"

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3108	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

INTERNET OF THINGS

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1	Vision and Introduction to Internet of Things (IoT).
2	Understand IoT Market perspective.
3	Data and Knowledge Management and use of Devices in IoT Technology.
4	Understand State of the Art – IoT Architecture
5	Understand storage of IoT data in the cloud.

Course Outcomes: At the end of the course, students will be able to**,**

S.No	Outcome	Knowledge Level
1.	**Illustrate** design principles and application layer protocols in IoT	K2
2.	**Apply** various designs of IoT and IoT architectures	K3
3.	**Demonstrate** the use of various sensors and actuators in IoT applications and develop IoT applications using Arduino	K3
4.	**Analyze** data in IoT applications	K4
5.	**Analyze** Storage and Computing Using a cloud platform.	K4

SYLLABUS

UNIT-I (10 Hrs)	The Internet of Things: An Overview of Internet of things, Internet of Things Technology, behind IoTs Sources of the IoTs, M2M Communication, Examples of IoTs, Design Principles For Connected Devices Internet Connectivity Principles, Internet connectivity, Application Layer Protocols: HTTP, HTTPS, FTP, Telnet.
UNIT-II (10 Hrs)	IoT Network Architecture and Design: Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture. IoT/M2M systems LAYERS AND designs standardizations, Modified OSI Stack for the IoT/M2M Systems, ETSI M2M domains and High- level capabilities, Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability.
UNIT-III (10 Hrs)	Design Principles for the Web Connectivity for connected-Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity protocols for connected-Devices.

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UNIT-IV (10 Hrs)	Data Acquiring, Organizing and Analytics in IoT/M2M, Applications /Services /Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet Of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.
UNIT-V (10 Hrs)	Data Collection, Storage and Computing Using cloud platform Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits and other platforms Sensor, Participatory Sensing, Actuator, Radio Frequency Identification, and Wireless, Sensor Network Technology, Sensors Technology, Sensing the World.
Textbooks:	
1.	Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education
2.	Internet of Things, A.Bahgya and V.Madisetti, Univesity Press, 2015
Reference Books:	
1.	Designing the Internet of Things, Adrian McEwen and Hakim Cassimally,Wiley
2.	Getting Started with the Internet of Things, Cuno Pfister , Oreilly
e-Resources	
1.	https://nptel.ac.in/courses/106105166
2.	https://www.coursera.org/specializations/iot

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Code	Category	L	T	P	C	I.M	E.M	Exam
B23AM3110	**PC**	**--**	**--**	**3**	**1.5**	**30**	**70**	**3 Hrs.**

DEEP LEARNING LAB

(For AI & ML)

Pre-requisites: Machine Learning, Machine Learning Lab

Software Packages Required:

- Keras
- Tensorflow
- PyTorch

Course Objectives: This course aims to equip students with the following:

1	To implement different deep learning models in Python
2	To work with different deep learning frameworks like Keras, Tensor flow, PyTorch etc.

Course Out Comes: At the end of the course, students will be able to

S. No.	OUTCOME	Knowledge Level
1	**Apply** MLP for classification and regression problems.	K3
2	**Analyze** the impact of feature engineering techniques like one-hot encoding, word embeddings, and data augmentation on model performance	K4
3	**Use** Convolutional Neural Network for classification and object detection	K3
4	**Apply** Recurrent neural network and Autoencoder architectures for real-world applications such as sentiment analysis, language translation and data denoising	K3

SYLLABUS

Experiment 1	Implement multilayer perceptron algorithm for MNIST Hand written Digit Classification.
Experiment 2	Implement one hot encoding of words or characters.
Experiment 3	Apply data augmentation techniques on images.
Experiment 4	Implement word embeddings for IMDB dataset.
Experiment 5	Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
Experiment 6	Design a neural Network for classifying news wires (Multi class classification) using Reutersdataset.
Experiment 7	Design a neural network for predicting house prices using Boston Housing Price dataset.
Experiment 8	Build a Convolution Neural Network for MNIST Hand written Digit Classification.
Experiment 9	Build a Convolution Neural Network for simple image (dogs and Cats) Classification. Study the effect of batch normalization and dropout on the performance of CNN.
Experiment 10	Use a pre-trained convolution neural network (VGG16) for image classification

Experiment 11	Implement a Recurrent Neural Network for IMDB movie review classification problem.
Experiment 12	Implement Denoising Autoencoder on MNIST handwritten digits dataset
Additional Programs (For Practice only)	
Experiment 1	Implement a deep learning model for object detection
Experiment 2	Implement LSTM for language translation
REFERENCE BOOKS:	
1.	RezaZadeh and Bharath Ramsundar, “Tensorflow for DeepLearning”, O’Reilly publishers, 2018
2.	Chris Albon, “Machine Learning with Python Cookbook-practical solutions from preprocessing to Deep learning”, O’REILLY Publisher,2018
3.	Sebastian Raschka & Vahid Mirjalili, “Python Machine Learning”, Packt Publisher, 2017
4.	Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.
5.	Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
6.	Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018.
7.	Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018.
Useful Reference Links:	
1.	https://github.com/fchollet/deep-learning-with-python-notebooks

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3111	**PC**	**--**	**--**	**3**	**1.5**	**30**	**70**	**3 Hrs.**

NATURAL LANGUAGE PROCESSING LAB

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1	Students will gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information.
2	Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1	**Use** the NLTK and spaCy toolkit for NLP Programming.	K3
2	**Apply** various pre-processing techniques for a given corpus.	K3
3	**Implement** NLP models to solve for a given corpus.	K3

SYLLABUS

1	**Exercise – 1** **Demonstrate the following preprocessing of text in NLP using NLTK,SPACY libraries** (i)Installation and exploring features of NLTK and spaCy tools. Download Word Cloud and few corpora. (ii) To implement word Tokenizer, Sentence and Paragraph Tokenizers. (iii) Check how many words are there in any corpus. Also ch eck how many distinct words are there?
2	**Exercise – 2** **Demonstrate both user-defined and pre-defined functions to generate** (i)(a) Uni-grams (b) Bi-grams (c) Tri-grams (d) N-grams (ii) To calculate the highest probability of a word (w2) occurring after another word (w1).
3	**Exercise – 3** **Demonstrate Regular expressions** (i) To identify the mathematical expression in a given sentence. (ii) To identify different components of an email address.
4	**Exercise – 4** **Demonstrate Word level analysis** (i) To identify all antonyms and synonyms of a word. (ii) To find hyponymy, homonymy, polysemy for a given word. (iii) To find all the mis-spelled words in a paragraph

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5	**Exercise – 5** **Investigate the Minimum Edit Distance (MED) algorithm.** a)Test the algorithm on strings with different type of variations (e.g., substitutions, insertions, deletions)
6	**Exercise – 6** **Demonstrate concept of Stop words** (i)To find all the stop words in any given text. (ii) Function that finds the 50 most frequently occurring words of a text that are not stopwords.
7	**Exercise – 7** **Implement different Stemming Methods** To implement various stemming techniques and prepare a chart with the performance of each method.
8	**Exercise – 8** **Implement different Lemmatization Methods** To implement various lemmatization techniques and prepare a chart with the performance of each method.
9	**Exercise – 9** **Demonstrate the Parts Of Speech Tagging** (i) To implement Part-of-Speech (PoS) tagging for any corpus. (ii) To identify which word has the greatest number of distinct tags? What are they, and what do they represent? (iii) To list tags in order of decreasing frequency and what do the 20 most frequent tags represent? (iv) To identify which tags are nouns most commonly found after? What do these tags represent?
10	**Exercise – 10** **Implement the Text Representation Techniques** a) One-hot encoding b) Bag-of-Words c) TF-IDF d)Word2Vec
11	**Exercise – 11** Case Study-1. To implement Named Entity Recognition (NER) for any corpus.
12	**Exercise – 12** Case Study-2. Check for all positive words in a news article/ any text.
Reference Books:	
1	Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python–Analyzing Text with the Natural Language"

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3112	SEC	-	1	2	2	30	70	3 Hrs.

FULL STACK DEVELOPMENT – 2

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1	Make use of router, template engine, and authentication using sessions to develop applications in ExpressJS.
2	Build a single-page application using RESTful APIs in ExpressJS.
3	Apply routers and hooks in designing ReactJS applications.
4	Make use of MongoDB queries to perform CRUD operations on document databases.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1	**Organize** responsive web interfaces using ReactJS..	K4
2	**Create** web applications using MongoDB for document-based storage.	K6
3	**Analyze** RESTful web services using ExpressJS and middleware techniques.	K4

SYLLABUS

1	**Node.js** a. Write a program to show the workflow of JavaScript code executable by creating a web server in Node.js. b. Write a program to transfer data over http protocol using http module. c. Create a text file src.txt and add the following content to it. (HTML, CSS, Javascript, Typescript, MongoDB, Express.js, React.js, Node.js) d. Write a program to parse an URL using URL module. e. Write a program to create a user-defined module and show the workflow of Modularization of application using Node.js

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2	**Typescript** a. Write a program to understand simple and special types. b. Write a program to understand function parameter and return types. c. Write a program to show the importance with Arrow function. Use optional, default and REST parameters. d. Write a program to understand the working of Typescript with class, constructor, properties, methods and access specifiers. e. Write a program to understand the working of namespaces and modules. f. Write a program to understand generics with variables, functions and constraints.
3	**Augmented Programs:** (Any 2 must be completed) a. Write a CSS program, to apply 2D and 3D transformations in a web page. b. Design a web page with new features of HTML5 and CSS3. c. Design a to-do list application using JavaScript.
4.	**ExpressJS – Routing, HTTP Methods, Middleware.** a. Write a program to define a route, Handling Routes, Route Parameters, Query Parameters and URL building. b. Write a program to accept data, retrieve data and delete a specified resource using http methods. c. Write a program to show the working of middleware.
5	**ExpressJS – Templating, Form Data** a. Write a program using templating engine. b. Write a program to work with form data.
6	**ExpressJS – Cookies, Sessions, Authentication** Write a program for session management using cookies and sessions. Write a program for user authentication.
7	**ExpressJS – Database, RESTful APIs** a. Write a program to connect MongoDB database using Mongoose and perform CRUD operations. b. Write a program to develop a single page application using RESTful APIs.
8	**ReactJS – Render HTML, JSX, Components – function & Class** a. Write a program to render HTML to a web page. b. Write a program for writing markup with JSX. c. Write a program for creating and nesting components (function and class).

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9	**ReactJS – Props and States, Styles, Respond to Events** a. Write a program to work with props and states. b. Write a program to add styles (CSS & Sass Styling) and display data. c. Write a program for responding to events.
10	**ReactJS – Conditional Rendering, Rendering Lists, React Forms** a. Write a program for conditional rendering. b. Write a program for rendering lists. c. Write a program for working with different form fields using react forms.
11	**ReactJS – React Router, Updating the Screen** a. Write a program for routing to different pages using react router. b. Write a program for updating the screen.
12	**ReactJS – Hooks, Sharing data between Components** a. Write a program to understand the importance of using hooks. b. Write a program for sharing data between components.
13	**ReactJS Applications – To-do list and Quiz** Design a to-do list application.
14	**MongoDB – Installation, Configuration, CRUD operations** a. Install MongoDB and configure ATLAS b. Write MongoDB queries to perform CRUD operations on document using insert(), find(), update(), remove()
15	**MongoDB – Databases, Collections and Records** a. Write MongoDB queries to Create and drop databases and collections. b. Write MongoDB queries to work with records using find(), limit(), sort(), createIndex(), aggregate().
16	**Augmented Programs: (Any 2 must be completed)** a. Design a to-do list application using NodeJS and ExpressJS. b. Design a Quiz app using ReactJS. c. Complete the MongoDB certification from MongoDB University website.
Reference Books:	
1.	Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, 2nd edition, APress, O'Reilly.
2.	Node.Js in Action, Mike Cantelon, Mark Harter, T.J. Holowaychuk, Nathan Rajlich,Manning Publications. (Chapters 1-11)
3.	React Quickly, AzatMardan,Manning Publications(Chapters 1-8,12-14)

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Web Links:	
1.	ExpressJS - https://www.tutorialspoint.com/expressjs
2.	ReactJS - https://www.w3schools.com/REACT (and) https://react.dev/learn#
3.	MongoDB - https://learn.mongodb.com/learning-paths/introduction-to-mongodb

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3113	**ES**	**--**	**--**	**2**	**1**	**30**	**70**	**3 Hrs.**

TINKERING LAB (USER INTERFACE DESIGN USING FLUTTER)

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	To understand and apply the fundamentals of Dart programming and Flutter framework setup.
2.	To explore and implement core Flutter widgets, layouts, and responsive UI design techniques.
3.	To develop interactive mobile applications using navigation, state management, and custom widgets.
4.	To integrate animations, form handling, REST API communication, and testing in Flutter applications.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Explain** the basics of Dart language and Flutter tools to design apps that work on multiple platforms with organized screens and visual elements.	K2
2.	**Use** Flutter features like buttons, layouts, page switching, and data handling to build user-friendly and dynamic interfaces.	K3
3.	**Build** real-time apps by connecting to web services, managing forms, adding motion effects and personalized elements, and checking and fixing issues in Flutter apps.	K6

SYLLABUS

1.	**Week 1: Setup and Dart Basics** **a)** Install Flutter SDK and Dart environment. **b)** Write simple Dart programs to understand variables, control structures, and functions.
2.	**Week 2: Exploring Flutter Widgets** **a)** Explore basic Flutter widgets like *Text, Image, Container, Icon*, etc. **b)** Create simple UI layouts using *Row, Column*, and *Stack.*
3.	**Week 3: Layouts and UI Design** **a)** Implement advanced layout strategies with *Expanded, Flexible*, and nested widgets. **b)** Design a clean UI screen using composition and layout principles.
4.	**Week 4: Responsive Design** **a)** Create responsive UI that adapts to screen sizes using *MediaQuery* and *LayoutBuilder*. **b)** Implement breakpoints and scalable layouts for tablets and phones.
5.	**Week 5: Navigation and Routing** **a)** Set up navigation between multiple screens using *Navigator* and *Navigator.push.* **b)** Use named routes and pass data between screens.
6.	**Week 6: State Management & Theming**

	a) Compare and implement *StatelessWidget* and *StatefulWidget*. **b)** Use *Provider* for simple state management. **c)** Apply app-wide theming with *ThemeData* and custom styles.
7.	**Week 7: Forms and API Integration** **a)** Design a form with input fields (TextField, Dropdown, Switch). **b)** Validate input and handle errors. **c)** Fetch and display data from a REST API.
8.	**Week 8: Animations and Testing** **a)** Add basic animations using *AnimatedContainer*, *AnimatedOpacity*, etc. **b)** Write unit tests for widgets and use Flutter DevTools for debugging.
9.	**Week 9: Mini Project** **Objective:** Build a fully functional Flutter app that includes: • Multiple screens with navigation • State management using Provider • REST API integration (e.g., Weather, News, or User Data) • Form with validation • Basic animation and theming **Examples:** To-do app, Weather app, Movie list app, Student form with database.

Textbooks:	
1.	*Beginning Flutter: A Hands-On Guide to App Development* – Marco L. Napoli, Wiley, 2020.
2.	*Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter and Dart 2* – Alessandro Biessek, Packt Publishing, 2020.
Reference Books:	
1.	*Flutter Recipes: Mobile Development Solutions for iOS and Android* – Fu Cheng, Apress, 2019.
2.	*Flutter in Action* – Eric Windmill, Manning Publications, 2020.
3.	*Flutter & Dart Cookbook: Developing Full-Stack Applications for the Cloud* – Richard Rose, O'Reilly Media, 2021.
e-Resources	
1.	https://www.udemy.com/course/flutter-bootcamp-with-dart/?couponCode=LEARNNOWPLANS
2.	https://www.coursera.org/learn/flutter-and-dart-developing-ios-android-mobile-apps

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23MC3101	MC	2	--	--		30		

EMPLOYABILITY SKILLS

(For AIML, CSBS, CSE, IT and MECH)

Course Objectives:

1.	To introduce concepts required in framing grammatically correct sentences and identifying errors while using standard English.
2.	To acquaint the learner of making a coherent and cohesive sentences and paragraphs for composing a written discourse.
3.	To inculcate logical thinking in order to frame and use data as per the requirement.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	Match various vocabulary items that appear in competitive examinations with their contextual meanings accurately.	K1
2.	Identify grammatical and ungrammatical usage of English language in all the grammar related questions asked in various competitive examinations like CAT, GRE, IBPS.	K3
3.	Infer meaning from complex texts that are set as questions in different competitive examinations held for higher education or employment	K2
4.	Find solutions to complex arithmetic problems set as questions in the competitive examinations held for employment or higher education	K1
5.	Apply logical thinking abilities in solving the problems of reasoning that appear in the examinations like CAT, GRE, GATE, IBPS.	K3

SYLLABUS

UNIT-I (10Hrs)	Synonyms, Antonyms, Frequently Confused Words, Foreign Phrases, Idioms and Phrasal Verbs, Collocations. Spotting Errors, Sentence Improvement
UNIT-II (10 Hrs)	Time and work, Pipes and Cisterns. Time and Distance Problems, Problems on boats and streams. Percentages, Profit and loss, Simple interest and Compound interest. Discount Problems.
UNIT-III (10 Hrs)	Analogies, Odd One Out. (Verbal ability) Number Series, Letter Series, Analogy, Alpha Numeric Series, Order and Ranking, Directions, Data sufficiency, Syllogisms.

UNIT-IV (10 Hrs)	Sentence Completion, Sentence Equivalence, Close Test Reading Comprehension , Para Jumbles
UNIT-V (10 Hrs)	Number System: Divisibility tests, finding remainders in various cases, Problems related to numbers, Methods to find LCM, Methods to find HCF.
Textbooks:	
1.	*How to Prepare for Verbal Ability and Reading Comprehension for CAT* (10th edition) by Arun Sharma and Meenakshi Upadhyay, McGraw Hill Education, 2022.
2.	*How to Prepare for Quantitative Aptitude for CAT (10th edition) by* by Arun Sharma , McGraw Hill Education, 2022.
Reference Books:	
1.	*English Collocation in Use*- Intermediate (2nd edition) by Michael McCarthy& Felicity O'Dell, CUP, 2017.
2.	*Magical Book On Quicker Maths* (5th Edition) By M.Tyra, BSC Publishing Co Pvt. Ltd, 2018.
e-Resources	
1.	www.Indiabix.com
2.	www.800score.com

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Regulation: R23	**III / IV - B.Tech. II – Semester**

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

COURSE STRUCTURE
(With effect from 2023-24 admitted Batch onwards)

Course Code	Course Name	Category	L	T	P	Cr	C.I.E.	S.E.E.	Total Marks
B23AM3201	Reinforcement Learning	PC	3	0	0	3	30	70	100
B23AM3202	Big Data Analytics	PC	3	0	0	3	30	70	100
B23AM3203	Data Visualization	PC	3	0	0	3	30	70	100
#PE-II	Professional Elective-II	PE	3	0	0	3	30	70	100
#PE-III	Professional Elective-III	PE	3	0	0	3	30	70	100
#OE-II	Open Elective – II	OE	3	0	0	3	30	70	100
B23AM3214	Big Data Analytics Lab	PC	0	0	3	1.5	30	70	100
B23AM3215	Data Visualization Lab	PC	0	0	3	1.5	30	70	100
B23BS3201	Soft skills	SEC	0	1	2	2	30	70	100
B23AC3201	Technical Paper Writing & IPR	AC	2	--	--	--	30	--	30
		TOTAL	**20**	**1**	**8**	**23**	**300**	**630**	**930**

	Course Code	Course
#PE-II	B23AM3204	Cryptography & Network Security
	B23AM3205	Software Engineering
	B23AM3206	Social Network Analysis
	B23AM3207	Soft Computing
	B23AM3208	MOOCS-II
#PE-III	B23AM3209	Computer Vision
	B23AM3210	Operating Systems
	B23AM3211	Robotic Process Automation
	B23AM3212	Recommender Systems
	B23AM3213	MOOCS-III
#OE-II	Student has to study one Open Elective offered by CE or ECE or EEE or ME or S&H from the list enclosed.	
*Mandatory Industry Internship /Mini Project of 08 weeks duration during summer vacation		

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23AM3201	**PC**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

REINFORCEMENT LEARNING		
(For AI & ML)		
Course Objectives: This course aims to equip students with the following**:**		
1.	Enumerate the elements of Reinforcement Learning	
2	Solve then-armed Bandit problem	
3	Compare different Finite Markov Decision Process	
Course Outcomes: At the end of the course, students will be able to		
S.No	**Outcome**	**Knowledge Level**
1.	**Explain** key components of Reinforcement Learning and their roles in agent-environment interaction.	K2
2.	**Solve** the n-Armed Bandit problem using strategies that balance exploration and exploitation.	K3
3.	**Demonstrate** types of Finite Markov Decision Processes and analyze their role in decision-making.	K3
4.	**Apply** Monte Carlo methods to solve real-world, model-free reinforcement learning problems	K3
5.	**Apply** Monte Carlo methods for solving reinforcement learning problems in real-world, model-free environments	K3
SYLLABUS		
UNIT-I (10Hrs)	**The Reinforcement Learning Problem:** Reinforcement Learning, Examples, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example: Tic-Tac-Toe, Summary, History of Reinforcement Learning.	
UNIT-II (10 Hrs)	**Multi-arm Bandits:** An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandits, Associative Search (Contextual Bandits)	
UNIT-III (10 Hrs)	**Finite Markov Decision Processes**: The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation. **Dynamic Programming:** Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration	
UNIT-IV (10 Hrs)	**Monte Carlo Methods:** Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off- policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Returns	

UNIT-V (8 Hrs)	**Policy Gradient Methods:** Policy Approximation and its Advantages, The Policy Gradient Theorem. REINFOECE: Monte Carlo Policy Gradient. **Applications and Case Studies:** TD-Gammon, Samuel's Checkers Player, The Acrobot, Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling.
Textbooks:	
1.	R. S. Sutton and A. G. Bart,. "Reinforcement Learning - An Introduction," Second Edition, MIT Press, 2020.
2	Marco Wiering and Martijn Van Otterlo, "Reinforcement Learning: State-of-the-Art," Adaptation, Learning, and Optimization, Vol. 12, Springer, 2012.
Reference Books:	
1.	Szepesvári, Csaba, "Algorithms for Reinforcement Learning," United States: Morgan & Claypool, 2010.
2.	Puterman, Martin L., "Markov Decision Processes: Discrete Stochastic Dynamic Programming," Germany: Wiley, 2014.
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc20_cs74/preview
2.	https://www.coursera.org/learn/fundamentals-of-reinforcement-learning

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3202	PC	3	--	--	3	30	70	3 Hrs.

BIG DATA ANALYTICS

(For AI & ML)

Course Objectives: This course aims to equip students with the following**:**

1	To provide an overview of an exciting growing field of big data analytics.
2	To introduce the tools required to manage and analyze big data like Hadoop, Map Reduce, Pig, HIVE, Spark.
3	To optimize business decisions and create competitive advantage with Big Data analytics

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Illustrate** the characteristics and applications of Big Data in various industries	K2
2	**Apply** NoSQL concepts and work with Cassandra for data management	K3
3.	**Use** Hadoop components like HDFS, MapReduce, and Hive for data processing.	K3
4.	**Analyze** the performance of Hadoop and Spark frameworks.	K4
5.	**Use** Spark streaming and tuning techniques for real-time data analysis.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to Big Data:** Introduction to Big Data, Characteristics of Big Data, Types of Data, Applications of Big data, Importance of Big Data, Concept of Serialization, Wrapper Classes**.** **Distributed File System**: Scaling Out, Google File System (GFS)
UNIT-II (10 Hrs)	**Working with Big Data:** Hadoop Echo Systems, Hadoop Distributed File System (HDFS) Building blocks of Hadoop. Introducing and Configuring Hadoop cluster (Local, Pseudo-distributed mode, Fully Distributed mode), Configuring XML files. Scaling Out, Java interfaces to HDFS Basics, HDFS Read & Write
UNIT-III (10 Hrs)	**Writing Map Reduce Programs:** A Weather Dataset, Filtering Streams using Bloom filters, Understanding Hadoop API for Map Reduce Framework (Old and New), Hadoop Streaming, Basic programs of Hadoop Map Reduce Types and Formats, Anatomy of a Map Reduce Job run, Failures, Map Reduce: Driver code, Mapper code, Reducer code, Record Reader, Combiner, Partitioner.
UNIT-IV (10 Hrs)	**Spark:** Hadoop vs Spark, Introduction to Spark Concept , Spark Architecture and components , Spark installation , Spark RDD(Resilient Distributed Dataset) – Spark RDD operations. Cluster Deployments, Cluster Managers- Standalone Mode, Spark on YARN, Spark Logs, Streaming live data with spark

UNIT-V (10 Hrs)	**Pig:** Hadoop Programming Made EasierAdmiring the Pig Architecture, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Evaluating Local and Distributed Modes of Running Pig Scripts. **Applying Structure to Hadoop Data with Hive:** Hive architecture, Hive QL, Working with Hive Data Types, Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works, Querying and Analyzing data. Fundamentals and components of HBase and Zookeeper
Textbooks:	
1.	Big Data, Big Analytics: Emerging, Michael Minnelli, Michelle Chambers, and AmbigaDhiraj, 1st edition ,2013
2.	SPARK: The Definitive Guide, Bill Chambers &MateiZaharia, O'Reilley, 2018-first Edition.
Reference Books:	
1.	Wiley & Big Java 4th Edition, Cay Horstmann, Wiley John Sons, INC
2.	Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012
e-Resources	
1.	https://www.shiksha.com/online-courses/articles/best-online-resources-to-learn-big-data/

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3203	PC	3	--	--	3	30	70	3 Hrs.

DATA VISUALIZATION

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	Familiarize students with the basic and advanced techniques of information visualization and scientific visualization.
2.	Learn key techniques of the visualization process and implement.
3.	Detailed view of visual perception, the visualized data and the actual visualization, interaction and distorting techniques.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Illustrate** the key stages of the visualization process from data acquisition to visual representation.	K2
2.	**Apply** visual mapping techniques to develop effective visualization applications.	K3
3.	**Apply** suitable visualization and interaction techniques to develop and enhance visualization systems.	K3
4.	**Apply** suitable visualization techniques to effectively represent the complex data structures including the use of metaphorical visualization.	K3
5.	**Demonstrate** the ability to visualize complex data types using appropriate techniques and data structures	K3

SYLLABUS

UNIT-I (10Hrs)	What Is Visualization?, History of Visualization, Relationship between Visualization and Other Fields, The Visualization Process, Introduction of visual perception, visual representation of data, Gestalt principles, information overloads.
UNIT-II (10 Hrs)	Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.
UNIT-III (10 Hrs)	Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents.
UNIT-IV (10 Hrs)	Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization.

UNIT-V (10 Hrs)	Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, Evaluating visualizations. **Recent trends** in various perception techniques, various visualization techniques, data structures used in data visualization.
Textbooks:	
1.	Interactive Data Visualization: Foundations, Techniques, and Applications. WARD, GRINSTEIN, KEIM. Natick : A K Peters, Ltd.(2015)
2.	Information Visualization: Perception for Design by Colin Ware, Interactive Technologies(2004)
Reference Books:	
1.	The Visual Display of Quantitative Information E. Tufte, Graphics Press.(2001)
2.	Visualizing Data-Ben Fry 'Reilly Media (2008)
e-Resources	
1.	**https://kdd.cs.ksu.edu/Courses/CIS536/Lectures/Slides/Lecture-34-Main_6up.pdf**
2.	https://www.slideteam.net/powerpoint/Data-Visualization
3.	https://www.slideshare.net/slideshow/unit-iiipptx/265063170

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3204	PE	3	--	--	3	30	70	3 Hrs.

CRYPTOGRAPHY AND NETWORK SECURITY

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	Describe the Mathematics of Cryptography
2.	Summarizing the fundamental ideas of Symmetric and Asymmetric Cryptographic Algorithms
3.	Discusses the Network layer, Transport Layer and Application Layer Protocols Enhanced security mechanisms

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Apply** security services and mechanisms to develop secure communication models.	K3
2.	**Apply** algebraic and number-theoretic techniques to cryptographic problems.	K3
3.	Apply different encryption and decryption techniques to solve problems related to confidentiality.	K3
4.	**Apply** cryptographic hash functions and the message digest algorithms to verify integrity and authentication.	K3
5.	**Apply** transport-level and network-level security protocols for Secure Communication.	K3

SYLLABUS

UNIT-I (10Hrs)	**Security Concepts:** Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security Cryptography. Classical Encryption Techniques-symmetric cipher model, Substitution techniques, Transposition techniques, Rotor Machines, Steganography.
UNIT-II (10 Hrs)	**Introduction to Symmetric Cryptography:** Algebraic Structures-Groups, Rings, Fields, GF(2^n) fields, Polynomials. **Mathematics of Asymmetric cryptography**: Primes, checking for Primness, Euler's phi-functions, Fermat's Little Theorem, Euler's Theorem, Generating Primes, Primality Testing, Factorization, Chinese Remainder Theorem, Quadratic Congruence, Exponentiation and Logarithm.
UNIT-III (10 Hrs)	**Symmetric key Ciphers**: Block Cipher principles, DES, AES, Blowfish, IDEA, Block cipher operation. Stream ciphers: RC4, RC5 **Asymmetric key Ciphers**: Principles of public key cryptosystems, RSA algorithm, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography.

UNIT-IV (10 Hrs)	**Cryptographic Hash Functions:** Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithms (SHA). **Message Authentication Codes:** Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, HMAC, CMAC. **Digital Signatures:** Digital Signatures, Elliptic Curve Digital Signature Algorithm, RSA-PSS Digital Signature Algorithm.
UNIT-V (10 Hrs)	**Network and Internet Security:** **Transport-Level Security:** SSL, Transport Level Security, HTTPS. **IP Security:** IP Security Overview, IP Security Policy, Encapsulating Security Payload, Authentication Header Protocol. **Electronic-Mail Security:** Internet-mail Security, Email Format, Email Threats and Comprehensive Email Security, S/MIME, PGP.
Textbooks:	
1.	Cryptography and Network Security - Principles and Practice: William Stallings, Pearson Education, 7th Edition, 2017
2.	Cryptography and Network Security: Behrouz A. Forouzan Debdeep, Mc Graw Hill, 3rd Edition, 2015
Reference Books:	
1.	Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition
2.	Introduction to Cryptography with Coding Theory: Wade Trappe, Lawrence C. Washington, Pearson.
3.	Modern Cryptography: Theory and Practice By Wenbo Mao. Pearson.
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc22_cs90/preview
2.	http://williamstallings.com/Cryptography.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3205	PE	3	--	--	3	30	70	3 Hrs.

SOFTWARE ENGINEERING

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	Software life cycle models, Software requirements and SRS document.
2.	Project Planning, quality control and ensuring good quality software.
3.	Software Testing strategies, use of CASE tools, Implementation issues, validation & verification procedures.

Course Outcomes: At the end of the course, Students will be able to**,**

S. No.	Outcome	Knowledge Level
1.	**Determine** the appropriate software life cycle model for a specific application or problem	K3
2.	**Use** UML modelling for analyzing and specifying the proposed system for a given application/problem	K3
3.	**Apply** software designing principles for designing the proposed system	K3
4.	**Demonstrate** approaches for ensuring software reliability, quality management and testing	K3
5.	**Apply** project management techniques to assess and monitor project progress effectively	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction:** Evolution, Software development projects, Exploratory style of software developments, Emergence of software engineering, Notable changes in software development practices, Computer system engineering. **Software Life Cycle Models**: Basic concepts, Waterfall model and its extensions, Rapid application development, Spiral model. **Agility:** Agility and the Cost of Change, Agile Process, Extreme Programming (XP), Other Agile Process Models.
UNIT-II (10 Hrs)	**Requirements Analysis And Specification:** Requirements gathering and analysis, Software Requirements Specification (SRS), Formal system specification. **Object Modelling using UML**: Basic Object-Orientation Concepts, Unified Modelling Language, UML Diagrams, Use Case Model, Class Diagrams, Interaction Diagrams, Activity Diagrams and State Chart Diagram.

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UNIT-III (10 Hrs)	**Software Design:** Overview of the design process, How to characterize a good software design? Layered arrangement of modules, Cohesion and Coupling. Approaches to Software design. **Function-Oriented Software Design:** Overview of SA/SD methodology, Structured analysis, Developing the DFD model of a system, Structured design**.** **User Interface Design:** Characteristics of a good user interface, Basic concepts, user interface design methodology**.**
UNIT-IV (10 Hrs)	**Coding And Testing:** Coding, Code review, Software documentation, Testing, Black-box testing, White-Box testing, Debugging, Program analysis tools, Integration testing, Testing object-oriented programs, System testing. **Software Reliability And Quality Management:** Software reliability, Statistical testing, Software quality, Software quality management system, SEI Capability maturity model, and Six Sigma.
UNIT-V (10 Hrs)	**Software Project Management:** Metrics for project size estimation, Project estimation techniques, Empirical Estimation techniques, COCOMO, Configuration Management **Software Maintenance:** Characteristics of software maintenance, Software reverse engineering, and Software maintenance process models and Estimation of maintenance cost.

Textbooks:	
1.	Fundamentals of Software Engineering, Rajib Mall, 5th Edition, PHI.
2.	Software Engineering A practitioner's Approach, Roger S. Pressman, 9th Edition, Mc-Graw Hill International Edition.
Reference Books:	
1.	Software Engineering, Ian Sommerville, 10th Edition, Pearson.
2.	Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.
e-Resources	
1.	https://nptel.ac.in/courses/106/105/106105182/
2.	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01260589506387148827_sh
3	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01338269041100390473 5_s

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3206	PE	3	--	--	3	30	70	3 Hrs.

SOCIAL NETWORK ANALYSIS

(For AI & ML)

Course Objectives: This course aims to equip students with the following

1.	Introduce the concepts of the Semantic Web and Social Web, highlighting the limitations of the current Web and the need for semantic technologies.
2.	Explain the principles of Social Network Analysis, including key measures, modelling techniques, and community detection methods.
3.	Develop the ability to represent, aggregate, and reason with social network data using ontology-based knowledge representation and Semantic Web standards.
4	Explore real-world applications of social network analysis, including behaviour prediction, trust management, and network visualization techniques.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	**Demonstrate** the evolution and development of the Semantic Web, including research trends, standardization, and technology adoption.	K2
2.	**Illustrate** how social individuals and relationships can be represented using ontological models.	K2
3.	**Apply** community detection algorithms and explain the characterization of Dynamic Social Network Communities.	K3
4.	**Illustrate** how technologies like reality mining and context-awareness can enhance user experiences.	K2
5.	**Apply** node-edge diagrams and matrix representations for visualizing and exploring social network structures.	K3

SYLLABUS

UNIT-I (10Hrs)	**INTRODUCTION** **Introduction to Semantic Web** - Limitations of current Web: What's wrong with the Web, Diagnosis for lack of knowledge - Development of Semantic Web: Research, development and standardization, Technology adoption - Emergence of the Social Web **Social Network analysis** - Development of Social Network Analysis - Key concepts and measures in network analysis: The global structure of networks, The macro-structure of social networks, Personal networks - Web-based networks - Applications of Social Network Analysis.

UNIT-II (10 Hrs)	**MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION** **Knowledge Representation on the Semantic Web** - Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework, Web Ontology Language **Modelling and Aggregating Social Network Data** - Ontological representation of social individuals – Ontological representation of social relationships: Conceptual model, – Aggregating and reasoning with social network data: Representing identity, On the notion of equality, Determining equality, Reasoning with instance equality, Evaluating smushing.
UNIT-III (10 Hrs)	**COMMUNITIES IN SOCIAL NETWORKS** **Detecting Communities in Social Networks** - Definition of Community: Local definitions**,** Global definitions, Definitions Based on Vertex Similarity - Evaluating communities - Methods for community detection: Divisive Algorithms, Modularity Optimization, Spectral Algorithms - Applications of community mining algorithms. **Multi-Relational Characterization of Dynamic Social Network Communities** - Actions, Networking and Community Formation: Mutual Awareness and Community Discovery, Extracting Communities Based on Mutual Awareness Structure, Analyzing Communities and Evolutions in Dynamic Network**:** Sustained Membership, Evolution and Community Discovery, Extracting Sustained Evolving Communities.
UNIT-IV (10 Hrs)	**PREDICTING HUMAN BEHAVIOR AND PRIVACY ISSUES** **Understanding and predicting human behavior for social communities** - User Data Management, Inference and Distribution - Enabling new human experiences: Reality mining, Context – Awareness **Managing Trust in Online Social Networks** - Online Social Networks, Trust in online environment – Trust models based on subjective logic – Trust network analysis.
UNIT-V (10 Hrs)	**VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS** **Visualization of Social Networks -** Social Network Analysis: Graph theory, Centrality, Clustering – Visualization**:** Node-Edge Diagrams, Matrix representation - Visualizing online social networks: Web Communities, Email Groups, Digital Libraries, Web 2.0 Services **Visualizations and Interactions for Social Networks Exploration** - Visualizing social networks with matrix-based representations: Matrix or Node-Link Diagram, Matrix + Node-Link Diagrams – Applications of Social Network Analysis: Community welfare, Collaboration networks, Co-Citation networks.
Textbooks:	
1.	"Social Networks and the Semantic Web", Peter Mika, First Edition, Springer 2007.
2.	"Handbook of Social Network Technologies and Applications", Borko Furht, 1st Edition, Springer, 2010.
Reference Books:	
1.	"Web Mining and Social Networking Techniques and applications", Guandong Xu ,Yanchun Zhang and Lin Li, First Edition, Springer, 2011.

2.	“Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively”, Dion Goh and Schubert Foo, IGI Global Snippet, 2008.
3.	“Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling”, Max Chevalier, Christine Julien and Chantal Soulé Dupuy, IGI Global Snippet, 2009.
4.	“The Social Semantic Web”, John G. Breslin, Alexander Passant and Stefan Decker, Springer, 2009.
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc22_cs117/preview

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Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23AM3207	PE	3	--	--	3	30	70	3 Hrs.

SOFT COMPUTING

(For AI & ML)

Course Objectives: This course aims to equip students with the following

1.	Understand soft computing techniques and their basics.
2.	Apply neural networks and fuzzy logic for problem solving.
3.	Use genetic algorithms and hybrids for optimization.

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

S.No	Outcome	Knowledge Level
1.	**Explain** soft computing and ANN basics	K2
2.	**Apply** neural network models and training algorithms for problem solving.	K3
3.	**Demonstrate** fuzzy logic methods to solve practical problems	K3
4.	**Find** fuzzy logic concepts, inference systems, and neuro-fuzzy models to handle uncertainty and support intelligent decision-making	K3
5.	**Apply** genetic algorithms and analyze genetic-based hybrid systems for optimization.	K3

SYLLABUS

UNIT-I (10Hrs)	Introduction to Soft Computing, Artificial neural networks, biological neurons, Basic models of artificial neural networks, Connections, Learning, Activation Functions, McCulloch and Pitts Neuron, Hebb network.
UNIT-II (10 Hrs)	Perceptron networks, Learning rule, Training and testing algorithm, Adaptive Linear Neuron, Back propagation Network, Architecture, Training algorithm.
UNIT-III (10 Hrs)	Fuzzy logic, fuzzy sets, properties, operations on fuzzy sets, fuzzy relations, operations on fuzzy relations, Fuzzy membership functions, fuzzification, Methods of membership, value assignments, intuition, inference, rank ordering, Lambda –Cuts for fuzzy sets, Defuzzification methods
UNIT-IV (8 Hrs)	Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules, Decomposition of rules, Aggregation of rules, Fuzzy Inference Systems, Mamdani and Sugeno types, Neuro-fuzzy hybrid systems, characteristics, classification
UNIT-V (8 Hrs)	Introduction to genetic algorithm, operators in genetic algorithm, coding, selection, crossover, mutation, Stopping condition for genetic algorithm flow, Genetic-neuro hybrid systems, Genetic Fuzzy rule based system.

Textbooks:	
1.	S.N. Sivanandam and S.N.Deepa, Principles of soft computing–JohnWiley & Sons,2007.
2	Timothy J. Ross, Fuzzy Logic with engineering applications, JohnWiley & Sons, 2016.
Reference Books:	
1.	N.K. Sinha and M.M. Gupta, Soft Computing & Intelligent Systems: Theory & Applications-Academic Press /Elsevier. 2009.
2.	R. Eberhart and Y. Shi, Computational Intelligence: Conceptsto Implementation, Morgan Kaufman/Elsevier, 2007.
e-Resources	
1.	https://cse.iitkgp.ac.in/~dsamanta/courses/sca/#:~:text=Resources%20&%20References,Haykin%2C%20PHI%20Learning%2C%202011.

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Code	Category	L	T	P	C	I.M	E.M	Exam
B23AM3209	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

COMPUTER VISION

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1	Understand image representation and preprocessing techniques.
2	Learn classical methods for feature extraction and image classification.
3	Explore deep learning models for detection and segmentation.
4	Study generative and retrieval-based vision applications

Course Out Comes: At the end of the course students will be able to

S. No	Outcome	Knowledge Level
1	**Apply** basic image processing and color space transformations for image understanding	K3
2	**Apply** edge detection for visual analysis and classical machine learning methods for image classification	K3
3	**Use** advanced CNN architectures and transfer learning for classification tasks	K3
4	**Apply** object detection and segmentation techniques using R-CNN, SSD, YOLO, Mask R-CNN, and U-Net to localize and classify objects and regions in images and videos	K3
5	**Demonstrate** techniques for generation, retrieval, and other advanced vision tasks such as pose estimation and object analysis	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Image Processing and Representation** Introduction to Computer Vision and its Applications Image Input and Representation: RGB, HSV, YCbCr color spaces Image Preprocessing: Grayscale conversion, Noise removal, Histogram Equalization, Contrast enhancement Basic Image Transformations: Translation, Rotation, Scaling, Cropping, Flipping Morphological Operations: Erosion, Dilation, Opening, Closing
UNIT-II (10 Hrs)	**Feature Extraction and Machine Learning-Based Classification** Edge Detection Techniques: Sobel, Canny edge detectors, Feature Extraction: Color histograms, Texture features (GLCM), Image Classification with Traditional ML Algorithms: SVM, Decision Trees, Basics of Convolutional Neural Networks (CNNs): Architecture, operation, convolution, pooling layers, Evaluating classification models: Accuracy, Precision, Recall, F1-score, Confusion Matrix

UNIT-III (10 Hrs)	**Advanced CNN Architectures and Transfer Learning** **Advanced CNN Architectures** Advanced CNN Architectures: VGGNet, Inception, GoogLeNet, MobileNet, EfficientNet **Transfer Learning:** What problems does transfer learning solve, what is transfer learning, Transfer learning approaches, Choosing the appropriate level of transfer learning, Open source datasets
UNIT-IV (12 Hrs)	**Object Detection and Image Segmentation** **Object Detection with R-CNN, SSD and YOLO:** General object detection framework, Region-based convolutional neural networks (R-CNNs), Single-shot detector (SSD), You only look once (YOLO) **Image Segmentation:** Mask RCNN and Instance Segmentation, UNet and Semantic Segmentation
UNIT-V (12 Hrs)	**Generative Models and Advanced Vision Applications** **Generative Adversarial Networks** GAN architecture, Evaluating GAN models, GAN applications, Visual Embeddings: Concepts, Learning Embeddings, Applications of Visual Embeddings **Advanced Vision Problems:** Object Measurement, Counting, Pose Estimation, Image Search

TEXTBOOKS:	
1.	Deep Learning for Vision Systems: Mohamed Elgendy, Manning Publishers, 2020
2	Fundamentals of Image Data Mining: Dengsheng Zhang, 2nd Edition , Springer
REFERENCE BOOKS:	
1.	Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2nd Edition, 2022.
2.	Computer Vision: Models, Learning, and Inference, Somon J.D. Prince, 1st Edition, Cambridge University Press
3.	Lakshmanan, Valliappa, Martin Görner, and Ryan Gillard. Practical machine learning for computer vision. " O'Reilly Media, Inc.", 2021.
Online MOOC Courses:	
1.	Introduction to Computer Vision and Image Processing, Introduction to Computer Vision and Image Processing | Coursera, Courseera
2.	Deep Learning for Computer Vision, Deep Learning for Computer Vision - Course (nptel.ac.in), Prof. Vineeth N. Balasubramanian

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3210	PE	3	--	--	3	30	70	3 Hrs.

OPERATING SYSTEMS

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	Understand the basic concepts and principles of operating Systems, including process management, memory management, file Systems, and Protection.
2.	Make use of process scheduling algorithms and synchronization techniques to achieve better performance of a computer System.
3.	Illustrate different conditions for deadlock and their possible solutions.

Course Outcomes: At the end of the course, students will be able to,

S.No	Outcome	Knowledge Level
1.	**Describe** various generations of Operating System and functions of Operating System, System calls	K2
2.	**Apply** various process scheduling algorithms and thread management techniques to optimize System performance.	K3
3.	**Apply** synchronization mechanisms and deadlock handling strategies to ensure efficient concurrent System operation.	K3
4.	**Analyze** the memory management strategies in OS to optimize the practical computing scenarios.	K4
5.	**Summarize** various file allocation methods, fundamental Protection techniques in OS to secure data integrity and accessibility.	K2

SYLLABUS

UNIT-I (10Hrs)	**Operating Systems Overview:** Operating System Functions, Computing Environments, Free and Open-Source Operating Systems, **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, Operating System debugging.
UNIT-II (10 Hrs)	**Processes:** Introduction, Process Scheduling, Operations on Processes, Inter-Process Communication. **Threads and Concurrency:** Multithreading models, Thread libraries, Threading issues. **CPU Scheduling:** Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling.
UNIT-III (10 Hrs)	**Process Synchronization:** The Critical Section Problem, Peterson's Solution, Mutex Locks, Semaphores, Monitors, Classic problems of Synchronization. **Deadlocks:** System Model, Deadlock characterization, Methods for handling Deadlocks,

	Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.
UNIT-IV (10 Hrs)	**Memory-Management Strategies:** Introduction, Contiguous memory allocation, Paging, Segmentation. **Virtual Memory Management:** Introduction, Demand paging, Page replacement, Allocation of frames, Thrashing**.** **Storage Management:** Overview of Mass Storage Structure, Disk Structure, Disk Scheduling.
UNIT-V (10 Hrs)	**File System:** File concept, Access methods, Directory Structure, File system Implementation, File-system structure, File-system Operations, Directory implementation, Allocation method, Free space management**.** **Protection:** Goals of protection, Principles of protection, Protection Rings, Domain of protection, Access matrix.

Textbooks:	
1.	Operating System Concepts, Silberschatz A, Galvin P B, Gagne G, 10th Edition, Wiley, 2018.
2.	Modern Operating Systems, Tanenbaum A S, 4th Edition, Pearson , 2016.
Reference Books:	
1.	Operating Systems -Internals and Design Principles, Stallings W, 9th edition, Pearson, 2018
2.	Operating Systems: A Concept Based Approach, D.M Dhamdhere, 3rd Edition, McGraw- Hill, 2013
e-Resources	
1.	https://nptel.ac.in/courses/106/106/106106144/
2.	http://peterindia.net/OperatingSystems.html

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Course Code	Category	L	T	P	C	I.M	E.M	Exam
B23AM3211	PE	3	--	--	3	30	70	3 Hrs.

ROBOTIC PROCESS AUTOMATION

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	Understand the Fundamentals of Robotic Process Automation (RPA)
2.	Expertise in utilizing UI Path and managing control flows
3.	Get proficiency in Advanced Automation Techniques and Exception Handling.

Course Outcomes: At the end of the course students will be able to

S. No	Outcome	Knowledge Level
1.	**Explain** concepts and applications of RPA	K2
2.	**Use** RPA tool to manipulate text data.	K3
3.	**Apply** Image, Text and Data Tables Automation techniques.	K3
4.	**Describe** handling of User Events & Assistant Bots and Exceptions	K2
5.	**Demonstrate** the deployment and maintenance of a bot	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to Robotic Process Automation:** Scope and techniques of automation, Robotic process automation, what is RPA, what can RPA do, Benefits of RPA, Components of RPA, RPA platforms, The future of automation. **RPA Basics:** RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, What Processes can be Automated, Types of Bots, Workloads which can be automated, RPA Development methodologies, Difference from SDLC, Robotic control flow architecture, RPA business case, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks & Challenges with RPA, RPA and emerging ecosystem.
UNIT-II (12 Hrs)	**RPA Tool Introduction and Basics:** **Introduction to RPA Tool:** The User Interface, Variables, Managing Variables, Naming Best Practices, The Variables Panel, Generic Value Variables, Text Variables, True or False Variables, Number Variables, Array Variables, Date and Time Variables, Data Table Variables, Managing Arguments, Naming Best Practices, The Arguments Panel, Using Arguments, About Imported Namespaces, Importing New Namespaces, Control Flow, Control Flow Introduction, If Else Statements, Loops, Advanced Control Flow, Sequences, Flowcharts, About Control Flow, Control Flow Activities, The Assign Activity, The Delay Activity, The Do While Activity, The If Activity, The Switch Activity, The While Activity, The For Each Activity, The Break Activity.

	Data Manipulation: Introduction to Data Manipulation, Scalar variables, collections and Tables, Text Manipulation, Data Manipulation, Gathering and Assembling Data.
UNIT-III (12 Hrs)	**Advanced Automation Concepts & Techniques:** Recording Introduction, Basic and Desktop Recording, Web Recording, Input/ Output Methods, Screen Scraping, Data Scraping, scraping advanced techniques, Selectors, Defining and Assessing Selectors, Customization, Debugging, Dynamic Selectors, Partial Selectors, RPA Challenge, Image. **Introduction to Image & Text Automation**: Image based automation, Keyboard based automation, Information Retrieval, Advanced Citrix Automation challenges, Best Practices, using tab for Images, Starting Apps, Excel Data Tables & PDF, Data Tables in RPA, Excel and Data Table basics, Data Manipulation in excel, Extracting Data from PDF, Extracting a single piece of data, Anchors, Using anchors in PDF.
UNIT-IV (8 Hrs)	**Handling User Events & Assistant Bots**, **Exception Handling:** What are assistant bots, Monitoring system event triggers, Hotkey trigger, Mouse trigger, System trigger, an example of monitoring email. **Exception Handling:** Debugging and Exception Handling, Debugging Tools, Strategies for solving issues, Catching errors.
UNIT-V (8 Hrs)	**Deploying and Maintaining the Bot:** Publishing using publish utility, Creation of Server, Using Server to control the bots, Creating a provision Robot from the Server, Connecting a Robot to Server, Deploy the Robot to Server, Publishing and managing updates, Managing packages, Uploading packages, Deleting packages.

Textbooks:	
1.	Alok Mani Tripathi, "Learning Robotic Process Automation", Packt Publishing, 2018.
Reference Books:	
1.	RPA Design and Development V 4.0 Student Manual.
2.	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, "Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation,1st Edition 2015.
3.	Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant", Independently Published, 1st Edition 2018.
4.	Lim Mei Ying, "Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes", Packt Publishing, 1st Edition 2018.
e-Resources	
1.	What is Robotic Process Automation - RPA Software | UiPath

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3212	PE	3	--	--	3	30	70	3 Hrs.

RECOMMENDER SYSTEMS

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1.	Understand the fundamental principles, mathematical foundations, and practical applications of various recommender system techniques
2.	Explore collaborative, content-based, knowledge-based, and hybrid recommendation approaches for personalized information filtering
3.	Examine evaluation methodologies and the role of recommender systems in community-based and personalized web environments

Course Outcomes: At the end of the course students will be able to

S. No.	Outcome	Knowledge Level
1.	**Apply** basic concepts and matrix operations to understand recommender system functions and issues	**K3**
2.	**Use** collaborative filtering techniques for generating personalized recommendations	**K3**
3.	**Demonstrate** content-based filtering methods using item and user profiles	**K3**
4.	**Use** knowledge-based and hybrid approaches to design intelligent recommender systems.	**K3**
5.	**Apply** evaluation methods, metrics, to assess recommender systems and build community-based personalized web applications.	**K3**

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.
UNIT-II (10 Hrs)	**Collaborative Filtering**: User-based nearest neighbour recommendation, Item-based nearest neighbour recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems
UNIT-III (10 Hrs)	**Content-based recommendation:** High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms

UNIT-IV (10 Hrs)	**Knowledge based recommendation:** Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders **Hybrid approaches:** Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies
UNIT-V (10 Hrs)	**Evaluating Recommender System:** Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics. **Recommender Systems and communities:** Communities, collaboration and recommender systems in personalized web search
Textbooks:	
1.	Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed.
2.	Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed.
Reference Books:	
1.	Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st ed.
2.	Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016
e-Resources	
1.	D:/Dib/Papers/2008/Recommender Systems Handbook/camera ready/LOPS_UNIBA.dvi

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3214	PC	-	-	3	1.5	30	70	3 Hrs.

BIG DATA ANALYTICS LAB

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1	Understand Distributed Systems and Parallel Processing.
2	Implement distributed applications using Hadoop platform

Course Outcomes: At the end of the course students will be able to

S. No	Outcome	Knowledge Level
1	Demonstrate installation and configuration of Hadoop Distributed File System (HDFS) in pseudo-distributed and fully distributed modes.	K3
2	Develop distributed data processing applications using the Hadoop MapReduce framework.	K3
3	Apply Pig and Hive tools to process, manage, and query large data.	K3
4	Analyze big data workflows by integrating Apache Spark with RDDs, Data Frames, SQL, and MongoDB.	K4

SYLLABUS

1	**Week 1 & 2:** (i)Perform setting up and Installing Hadoop in its three operating modes:Standalone, Pseudo distributed, fully distributed (ii)Use web-based tools to monitor your Hadoop setup.
2	**Week 3:** Implement the following file management tasks in Hadoop: Adding files and directories Retrieving files Deleting files
3	**Week 4:** Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
4	**Week 5:** Write a map reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce, since it is semi structured and record-oriented.
5	**Week 6:** Use MapReduce to find the shortest path between two people in a social graph. **Hint**: Use an adjacency list to model a graph, and for each node store the distance from the original node, as well as a back pointer to the original node. Use the mappers to propagate

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6	**Week 7:** Perform an efficient semi-join in MapReduce. **Hint:** Perform a semi-join by having the mappers load a Bloom filter from the Distributed Cache and then filter results from the actual MapReduce data source by performing membership queries against the Bloom filter to determine which data source records should be emitted to the reducers.
7	**Week 8:** Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.
8	**Week 9:** Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes
9	**Week 10:** Set up and configure Apache Spark and explore basic RDD (Resilient Distributed Dataset) transformations and actions using PySpark or Scala.
10	**Week 11:** Implement operations on Spark Data Frames and use Spark SQL to query structured data for insights.
11	**Week 12**: Integrate Apache Spark with MongoDB to perform data processing and analytics on data stored in a NoSQL database.
Reference Books:	
1	Dirk deRoos, Chris Eaton, George Lapis, Paul Zikopoulos, Tom Deutsch "Understanding Big Data Analytics for Enterprise Class Hadoop and Streaming Data", 1st Edition, TMH,2012.
2	Hadoop: The Definitive Guide by Tom White, 3rd Edition, O'reilly
3	Learning Spark: Lightning-Fast Data Analytics by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia (O'Reilly)
4	MongoDB: The Definitive Guide, by Kristina Chodorow, 3rd Edition (2019)
e-Resources:	
1.	https://www.nielit.gov.in/chandigarh/content/bjg-data-lab#:~:text=Hive:%20For%20data%20warehousing%20and,Building%20chatbots.

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23AM3215	PC	--	--	3	1.5	30	70	3 Hrs.

DATA VISUALIZATION LAB

(For AI & ML)

Course Objectives: This course aims to equip students with the following:

1	To visualize the different datasets using histograms, line charts, bar charts and box plots.
2	To understand Scatter plots, mosaic plots, heat maps and different map visualizations.
3	To understand different Map visualizations and learn advanced graphs such as correlogram, heat map and 3D graphs.

Course Outcomes: At the end of the course students will be able to

S.No	Outcome	Knowledge Level
1	**Use** histograms, line charts, bar charts and box plots to visualize and analyze patterns, trends, and distributions in various datasets.	K3
2	**Apply** scatter plots and mosaic plots using R to explore relationships and patterns in categorical and numerical datasets.	K3
3	**Apply** correlograms to visualize correlation patterns in multivariate datasets using R.	K3
4	**Analyze** complex data insights using advanced map and graphical visualizations in R**.**	K4

SYLLABUS

1	a) Load VADeaths(Death Rates in Virginia)dataset in R and visualize the data using different histograms. b) Load air quality dataset in R and visualize La Guardia Airport's dialy maximum temperature using histogram.
2	Load AirPassengers dataset in R and visualize the data using line chart that shows increase in air passengers over given time period.
3	a) Load iris dataset in R, visualize the data using different Bar Charts and also demonstrate the use of stacked plots. b) Load air quality dataset in R and visualize ozone concentration in air.
4	a) Load iris dataset in R, visualize the data using different Box plots including group by option and also use color palette to represent species. b) Load air quality dataset in R and visualize air quality parameters using box plots.
5	Visualize iris dataset using simple scatter, multivariate scatter plot and also visualize scatter plot matrix to visualize multiple variables across each other.
6	Load diamonds dataset in R and visualize the structure in datasets with large data points using hexagon binning and also add color palette
7	Load HairEyeColor dataset in R and plot categorical data using mosaic plot
8	Load mtcars dataset in R and visualize data using heat map.

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9	Install leaflet library in R and perform different map visualizations.
10	Visualize iris dataset using 3d graphs such as scatter3d, cloud, xyplot.
11	Make use of correlogram to visualize data in correlation matrices for iris dataset.
12	Install maps library in R and draw different map visualizations.
Reference Books:	
1	Visualizing Categorical Data: Michael Friendly, SAS Publishing
2	Visualizing Time: Designing Graphical Representations for Statistical Data, Graham Wills
e-Resources:	
1	**https://www.analyticsvidhya.com/blog/2015/07/guide-data-visualization-r/**
2	https://www.geeksforgeeks.org/data-visualization-in-r/

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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23BS3201	SEC	0	1	2	2	30	70	3 Hrs

EMPLOYABILITY SKILLS

(For AIDS, CIC, CSIT, CSD, ECE and EEE)

Course Objectives:

1.	To introduce concepts required in framing grammatically correct sentences and identifying errors while using standard English.
2.	To acquaint the learner of making a coherent and cohesive sentences and paragraphs for composing a written discourse.
3.	To inculcate logical thinking in order to frame and use data as per the requirement.

Course Outcomes

S.No	Outcome	Knowledge Level
1.	Match various vocabulary items that appear in competitive examinations with their contextual meanings accurately.	K1
2.	Identify grammatical and ungrammatical usage of English language in all the grammar related questions asked in various competitive examinations like CAT, GRE, IBPS.	K3
3.	Infer meaning from complex texts that are set as questions in different competitive examinations held for higher education or employment	K2
4.	Find solutions to complex arithmetic problems set as questions in the competitive examinations held for employment or higher education	K1
5.	Apply logical thinking abilities in solving the problems of reasoning that appear in the examinations like CAT, GRE, GATE, IBPS.	K3

SYLLABUS

UNIT-I (10Hrs)	Synonyms, Antonyms, Frequently Confused Words, Foreign Phrases, Idioms and Phrasal Verbs, Collocations. Spotting Errors, Sentence Improvement
UNIT-II (10 Hrs)	Time and work, Pipes and Cisterns. Time and Distance Problems, Problems on boats and streams. Percentages, Profit and loss, Simple interest and Compound interest. Discount Problems.
UNIT-III (10 Hrs)	Analogies, Odd One Out. (Verbal ability) Number Series, Letter Series, Analogy, Alpha Numeric Series, Order and Ranking, Directions, Data sufficiency, Syllogisms.
UNIT-IV (10 Hrs)	Sentence Completion, Sentence Equivalence, Close Test Reading Comprehension , Para Jumbles

UNIT-V (10 Hrs)	Number System: Divisibility tests, finding remainders in various cases, Problems related to numbers, Methods to find LCM, Methods to find HCF.
Textbooks:	
1.	*How to Prepare for Verbal Ability and Reading Comprehension for CAT* (10th edition) by Arun Sharma and Meenakshi Upadhyay, McGraw Hill Education, 2022.
2.	*How to Prepare for Quantitative Aptitude for CAT (10th edition) by* by Arun Sharma , McGraw Hill Education, 2022.
Reference Books:	
1.	*English Collocation in Use*- Intermediate (2nd edition) by Michael McCarthy& Felicity O'Dell, CUP, 2017.
2.	*Magical Book On Quicker Maths* (5th Edition) By M.Tyra, BSC Publishing Co Pvt. Ltd, 2018.
e-Resources	
1.	www.Indiabix.com
2.	www.800score.com

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