Bharatiya Vidya Bhavan

BHAVAN'S VIVEKANANDA COLLEGE

OF SCIENCE, HUMANITIES AND COMMERCE
(Reaccredited with 'A' Grade by NAAC)
Autonomous College – Affiliated to Osmania University
Sainikpuri, Secunderabad-500094

Department of Computer Science

13th BOS Meeting for M.Sc. (CS) II Year

(III and IV Semesters 2024-26 Batch)

Syllabus

BOS Approval

2025-2026

Board of Studies, OU Nominee

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Dept. of Computer Science & Engg.
College Of Engg., O.U. Hyderabad.

Chairperson & Head of the Department

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Bhavan's Vivekananda College
Sainikpuri

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Autonomous College – Affiliated to Osmania University, w.e.f. 2025-2026

Scheme of Instruction and Examination [CBCS]

Department of Computer Science

M.Sc. [Computer Science] SEMESTER-III

effective for 2024-2026 Batch

Paper	Code	Paper Title	PPW		Max Marks		Max Marks		Credits
			TH	PR	TH	TH-CIA	PR	PR-CIA	
I	CS301	Artificial Intelligence	4		70	30			4
II	CS302	Compiler Design	4		70	30			4
III	**Elective-I** CS303(A)	Network Security	4		70	30			4
	CS303(B)	Block Chain and Crypto Currency Technologies							
	CS303(C)	Big Data Analytics							
IV	**Elective-II** CS304(A)	Natural Language Processing	4		70	30			4
	CS304(B)	Web Mining							
	CS304(C)	DEVOPS							
V	CS305 (AECC)	MOOCS (Online SWAYAM Course)	2				50		2
VI	CS301P	Artificial Intelligence Lab		4			50		2
VII	CS302P	Compiler Design Lab		4			50		2
		Total	**18**	**8**	**280**	**120**	**150**		**22**

M.Sc. [Computer Science] SEMESTER-IV

Paper	Code	Paper Title	PPW		Max Marks		Max Marks		Credits
			TH	PR	TH	TH-CIA	PR	PR-CIA	
I	CS401	Cloud Computing	4		70	30			4
II	CS402	Data Science with R	4		70	30			4
III	**Elective-I** CS403(A)	Computer Organization	4		70	30			4
	CS403(B)	Distributed Systems							
	CS403(C)	Machine Learning							
IV	CS401P	Data science with R Lab		4			50		2
V	CS402P	Project Work		12			100	50	6
		Total	**12**	**16**	**210**	**90**	**150**	**50**	**20**

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Department of Computer Science

PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: ARTIFICIAL INTELLIGENCE

PAPER CODE: CS301 **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To help the students understand and practice concepts of AI, Learning & Planning Techniques and Neural Networks.

UNIT-WISE COURSE OBJECTIVES:

COb1: To inculcate knowledge about Artificial Intelligence and the search strategies for solving problems.
COb2: To Paraphrase the concepts of Learning.
COb3: To implement the Game playing logic in various real-time applications.
COb4: To Summarize the concepts of Machine Learning.

Unit - I **15 Hrs.**

Introduction to Artificial Intelligence: Introduction, AI Techniques, Problem Solving with AI, AI models, Data Acquisition and Learning aspects in AI.
Problem Solving: Problem-Solving Process, Formulating Problem, Problem types and Characteristics, Problem analysis and Representation, Problem Space and Search - Defining the Problem as a State-Space Search, Issues in Design of Search Programs, Problem Reduction Methods.
Uniformed Search: General Search Algorithm, Searching for Solutions, Problem-Solving Agents, Control Strategies, Uniformed Search Methods, Breadth First Search (BFS), Uniform Cost Search, Depth First Search (DFS), Depth Limited Search (DLS), Iterative Deepening Search (IDS).
(Ch:1, 2 & 3)

Unit – II **15 Hrs.**

Informed Search: Generate and Test, Best First Search, Greedy Search, A* Search, Admissible Heuristic, Memory Bounded Heuristic Search, IDA*, AO* Search.
Intelligent Agents: What is an intelligent agent? Precept, Agent Function, Representation of Agent Function as a Subset of Agent Program, Rationality and Rational Agents, Task Environment Properties, Types of Agents, what is Constraint Satisfaction Problem? (CSP) (Only Definition).

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Knowledge and Reasoning: Knowledge Representation Approaches and Issues of Knowledge Representation, Knowledge based agents, Predicate Logic, Representing Fats in Logic: Syntax and Semantics, Representing Knowledge using rules, Declarative and Procedural Knowledge, Logic Programming, Forward and Backward Reasoning, Types of Reasoning. (Ch:4, 5, 6 & 7)

Unit - III **l5Hrs.**

Uncertain Knowledge and Reasoning: Uncertainty and Methods, Bayesian Probability and Belief Network, Bayesian Inference, Belief Network - Forward and Backward Reasoning, Perception, other techniques in Uncertainty and Reasoning Process Non-Monotonic Reasoning, Data Mining, Fuzzy Logic, Knowledge Engineering, Ontological Engineering.

Planning: Introduction, Planning Problem- Components of Planning System, Basic Planning Representation, Simple Planning agent, Planning languages- Stanford Research Institute Problem Striper (STRIPS), Action Description Language (ADL), Planning Domain Description Language.

Learning: What is Machine Leaming? Concept, Scope of Machine Learning, Goals of Machine Learning, Challenges of Machine Leaming, Leaming paradigms, Leaming concepts, methods and models - Rote Leaming, Learning from Observations, Supervised Leaming, Unsupervised Leaming, Semi-Supervised Leaming, Ensemble Learning Discovery-Based Leaming, Leaming by Problem Solving, Artificial Neural Networks-based learning, Backpropagation Algorithm, Reinforcement Learning Model, Q-Learning. (Ch - 8, 9 & l0).

Unit - IV: **15 Hrs.**

Expert Systems: Introduction, Architecture of Expert System, Parameters in building an Expert System Confidence Factors, Knowledge Acquisition, Self-explaining System, Rule-based Expert Systems, Forward and Backward chaining, Frame-based expert systems, Uncertainty Management in Expert Systems, Expert System and DSS, Pros and Cons of Expert Systems,

Pattern Recognition & Game Playing: Machine Perception and Pattern Recognition, Classification, Object Rêcognition, Template Matching Theory, Prototype Matching Theory, Game Playing, Introduction, Important Concepts in Game theory, Game Classes, Game Strategies, Game as Search Problem, Minimax Approach, Minimax Algorithm.

Neural Network-based Learning: Introduction, Historical Developments of Neural Networks, Concepts and terminologies of ANN, Applications, and examples of Artificial Intelligence, Range of Applications, AI : Applications and Examples.

(Ch-11, 14, 15, 17 & 19).

Prescribed Book:

l. Parag Kulkarni, Prachi Joshi, Artificial Intelligence: Building Intelligent Systems, PHI Learning Private Limited., Eastern Economy Edition -2021

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Reference Books:

1. Nils J Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann Publishers, 2011.
2. Elaine Rich, Kevin Knight, Shivashankar B Nair, Artificial Intelligence, McGraw Hill Education (India) Private Limited, Third Edition. 2009.
3. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modem Approach, Prentice Hall series, Fourth Edition, 2022.
4. Eugene Charniak, Drew McDermott, Introduction to Artificial Intelligence, Pearson Education Limited, Fourth Impression 2009.
5. Vinod Chandra SS, Anand Hareendran S, Artificial Intelligence and Machine Learning, PHI Learning Pvt. Ltd., Eastern Economy Edition. Second Edition 2020.

COURSE OUTCOMES: By the end of the course students will be able to:

CS301 CO1: Analyze AI problem-solving techniques and their applications.
CS301 CO2: Demonstrate an understanding of various learning models and algorithms.
CS301 CO3: Develop AI-driven solutions using game-playing strategies.
CS301 CO4: Evaluate and apply Machine Learning algorithms to real-world problems.

Employability Aspect: Artificial Intelligence enhances employability by generating new tech jobs and increasing productivity through automation and data-driven insights.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: COMPILER DESIGN

PAPER CODE: CS302 **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of compiler and different phases involved in compiler design.

UNIT-WISE COURSE OBJECTIVES:

COb1: To inculcate knowledge on major concept areas of language translation, phases in compiler in compiler design
COb2: To demonstrate the concepts of various parsing techniques in syntax analysis.
COb3: To inculcate knowledge on three address code, storage allocation methods in runtime environment.
COb4: To illustrate the concepts of flow of graphs and code generation in target machine.

Unit – I: **15 Hrs.**

Introduction To Compiling: - language processors, phases of a compiler, a model for a compiler front end, Cousins of the Compiler, Grouping of Phases.

A Simple Syntax-Direct ed Translator: syntax-directed translation, parsing, a translator for simple expressions.

Lexical Analysis: The role of Lexical Analyzer, Input Buffering, specification of tokens, the lexical analyzer generator-Lex, Introduction-Data structures in compilation. (Ch-1,2,3).

Unit – II: **15 Hrs.**

Syntax Analysis - Role of the parser, Top-Down Parsing: Introduction, Context free grammar, writing a grammar, recursive-descent parsing, LL(1) grammars, predictive parsing, preprocessing steps required for predictive parsing. Bottom-up parsing – shift reduce parsing, SLR parsing, CLR parsing and LALR parsing, Introduction-error recovery in parsing, handling ambiguous grammar. Introduction to parser generators- YACC.

Semantic analysis syntax-directed definitions, Definition-evaluation order for SDD's, application of SDT. (Ch-4, 5).

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Unit – III: **15 Hrs.**

Intermediate-Code Generation: syntax trees, three-address code, types and declarations, translation of expressions, type checking.

Runtime Environment: storage organization, stack allocation of space, heap management, storage allocation for arrays, strings and records, Definitions-introduction to garbage collection and trace-based collection. (Ch-6,7).

Unit – IV: **15 Hrs.**

Code Generation: Issues in the design of code generator, target language, addresses in the target code, basic blocks and flow graphs, optimization of basic blocks, peephole optimization.

Code Optimization: principal sources of optimization, data flow analysis, Definitions-constant propagation, partial redundancy elimination, loops in flow graphs. (Ch-8,9).

Prescribed Book:

1. A. V. Aho, Monica S. Lam, Ravi Sethi, J. D. Ullman, Compilers Principles, Techniques, & Tools, (2e), 2006.

Reference Books:

1. Dick Grune, Henry E. Bal, Cariel T. H. Jacobs, Modern Compiler Design, 2000
2. Kenneth C. Louden, Compiler Construction Principles and Practice, 1997
3. Thomas w. Parsons, Introduction to Compiler Construction, 1992
4. Andrew N. Appel, Modern Compiler Implementation in C, 1998.
5. John R. Levin, Tony Mason, Doug Brown, LEX & YACC, 1992
6. Cooper, Linda, Engineering a Compiler, 2003

COURSE OUTCOMES: At the end of the course students will be able to:

CS302 CO1: Summarize the major concepts of language translation and compiler design phases.
CS302 CO2: Comprehend various parser techniques of SLR, CLR, LALR.
CS302 CO3: Familiarize with three address code, expressions, storage allocation arrays, strings and records.
CS302 CO4: Acquire knowledge on code generator, basic flow of graphs and data flow analysis.

Employability Aspect: Compiler design skills enhance employability by enabling the development of optimized software and advanced language processing tools.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: NETWORK SECURITY

PAPER CODE: CS303(A) **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of Network Security, different key encryption and decryption techniques.

UNIT-WISE COURSE OBJECTIVES:
COb1: To inculcate computer network security.
COb2: To demonstrate the concepts of the conventional and public key cryptosystem algorithms.
COb3: To inculcate knowledge on authentication techniques and algorithms.
COb4: To illustrate the concepts of cryptographic algorithms, key encryptions and Internet Security.

Unit-I: **15Hrs.**

Overview of Network Security: Computer Security Concepts, the OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, a Model for Network Security.
Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography.
Block Ciphers and the Data Encryption Standard: Traditional Block Cipher Structure, the Data Encryption Standard (DES), A DES Example, Strength of DES.
Block Cipher Operation: Double DES, Triple DES, Electronic Code Book, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Counter Mode.
(Ch-1,2, 3 & 6).

Unit-II: **15 Hrs.**

Advanced Encryption Standard (AES): The origins AES, AES Structure, AES Round Functions, AES Key Expansion, an AES Example, AES Implementation.
Pseudorandom Number Generation and Stream Ciphers: Principles of pseudorandom Number Generation, Pseudorandom Number Generators, Pseudorandom Number Generation using Block cipher, Stream Ciphers-RC4.
Public-Key cryptography and RSA: Principles of Public-Key Cryptosystems, the RSA Algorithm.

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Key Management and Distribution: Symmetric Key Distribution Using Symmetric Encryption and Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, Diffie-Hellman Key Exchange. (Ch-5,7, 9 & 14).

Unit - III: **15 Hrs.**

Cryptographic Hash Functions: Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Secure Hash Algorithm (SHA) & MD5 Algorithm.

Message Authentication Codes: Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, Security of MACs,
MACs Based on Hash Functions: HMAC, MACs Based on Block Ciphers: DAA and CMAC.

Digital Signatures: Digital Signatures, NIST Digital Signatures Algorithm. (Ch-11,12 &13).

Unit – IV: **15 Hrs.**

Transport-Level Security: Web Security Considerations, Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS, Secure Shell (SSH).

E-Mail Security: Pretty Good Privacy, S/MIME.

IP Security: IP Security Overview, IP Security Architecture, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange.

Intruders, Virus and Firewalls: Intruders, Intrusion Detection, Password Management, Virus and Related Threats, Countermeasures, Firewall Design Principles, Types of Firewalls.
(Ch-17, 19,20,21,22 & 23).

Prescribed Book:

1. William Stallings, Cryptography and Network Security - Principles and Practice (6e), 2013

Reference Books:

1. Zhenfu Cao, New Directions of Modem Cryptography, 2012
2. Douglas R. Stinson, Cryptography Theory and Practices, 2018
3. Tom St Denis, Simon Johnson, Cryptography for Developers, 2006
4. Joseph Migga Kizza, A Guide to Computer Network Security 6e, 2024
5. A. Menezes, P. Van Oorschot, S. Vanstone, Handbook of Applied Cryptography, 2018
6. Henk C.A. van Tilborg, Sushil Jajodia, Encyclopaedia of Cryptography and Security, 2011
7. Keith M. Martin, Everyday Cryptography-Fundamental Principles and Applications, 2017
8. Chwan-Hwa Wu, J. David Irwin, Introduction to Computer Networks and Cyber Security, 2013
9. Saiful Azad, Al-Sakib Khan Pathan, Practical Cryptography-Algorithms and Implementation, 2014

COURSE OUTCOMES: At the end of the course students will be able to:

CS303(A) CO1: Outline the basic security issues and classical encryption techniques.

CS303(A) CO2: Comprehend the Public Key Cryptosystems and how the keys are exchanged among different participating entities.

CS303(A) CO3: Acquire knowledge on Message Authentication algorithms and importance of Digital Signatures.

CS303(A) CO4: Comprehend various Transport layer level Security.

Employability Aspect: Network security expertise boosts employability by protecting systems from cyber threats and maintaining data integrity.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: BLOCK CHAIN AND CRYPTO CURRENCY TECHNOLOGIES

PAPER CODE: CS303(B) **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of Block chain and Crypto Currency Technologies.

UNIT-WISE COURSE OBJECTIVES:

COb1: To demonstrate the concepts of Cryptography, Types of Cryptography
COb2: To demonstrate the concepts Block chain, Currency Exchange.
COb3: To describe the functionalities of Bitcoin & Mining.
COb4: To illustrate Community, Politics, and Regulation of Bitcoin.

Unit- I: 15 Hrs.

Introduction to cryptography and crypto currencies: Foundations of Cryptography and security: ciphers and secret messages. security attacks and services.
Mathematical tools for cryptography: substitution techniques, modular arithmetic. Euclid's algorithm, finite fields, polynomial arithmetic.
Design Principles of Block Ciphers: Theory of Block cipher Design. Feistel cipher network structure, DES and Triple DES. modes of operation (ECB. CBC. OFB, CFB). strength of DES.
(T. Book-1: Ch-1, T. Book-2: Ch-2,3,5 &7)

Unit- II: 15 Hrs.

Block chain Achieves: Decentralization - Centralizations. Decentralization- Distributed consensus, Consensus with - out identity using a block chain, incentives and proof of work- Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges. Payment Services. Transaction Fees, Currency Exchange Markets. (T. Book-1: Ch-2)

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Unit- III: **15 Hrs.**

Mechanics of Bitcoin: Bitcoin transactions, Bitcoin Scripts, Applications of Bitcoin scripts, Bitcoin blocks, The Bitcoin network, Limitations, and improvements.

Bitcoin Mining: The task of Bitcoin miners. Mining Hardware. Energy consumption and ecology, Mining pools, Mining incentives and strategies.

Bitcoin and Anonymity: Anonymity's. How to De-anonymize Bitcoin. Mixing, Decentralized Mixing, Zerocoin and Zerocash. (T. Book-1: Ch-3, 5 & 6)

Unit- IV: **15 Hrs.**

Community, Politics, and Regulation: Consensus in Bitcoin, Bitcoin Core Software, Stakeholders Who sin Charge. Roots of Bitcoin. Governments Notice on Bitcoin, Anti Money Laundering Regulation, New York's Bit License Proposal.

Bitcoin as a Platform: Bitcoin as an Append only Log. Bitcoins as Smart Property. Secure Multiparty Lotteries in Bitcoin, Bitcoin as Public Randomness. Source- Prediction, Markets and Real World Data Feeds. (T. Book-1: Ch-7 & 9)

Prescribed Book:

1. Narayanan, A., Bonneau. J., Felten, E-, Miller, A., and Goldfeder. S. (2016). Bitcoin and crypto currency technologies: a comprehensive introduction. Princeton University Press.
2. William Stallings, Cryptography and Network Security. Pearson 2004.

Reference Books:

1. Antonopoulos, A. M. (2014). Mastering Bitcoin: unlocking digital cryptocurrencies. OReilly Medi4 Inc.2023
2. Franco, P. (2014). Understanding Bitcoin: Cryptography. engineering and economics. John Wiley and Sons

COURSE OUTCOMES: At the end of the course students will be able to:

CS303(B) CO1: To relate and understand Cryptography, Types of Cryptography.
CS303(B) CO2: To relate and understand Block chain, Currency Exchange.
CS303(B) CO3: To relate and understand Bitcoin & Mining.
CS303(B) CO4: To relate and understand Community, Politics, and Regulation of Bitcoin

Employability Aspect: Expertise in blockchain and cryptocurrency technologies boosts employability by advancing secure transactions and decentralized innovations.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: BIG DATA ANALYTICS

PAPER CODE: CS303(C) **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of big data, handling huge data for analytics.

UNIT-WISE COURSE OBJECTIVES:

COb1: To inculcate knowledge on Big Data, Applications and Hadoop ecosystem.
COb2: To inculcate knowledge on MapReduce fundamentals.
COb3: To demonstrate the usage of YARN, Hive and Pig Latin Script.
COb4: To illustrate the concepts of Oozie, NoSQL and Big Data Analytics.

Unit-I: **15Hrs.**

Overview of Big Data: What is Big Data? Evolution of Big Data, Structuring Big Data, Elements of Big Data. Big Data Analytics.

Exploring the Use of Big Data in Business context: Use of Big Data in Social Networking. Use of Big Dara in Preventing Fraudulent Activities, Use of Big Data in Detecting Fraudulent Activities in Insurance Sector. Use of Big Data in Retail Industry.

Introducing Technologies for Handling Big Data: Distributed and Parallel Computing for Big Data. introducing Hadoop.

Understanding Hadoop Eco System: Hadoop Ecosystem. HDFS, Map Reduce. Hadoop YARN. HBase. Hive, Pig and Pig Latin, Sqoop. Zookeeper, Flume, Oozie. (Ch-1, 2, 3 & 4).

Unit-II: **15Hrs.**

Understanding MapReduce Fundamentals and HBase: The MapReduce Framework, Techniques to optimize MapReduce Jobs. Role of HBase in Big Data processing. Exploring the Big Data Stack, Virtualization and Big Data, Virtualization Approaches.

Storing Data in Databases and Data warehouses: RDBMS and Big Data, Non-Relational Database, integrating Big Data with relational Data warehouses. Big Data Analysis and Data warehouse, Changing Deployment Models in Big Data Era.

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Processing Your Data with MapReduce: Developing Simple MapReduce Application, points to Consider while Designing MapReduce.

Customizing MapReduce Execution: controlling MapReduce Execution with Input Format, Reading Data with Custom RecordReader. organizing output Data with output formats. customizing Data with RecordWriter. optimizing MapReduce Execution with combiner, Implementing a MapReduce Program for Sorting Text Data. (Ch-5,6 &7).

Unit-III: **15Hrs.**

Understanding Hadoop YARN Architecture: introduction YARN, Advantages of YARN, YARN Architecture. Working of YARN.

Exploring Hive: Introducing Hive, getting Started '"with Hive, Hive Services, Data Types in Hive, Built-In Functions in Hive. Hive DDL, Data Manipulation in Hive, Data Retrieval queries, Using JOINS in Hive.

Analyzing Data with Pig: Introducing Pig, Running pig. Getting Starred with pig Latin, working with operators in Pig. working with Functions in Pig, Debugging pig, Error Handling in pig. (Ch-11, 12 & 13).

Unit-IV: **15Hrs.**

Using Oozie: introducing Oozie, installing and configure oozie, understanding the oozie Workflow. Simple Application.

NoSQL Data Management: introduction to NoSQL, Types of NoSeL Data Models, Schema-Less Databases. Materialized views. Distributed Models. Sharding. MapReduce partitioning and combining. Composing MapReduce Calculations.

Understanding Analytics and Big Data: Comparing Reponing and Analysis, Types of Analytics. Developing an Analytic Team.

Analytical Approaches and tools to Analyze Data: Analytical Approaches. History of Analytical Tools, Introducing Analytical Tools, Comparing Various Analytical Tools. (Ch-14,15,18 &19).

Prescribed Book:

1. D.T. Editorial Services. Big Data - Black Book (dream tech), 2016.

Reference Books:

1. Radha S, M. Vijaya Lakshmi. Big Data Analytics 2016.
2. Arshdeep B and Vijay M. Big Data Science & Analytics - A Hands-On Approach. 2016
3. Frank Ohlhorst, Big Data Fundamentals - Concepts, Drivers. Techniques 2012
4. Kuan-Ching Li, H Jiang, L T Yang, A Cuzzocrea, Big Data Algorithms, Analysis and Applications 2015.
5. Tom White, Hadoop: The Definitive Guide. 2015
6. Shiva Achari, Hadoop Essentials.2015
7. Alex Holmes, Hadoop in Practice. 2014

COURSE OUTCOMES: At the end of the course students will be able to:

CS303(C) CO1: Acquire knowledge on Big Data, Applications and Hadoop ecosystem.
CS303(C) CO2: Be familiar with MapReduce fundamentals.
CS303(C) CO3: Execute the applications of YARN, Hive and Pig Latin Script.
CS303(C) CO4: Acquire knowledge on Oozie, NoSQL and Big Data Analytics.

Employability Aspect: Big data analytics skills boost employability by leveraging data to drive strategic decisions and innovation.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: NATURAL LANGUAGE PROCESSING

PAPER CODE: CS304(A) **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of Big Data Analytics.

UNIT-WISE COURSE OBJECTIVES:

COb1: Develop competency to use the Python Programming Language.
COb2: Develop an appreciation for structures in natural language which computers are confronted with when processing natural language.
COb3: Learn various techniques under Natural Language Processing (NLP) to solve language processing problems and Deep learning in NLP.
COb4: Introduce frontier areas in NLP research.

Unit-I: **15Hrs.**

Language Processing and Python: Computing with Language: Texts and Words. A Closer Look at Python: Texts as Lists of Words. Computing with language: Simple Statistics, Back to Python: Making Decisions and Taking Control. Automatic Natural language Understanding.
Accessing Text Corpora and Lexical Resources: Accessing Text Corpora. Conditional Frequency Distributions. Lexical Resources. WordNet. (T. Book-1:Ch-1&2).

Unit-II: **15Hrs.**

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode. Regular Expressions for Detecting Word Patterns. Useful Applications of Regular Expressions. Normalizing Text. Regular Expressions for Tokenizing Text, Segmentation. Formatting: From Lists to Strings.
Categorizing and Tagging Words: Using a tagger, tagged Corpora. Mapping Words to Properties. Using Python Dictionaries, Automatic Tagging. N-Gram Tagging. Transformation- Based Tagging. How to Determine the Category of a Word. (T. Book-1: Ch-3 &5).

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Unit-III: **15Hrs.**

Leaming to Classify Text: Supervised Classification, Evaluation, Naive Bayes, Classifiers.
Deep Learning for NLP: Introduction to Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks. Classifying Text with Deep learning.
(T. Book-1: Ch-6 , T.Book-2: Ch-6).

Unit-IV: **15Hrs.**

Extracting information from Text: Information Extraction. Chunking, Developing and Evaluating Chunkers. Recursion in Linguistic Structure. Named Entity Recognition, Relation Extraction.
Analysing Sentence Structure: Some Grammatical Dilemmas. What's the Use of Syntax, Context-Free Grammar, Parsing with Context-Free Grammar.
NLP applications: Topic Modeling, Text classification. Sentiment analysis, Word sense disambiguation, Speech recognition and speech to text. Text to speech. Language detection and translation. (T.Book-1: Ch-7, 8, T.Book-2: Ch-9).

Prescribed Books:

1. steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python. OReily. 2009.
2. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. A press' 2019
3. Allen Jarnes. Natural Language Understanding, Benjamin/Cumming, 1995. Charniack. Eugene. Statistical Language Learning. MIT Press, 1993.
4. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

Reference Book:

1. Dipanjan Sarkar, Text Analytics with Python (A press/Springer, 2016)

COURSE OUTCOMES: At the end of the course students will be able to:

CS304(A) CO1: Use the Python programming language to solve general problems.
CS304(A) CO2: Process text by using NLP techniques such as lemmatization, POS tagging etc.
CS304(A) CO3: Extract meaningful information from a piece of text.
CS304(A) CO4: Engage various NLP techniques to solve a particular NLP problem.

Employability Aspect: Natural Language Processing skills boost employability by powering sophisticated language technologies and enhancing user interactions.

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Department of Computer Science

PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: WEB MINING

PAPER CODE: CS304(B) | **PPW: 4**
YEAR/SEMESTER: II/III | **NO. OF CREDITS: 4**

COURSE OBJECTIVE: Explore web data mining fundamentals, supervised and unsupervised learning techniques, information retrieval methodologies, and link analysis concepts, culminating in proficiency with sentiment classification and web crawling strategies.

UNIT-WISE COURSE OBJECTIVES:

COb1: Gain a comprehensive understanding of web data mining principles, covering the history of the World Wide Web, association rules, sequential patterns, and their mining algorithms.
COb2: Develop proficiency in supervised learning techniques, including decision tree induction, rule learning, classification based on associations, and Naive Bayesian classification for text and web data.
COb3: Explore the fundamentals of information retrieval and web search methodologies, encompassing relevance feedback, text and web page preprocessing, duplicate detection, and compression techniques.
COb4: Master the concepts of link analysis and web crawling, delving into social network analysis, page ranking algorithms, core communities, and various web crawling strategies along with sentiment classification based on sentiment phrases and text classification methods.

Unit-I: **15Hrs.**

Introduction to web: Data Mining and Data Mining Foundations, Introduction - world wide web (www). A Brief History of the web and the internet, web Data Mining-Data Mining. web Mining. Data Mining Foundations - **Association Rules and Sequential patterns** - Concepts of Association Rules. Apriori Algorithm- Frequent Item set Generation, Association Rule Generation, Data Formats for Association Rule Mining, Mining with multiple minimum supports Extended Model, Mining Algorithm, Rule Generation. Mining Class Association Rules. Concepts of Sequential Patterns. Mining Sequential patterns on GSP, Mining Sequential patterns on Prefix Span. Generating Rules from Sequential patterns. **(Ch-1 & 2)**

Unit-II: **15Hrs.**

Supervised and Unsupervised Learning: Supervised Learning - Concepts, Decision Tree Induction-Learning algorithm. Impurity Functions, Handling of Continuous Attributes, Classifier Evaluation. Rule Induction-Sequential covering, Rule Learning. Classification Based on Associations, Naive Bayesian

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Classification. Naive Bayesian Text Classification–Probabilistic Framework. Naive Bayesian Model. Unsupervised Learning - concepts, K-means Clustering, K-means Algorithm, Representation of Clusters, Hierarchical Clustering - Single link method, Complete link Method, Average link method. Strength and Weakness. **(Ch-3 &4).**

Unit-III: **15Hrs.**

Information Retrieval and Web Search: Concepts of Information Retrieval, Information Retrieval Methods- Boolean Model, Vector Space Model and Statistical Language Model, Relevance Feedback, Evaluation Measures, Text and web Page Preprocessing –Stop word Removal Stemming, Web page preprocessing, Duplicate Detection, Inverted Index and its Compression – Inverted Index, Search using Inverted Index, Index Construction, Index compression, Latent Semantic Indexing – singular Value Decomposition, Query and Retrieval, Web Search, Meta Search, Web Spamming. **(Ch-6).**

Unit-IV: **15Hrs.**

Link Analysis and Web Crawling: Link analysis – Social Network Analysis, Co-citation and Bibliographic coupling, Page Rank Algorithm, HITS algorithm, Community Discovery- Problem Definition, Bipartite Core communities, Maximum Flow communities, Email Communities.

Web Crawling – A crawler Algorithm – Breath First Crawlers, Preferential Crawlers, Implementation Issues – Fetching, Parsing, Strop word removal, Link Extraction, Spider Traps, Page Repository, Universal Crawlers, Focused Crawlers, Topical Crawlers, Crawler Ethics and conflicts.

Sentiment Classification – Classification based on Sentiment Phrases, Classification Using Text Classification Methods. **(Ch-7,8 &11).**

Prescribed Book:

1. Web Data Mining: Exploring Hyperlinks, Contents. and Usage Data by Bing Liu (Springer publications) 2011

Reference Books:

1. Data Mining: Concepts and Techniques, Second Edition Jiawei Han. Micheline Kamber (Elsevier Publications). 2022
2. Web Mining: Applications and Techniques by Anthony Scime. 2005
3. Mining the web: Discovering Knowledge from Hypertext Data by Soumen Chakrabarti. 2014

COURSE OUTCOMES: At the end of the course students will be able to:

CS304(B) CO1: Acquire comprehensive understanding of web data mining principles, covering the history of the World Wide Web, association rules, sequential patterns, and their mining algorithms.

CS304(B) CO2: Acquire and Develop proficiency in supervised learning techniques, including decision tree induction, rule learning, classification based on associations, and Naive Bayesian classification for text and web data.

CS304(B) CO3: Be familiar with fundamentals of information retrieval and web search methodologies, encompassing relevance feedback, text and web page preprocessing, duplicate detection, and compression techniques.

CS304(B) CO4: Analyse the concepts of link analysis and web crawling, delving into social network analysis, page ranking algorithms, core communities, and various web crawling strategies along with sentiment classification based on sentiment phrases and text classification methods.

Employability Aspect: Web mining skills increase employability by analyzing online data to uncover trends and inform business strategies.

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Department of Computer Science

PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: DEVOPS

PAPER CODE: CS304(C) **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of Big Data Analytics.

UNIT-WISE COURSE OBJECTIVES:

COb1: To understand the principles and practices of DevOps, including Agile development, ITIL, and continuous delivery.

COb2: To explore the influence of DevOps on software architecture, including the concepts of microservices, resilience, and database migrations.

COb3: To learn about project management tools and practices in DevOps, including source code control, Git servers, build automation with Jenkins, and testing methodologies.

COb4: To gain proficiency in deploying and managing systems using deployment tools such as Puppet, Ansible, Chef, Salt Stack, and Docker, along with testing automation tools like Selenium.

Unit-I: **15Hrs.**

Introduction: Introduction, Agile development model, DevOps, and ITIL. DevOps process and Continuous Delivery, Release management- Scrum. Kanban. delivery pipeline. Bottlenecks, examples.
Software development models and DevOps: DevOps Lifecycle for Business Agility, DevOps, and Continuous Testing. (Ch-1,2)

Unit-II: **15Hrs.**

DevOps influence on Architecture: Introducing software architecture, The monolithic scenario. Architecture rules of thumb. The separation of concerns. Handling database migrations. Microservices, and the data tier, DevOps, architecture, and resilience.
Introduction to project management: The need for source code control, The history of source code management, Roles and code, source code management system and migrations, Shared authentication. Hosted Git servers. Different Git server implementations. Docker intermission. Gerrit, The pull request model, GitLab. (Ch-3,4)

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Unit-III: **15Hrs.**

Integrating the system: Build systems, Jenkins build server, Managing build dependencies. Jenkins plugins, and file system layout. The host server, Build slaves, Software on the host. Triggers. Job chaining and build pipelines, build servers and infrastructure as code, building by dependency order, Build phases, Alternative build servers, Collating quality measures. (Ch-5)

Unit-IV: **15Hrs.**

Testing Tools and automation: Various types of testing. Automation of testing Pros and cons. Selenium - Introduction. Selenium features, JavaScript testing. Testing backend integration points. Test-driven development. REPL-driven development

Deployment of the system: Deployment systems, Virtualization stacks. code execution at the client. Puppet master and agents, Ansible, Deployment tools: Chef, Salt Stack and Docker.
(Ch-6,7)

Prescribed Books:

1. Joakim Verona. Practical Devops, Second Edition. Ingram short title: 2nd edition (2018). lSBNl0:1788392574.
2. Deepak Gaikwad, Viral Thakkar. DevOps Tools from Practitioner's Viewpoint. Wiley publications. ISBN: 9788 I 26579952, 2019.

Reference Books:

1. Len Bass, Ingo Weber, Liming Zhu. DevOps: A Software Architect's Perspective. Addison Wesley: ISBN-10. 2015

COURSE OUTCOMES: At the end of the course students will be able to:

CS304(C) CO1: Explain and apply Agile development principles, understand the DevOps process, and implement continuous delivery practices in software development.

CS304(C) CO2: Understand how DevOps impacts software architecture, including the transition from monolithic to microservices architecture, resilience strategies, and database management techniques.

CS304(C) CO3: Gain hands-on experience with project management tools like Git, Jenkins, and Docker, enabling them to efficiently manage source code, automate builds, and streamline deployment processes.

CS304(C) CO4: Proficient in deploying and managing systems using various DevOps tools, implementing testing automation with Selenium, and applying best practices for system deployment, configuration management and infrastructure as code.

Employability Aspect: DevOps skills enhance employability by streamlining development and operations, improving efficiency, and accelerating software delivery.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: MOOCs [Online NPTEL Courses]

PAPER CODE: CS305 (AECC) | **Program Duration:8 Weeks**
YEAR/SEMESTER: II/III | **NO. OF CREDITS: 2**

The students are advised to take NPTEL course on the topics other than curriculam-based subjects.

MOOCs Guidelines (For MSc CS - 2 Credits, 8 Weeks)

I. Eligibility

- PG students M.Sc. (CS) – Any semester
- The course must be of **postgraduate level**, **minimum 8 weeks**, and worth **2 credits**

II. Course Criteria

- Platform: SWAYAM / NPTEL etc.
- Duration: **8 weeks**
- Credits: **2**
- Level: **Postgraduate (PG)**
- Assessment: Must have a **proctored final exam or certification**

III. Steps to Join

1. **Choose a Suitable Course**
   - Visit official MOOC platforms (like SWAYAM)
   - Filter by duration (8 weeks), credits (2), and level (Postgraduate)
   - Select a course **relevant to Computer Science- (Should not be part of the regular syllabus)**
2. **Get Approval**
   - Inform the department/faculty coordinator
   - Submit course details for pre-approval (course name, platform, duration, syllabus)
3. **Register Online**
   - Create an account on the chosen platform
   - Enrol in the course before the registration deadline

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4. **Track Progress**
    - Attend all weekly lectures
    - Complete assignments on time
    - Take part in discussions/forums (if any)
5. **Final Certification**
    - Appear for the final exam (if required)
    - Download the **certificate upon successful completion**
6. **Instructions for Applying**

    While registering for the MOOC, **enter the correct institution details**:
    - **Institution Code**: 1072
    - **Institution Name**: *Bhavan's Vivekanand College of Science, Humanities and Commerce*

IV. Submission Requirements

- Submit:
    - Course Completion Certificate
- To be submitted to the department for credit transfer/evaluation

Note: The students will be allotted the subjects that are available in a particular year at NPTEL.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: ARTIFICIAL INTELLIGENCE LAB

PAPER CODE: CS301P | **PPW: 4**
YEAR/SEMESTER: II/III | **NO. OF CREDITS: 2**

COURSE OBJECTIVE: To provide an Understand the potential benefits of using AI in knowledge-sharing and management.

COb1: Identify problems where artificial intelligence techniques are applicable.
COb2: To demonstrate the concepts of basic AI techniques; judge applicability of more advanced techniques.

Week-1:

1. Program to print multiplication table for given no.
2. Program to check whether the given no is prime or not.

Week-2:

3. Program to find factorial of the given no and similar programs.
4. Write a program to implement List Operations (Nested list, Length, Concatenation, Membership, Iteration, Indexing and Slicing), List Methods (Add, Append, Extend & Delete)

Week-3:

5. Write a program to Illustrate Different Set Operations.
6. Write a program to implement Simple Chatbot.

Week-4:

7. Write a program to implement Breadth First Search Traversal,
8. Write a program to implement Depth First Search Traversal.

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Week-5:

9. Write a program to implement Water Jug Problem.
10. Write a Program to Implement Tic-Tac-Toe game using Python.

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Week-6:

11. Write a program to implement K-Nearest Neighbor algorithm.

Week-7:

12. Write a Program to Implement 8-Puzzle problem using Python.

Week-8:

13. Write a Program to Implement Travelling Salesman Problem using Python.

Week-9:

14. Write a program to implement Regression algorithm.

Week-10:

15. Write a program to implement Random Forest Algorithm.

Week-11:

16. Write a Program to Implement Tower of Hanoi using Python.

Week-12:

17. Write a Program to Implement Monkey Banana Problem using Python.

Week-13

18. Write a Program to Implement Alpha-Beta Pruning using Python.

Week-14:

19. Write a Program to Implement 8-Queens Problem using Python.

COURSE OUTCOMES: At the end of the course, students are able to:

CS301P CO1: Examine the issues involved in knowledge bases, reasoning systems and planning.
CS301P CO2: Apply difficult real-life problems in a state space representation so as to solve them using AI techniques like searching and game playing.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: COMPILER DESIGN LAB

PAPER CODE: CS302P **PPW: 4**
YEAR/SEMESTER: II/III **NO. OF CREDITS: 2**

COURSE OBJECTIVE: To provide an Understanding of the language translation peculiarities by designing complete translator for mini language.

COb1: To inculcate knowledge on major concept areas of language translation and compiler design.
COb2: To demonstrate the concepts of various storage allocation strategies implemented in compiler construction

Week – 1:
1. Write a program to design token separator for the given expression.

Week – 2:
2. Write a program to implement a symbol table.

Week – 3:
3. Write a program to develop a lexical analyzer to recognize a few patterns.

Week – 4:
4. Write a program to develop a lexical analyzer using Lex tool.

Week – 5:
5. Write a program to recognize a valid arithmetic expression using YACC.

Week – 6:
6. Write a program to recognize a valid variable name using YACC.

Week – 7:
7. Write a program to implement calculator using Lex and YACC.

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Week – 8:
8. Write a program for implementing type checking for given expression.

Week – 9:
9. Write a program to convert the BNF rules into YACC.

Week – 10:
10. Write a program to implement data flow and control flow analysis.

Week – 11:
11. Write a program to implement stack storage allocation strategies.

Week – 12:
12. Write a program to implement heap storage allocation strategies.

Week – 13:
13. Write a program to construct a directed acyclic graph (DAG).
14. Write a program to implement the back end of the compiler.

Week – 14:
15. Write a program to implement simple code optimization technique.
16. Write a program to implement simple code optimization technique using do-while.

Note:
- Recommended to use the **C/LEX/YACC** on Linux / Windows systems.

COURSE OUTCOMES: At the end of the course, students are able to:

CS302P CO1: Implement the concepts on compiler programming using various software.
CS302P CO2: Inculcate knowledge in storage allocation strategies and arithmetic calculations.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: CLOUD COMPUTING

PAPER CODE: CS401 **PPW: 4**
YEAR/SEMESTER: II/IV **NO. OF CREDITS: 4**

COURSE OBJECTIVE: to enable students acquire knowledge on the concepts of cloud computing environment and the different services available.

UNIT-WISE COURSE OBJECTIVES:

COb1: To inculcate knowledge about new model of cloud computing environment and various Cloud services.
COb2: To infer the concepts of new cloud security and services.
COb3: To acquire knowledge on IT services and SLA.
COb4: To exemplify the concepts of on data security, services, audits and MCC.

Unit - I: **15 Hrs.**

Era of Cloud Computing (CC): Introduction, Cloud and Other Similar Configurations, CC Vs. Peer-to-Peer Architecture, CC Vs. Client-Server Architecture, CC Vs. Grid Computing, Components of CC, Impact of CC on Businesses.

Introducing Virtualization: Introduction, Virtualization Benefits, Implementation Levels of Virtualization, Virtualization at the OS Level, Virtualization Structure, Open-Source Virtualization Technology, Xen Virtualization Architecture, Binary Translation with Full Virtualization, Paravirtualization with Compiler Support, Virtualization of CPU, Memory, I/O Devices, Hardware Support for Virtualization in Intel x86 Processor, Visualization in Multicore Processors.

Cloud Computing Services: IaaS, PaaS, Leveraging PaaS for Productivity, Guidelines for Selecting a PaaS Provider, Concerns with PaaS, Languages and PaaS, SaaS, DBaaS.

Cloud Computing and Business Value: key Drivers for CC, CC and Outsourcing, Types of Scalability, Use of Load Balancers to Enhance Scalability, Variable Operating Costs Using CC, Time-to-market Benefits of CC, Distribution Over the Internet, Levels of Business Values from CC.

Cloud Types and Models: Private Cloud- Components of a Private Cloud, Implementation Phases of a Private Cloud, Community Cloud, Public Cloud – Introduction, Hybrid Cloud, Private Versus Hybrid Cloud.

(Ch-1,2,3, 4 & 6).

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Unit - II: **15Hrs.**

Open-Source Cloud Implementation and Administration: Open-Source Eucalyptus Cloud Architectures - Features of Eucalyptus, Hybrid Cloud Management, AWS Compatibility, Compute, Networking, Storage, Self - Service Provisioning, Cloud Management, Components of Eucalyptus, Cloud Controller, Warlus, Cluster Controller, Storage Controller, Node Controller, VMware Broker, Modes of Operation, Managed Mode, Managed (No VLAN) Mode, System Mode, Static Mode.

Cloud Deployment Techniques: Cloud Services Brokerage (CSB).

Recent Trends in Cloud Computing and Standards: Recent Trends, Conflict of Interest for Public Cloud and IT Product Providers, Recent Trends in Security: BYOD and Encryption Exposures, Recent Trends in Cloud Standards, Cloud Ratings, CC Trends that are Accelerating Adoption.

Host Security in the Cloud: Security for the Visualization Product, Host Security for SaaS, PaaS & IaaS.

Data Security in the Cloud: Challenges with Cloud Data and Data Security, Data Confidentiality and Encryption, Data Availability, Data Integrity, Cloud Storage Gateways (CSGs).

Application Architecture for Cloud: Cloud Application Requirements, Service -Oriented Architecture (SOA) for Cloud Applications.

(Ch- 7, 8, 9, 10, 11 & 12).

Unit - III: **15 Hrs.**

Adoption and Use of Cloud by Small and Medium Businesses (SMBs): Place of Adoption, Benefits, Adoption Phases, Vendor Roles and Responsibilities, Selection Phases, Provider Liability, Provider Capabilities, Success Factors for Cloud Consumers.

Adoption and Use of Clouds by Enterprises: Adoption Process of Public Clouds by Enterprises.

Migrating Applications of the Cloud: Cloud Migration Techniques, Phases During the Migration of an Application to the Cloud.

IT Service Management for Cloud Computing: ITIL Based Service Management - Introduction - Five Phases of IT Service Lifecycle and Topics Covered in Each Phase (Figure- 1).

SLA with Cloud Service Providers: Concept, SLA Aspects and Requirements, Credit Calculation for SLA Breaches, Samples SLA 1: Amazon 53 SLA.

Risks ,Consequences, and Costs for Cloud Computing: Risk Assessment and Management, Risk of Vendor Lock-in, Risk of loss of Control, Risk of Not Meeting Regulatory Compliances, Risk of Resource scarcity or Poor Provisioning, Multi-Tenant Environment, Risk of Failure, Risk of Inadequate SLA, Risk of Malware and Internet Attacks, Risk of Management of Cloud Resources, Risk of Network Outages, Risks in the Infrastructure , Legal Risk in Due to Legislation, Risks with Software and Application Licensing, Calculating Total Cost of Ownership (TCO) for Cloud Computing, Direct and Indirect Cloud Costs, Cost Allocations in Cloud, Chargeback Models for Allocation of Direct and Indirect Cost , Chargeback Methodology, Billable Items.

(Ch-14, 15, 16, 17, 18 &19).

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Unit-IV: **15 Hrs.**

AAA (Authentication, Authorization, and Accounting) Administration for Clouds: The AAA Model, Single Sign - On for Clouds, Industry Implementation for AAA, Authentication Management in the Cloud, SAML, Accounting for Resource Utilization.

Security as A Service: Benefits of Security- as- a- Service, Concerns with Security-as-a-service, Security Service Providers, Identity management as a Service (IdMaaS), Attributes of IdMaaS Providers.

Cloud Certifications and Audits: Certifications, Cloud Audit Framework, Cloud Auditing Requirements.

Application Security in the Cloud: Cloud Application Software Development Lifecycle SDLC, Cloud Service Reports by Providers, Application Security in IaaS, PaaS and SaaS Environments.

Mobile Cloud Computing (MCC): Architecture of MCC, Benefits of MCC, MCC Challenges.
(Ch-20, 22, 23, 25 & 27).

Prescribed Book:

l. Kailash J, Jagannath K, Donald J H, Deven Shah, Cloud Computing - Black Book. 2016

Reference Books:

1. Rajkumar Buyya, Cloud Computing: Principles and Paradigms, 2013
2. Arshdeep Bahga, Vijay Madisetti, Cloud Computing - A Hands-On Approach, 2014
3. David E.Y. Sama, Implementing and Developing Cloud Computing Applications, 2018
4. Kai Hwang, Distributed and Cloud Computing from Parallel Processing to Internet of Thing, 2011

COURSE OUTCOMES: At the end of the course students will be able to:

CS401 CO1: Familiarize the major concepts related to Cloud Computing.
CS401 CO2: Summarize the concepts of virtualization and Cloud standards.
CS401 CO3: Outline the SMBs, IT Services and Security issues.
CS401 CO4: Acquire knowledge on Security, privacy, and Mobile related Cloud Computing.

Employability Aspect: Cloud computing skills boost employability by enabling scalable, flexible IT solutions and optimizing resource management.

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Department of Computer Science

PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: DATA SCIENCE WITH R

PAPER CODE: CS402 **PPW: 4**
YEAR/SEMESTER: II/IV **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the machine learning algorithms using R - Programming.

UNIT WISE COURSE OBJECTIVES:

COb1: To understand data science and data preprocessing.
COb2: To learn hypothesis formulation, candidate elimination algorithm, and basics of R.
COb3: To explore model fitting using R and data visualization techniques.
COb4: To gain knowledge of model performance evaluation methods.

Unit-I: **15Hrs.**

Data Science: Introduction to Data Science - Digital Universe - Sources of Data - Information Commons - Data Science Project Life Cycle: OSEMN Framework
(Book 1: Chapter 2)

Data Preprocessing: Introduction to Data Preprocessing – Reading, Selecting, Filtering, Data - Filtering Missing Values - Manipulating, Sorting, Grouping, Rearranging, Ranking Data. (T. Book 3: Ch-3, 5 & 7)

Unit-II: **15Hrs.**

Concept Learning: Formulation of Hypothesis - Probabilistic Approximately Correct Learning VC Dimension - Hypothesis Elimination - Candidate Elimination Algorithm.
(T. Book 2: Ch-2)

Essentials of R: R s - Data Types and Objects - Control Structures - Data Frame - Feature Engineering- Scaling, Label Encoding and One Hot Encoding, Reduction.
(T. Book 3: Ch-15)

Unit-III: **15Hrs.**

Model Fit Using R: Regression Models - Linear and Logistic Model. Classification Models - Decision Tree, Naive-Bayes, SVM and Random Forest. Clustering Models - K Means and Hierarchical Clustering.
(T. Book 5: Ch-3,4,8, T. Book3: Ch-8,9,10, T. Book1: Ch-3)

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Visualization: Data Visualization: Box plot, Histogram, Scatter Plot, Heat Map - Working with Tableau - Outlier detection - Data Balancing.
(T. Book 3: Ch-1)

Unit-IV: **15Hrs.**

Performance Evaluation: Loss Function and Error: Mean Squared Error, Root Mean Squared Error (T. Book 2: Ch-2, T. Book 5: Ch-3)

Model Selection and Evaluation Criteria: Accuracy. Precision, Fl score, Recall Score - Binary Predictive Classification - Sensitivity – Specificity, Recent Trends and Challenges in Data Science.
(T.Book 3: Ch-8)

Prescribed Books:

1. Doing Data Science: Straight Talk from the Frontline, By Cathy O'Neil, Rachel Schutt, 2013
2. Introduction to Machine Learning by Ethem Alpaydin, Fourth Edition, MIT Press, 2020.
3. Hadley Wickham. Garrett Grolemund. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data Paperback, 2017.
4. Han. J., Kamber, M., Pei, J. Data mining concepts and techniques Morgan Kaufmann, 2011.
5. Carl Shan, Henry Wang, William Chen, Max Song. The Data Science Handbook: Advice and Insight from 25 Amazing Data Scientists. The Data Science Bookshelf, 2016.

Reference Books:

1. James G.. Witten. D., T., Tibshirani, R. An Introduction to statistical learning with applications in R-Springer. 2013.
2. Names: Davies, Tilman M., author. Title: The book of R : a first course in programming and statistics / by. Tilman M. Davies. 2016

COURSE OUTCOMES: At the end of the course students will be able to:

CS402 CO1: Gain a thorough understanding of data science principles and techniques for effective data preprocessing.
CS402 CO2: Acquire skills in hypothesis formulation, implementing candidate elimination algorithms, and utilizing R basics for data analysis.
CS402 CO3: Explore model fitting using R and master data visualization techniques for insightful data analysis.
CS402 CO4: Develop expertise in evaluating model performance using various methods and metrics in data science.

Employability Aspect: Data science with R skills boost employability by enabling effective implementation of machine learning algorithms and data analysis.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: COMPUTER ORGANIZATION

PAPER CODE: CS403(A) **PPW: 4**
YEAR/SEMESTER: II/IV **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of digital computer operations, arithmetic unit operations, I/O device communications and memory management.

UNIT-WISE COURSE OBJECTIVES:

COb1: To inculcate knowledge on basic structure and operation of digital logic circuits, digital components, and data representation.
COb2: To demonstrate register transfer language and various micro-operations and computer instructions.
COb3: To discuss different ways of registering organizations, addressing modes and computer arithmetic calculations.
COb4: To describe various data transfer modes, interrupts, I/O communication and pipeline concept and parallel processing.

Unit – I: **15 Hrs.**

Digital Logic circuits: Digital computers. Logic Gates, Boolean algebra. Map Simplification, Combinational Circuits, Flip-Flops, Sequential Circuits.
Digital components: Integrated circuits. Decoders. Multiplexers. Registers. Shift Registers, Binary Counters, Memory Unit.
Data Representation: Data Types (number systems- binary, octal, decimal and hexadecimal), complements. Fixed point Representations, Floating point Representation. Binary Codes and Error Detection Codes. (Ch-1,2 & 3).

Unit – II: **15 Hrs.**

Register transfer and Micro-operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations and Shift Micro operations.

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Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input-Output and Interrupt, Design of Accumulator Logic. (Ch- 4 & 5).

Unit – III: **15 Hrs.**

Programming the Computer: Machine Language, Assembly Language, the Assembler, Program Loops, Programming Arithmetic and Logic Operations, Subroutines, Input–Output Programming.

Central Processing Unit: General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data and Transfer Manipulation, Program Control, Reduced Instruction Set Computer.

Computer Arithmetic: Addition and Subtraction, Multiplication Algorithms, Division Algorithms and Floating-Point Arithmetic Operations, Decimal Arithmetic Unit, Decimal Arithmetic Operations. (Ch-6,8 & 10).

Unit – IV: **15 Hrs.**

Input-Output Organization: Peripheral Devices, Input-Output interface, Asynchronous Data Transfer, Modes of Transfer, Priority interrupt, Direct Memory Access (DMA), input-output processors (IOP), Serial communication.

Pipeline and Vector Processing: Parallel Processing. Pipelining, Arithmetic Pipelines, Instruction Pipelines and RISC Pipelines, Vector Processing. (Ch-11 & 9).

Prescribed Books:

1. Computer System Architecture, M. Morris Mano, Prentice Hall of India Pvt. Ltd., Third Edition, Sept. 2017

Reference Books:

1. Andrew S. Tanenbaum, Structured Computer Organization, 2021
2. William Stallings, Computer Organization and Architecture, 2021
3. ZviKohavi, Niraj K. Jha, Switching and Finite Automata Theory 2012
4. Sajjan G. Shiva, Computer Organization, Design and Architecture, 2014
5. David A. Patterson, John L. Hennessy, Computer Organization Design 2013
6. Sivarama P. Dandamudi, Fundamentals of Computer Organization and Design 2013
7. David Money Hanis, Sarah L. Harris, Digital Design and Computer Architecture 2012
8. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization and Embedded Systems 2011

COURSE OUTCOMES: At the end of the course students will be able to:

CS403(A) CO1: Basic structure of digital computer and its functions.
CS403(A) CO2: Understand digital components and micro-operations.
CS403(A) CO3: Micro programming operations and CPU organization.
CS403(A) CO4: Understand Memory organization and I/O device processing.

Employability Aspect: Computer organization skills enhance employability by providing a deep understanding of hardware architecture and optimizing system performance.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: DISTRIBUTED SYSTEMS

PAPER CODE: CS403(B) **PPW: 4**
YEAR/SEMESTER: II/IV **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of distributed environment, uses, replications and security issues.

UNIT-WISE COURSE OBJECTIVES:

COb1: To inculcate knowledge on Hardware requirement of distributed systems and its process.
COb2: To demonstrate the concepts of communication, naming, and synchronization issues.
COb3: To inculcate knowledge on replication consistency, fault tolerance and security issues.
COb4: To illustrate the concepts related to distributed file system and web based systems.

Unit – I: **15 Hrs.**

Introduction: definition of a distributed system, goals, types of distributed systems.

Architectures: architectural styles, system architectures (Centralized, Multi Layered), architectures versus middleware, self-management in distributed systems (The Feedback Control Model).

Processes: threads. visualization. clients. servers, code migration (Approaches to Code Migration, Migration and Local Resources). (Ch-1,2 &3).

Unit – II: **15 Hrs.**

Communication: Remote Procedure Call. Message-oriented communication, Stream-oriented Communication. Multicast Communication (Application-Level Multicasting).

Naming: names, identifiers and addresses, flat naming (Simple Solutions, Home-Based Approaches), structured naming (Name Spaces), attribute-based naming.

Synchronization: clock synchronization. logical clocks. mutual exclusion (Decentralized and Token Ring Algorithms), global positioning of nodes. election algorithms. (Ch- 4,5 & 6).

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Unit – III: **15 Hrs.**

Consistency and Replication: introduction. data-centric consistency models, client-centric consistency models. replica management, consistency protocols (Primary-Based Protocols, Replicated -Write Protocols).

Fault Tolerance: introduction, process resilience (Design Issues, Failure detection), reliable client server communication, reliable group communication (Scalability in Reliable Multicasting), distributed commit (two phase commit), recovery-introduction, recovery-oriented computing.
Security: Introduction to security-Cryptography, secure channels, access control, security management. (Ch- 7, 8 & 9).

Unit – IV: **15 Hrs.**

Distributed object-Based Systems: architecture processes, communication, naming. synchronization. consistency and replication, fault tolerance, security.

Distributed File systems: architecture, process, communication, naming, synchronization, consistency and replication, fault tolerance, security.

Distributed web-based Systems: architecture, process, communication. naming, synchronization, consistency and replication, fault tolerance, security. (Ch-11, 12 & 13).

Prescribed Book:

l. Andrew S. Tanenbaum, Maarten Van Steen, Distributed Systems - Principles and Paradigms (2e). 2006

Reference Books:

l. Sukumar Ghosh, Distributed Systems An Algorithmic Approach.2014
2. Joel M. Crichlow, Distributed Systems Computing Over Networks. 2014
3. Kai Hwang, Distributed and Cloud Computing from Parallel Processing to Internet of Things.2011
4. Ajay D. Kshemkalyani, Mukesh Singhal, Distributed Computing Principles, Algorithms, and Systems. 2011
5. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Distributed Systems Concepts and Design. 2011

COURSE OUTCOMES: At the end of the course students will be able to:

CS403(B) CO1: Correlate the traditional client/server and distributed system functions.
CS403(B) CO2: Comprehend processes communication, naming and different synchronization issues.
CS403(B) CO3: Analyze data consistency, fault tolerance and security issues.
CS403(B) CO4: Acquire knowledge on distributed object-based environment and distributed web based systems.

Employability Aspect: Skills in distributed systems enhance employability by facilitating the creation and management of scalable, reliable, and efficient networked applications.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: MACHINE LEARNING

PAPER CODE: CS403(C) **PPW: 4**
YEAR/SEMESTER: II/IV **NO. OF CREDITS: 4**

COURSE OBJECTIVE: To enable students with the concepts of Machine Learning.

UNIT-WISE COURSE OBJECTIVES:

COb1: To demonstrate the concepts of Bayes Decision Theory and linear machines.
COb2: To learn the Decision tree and Instance based Learning.
COb3: To describe the limitations, Improvements, and assessments of machine learning.
COb4: To Analyze Vector machines.

Unit – I: **15 Hrs.**

Overview and Introduction to Bayes Decision Theory: Machine intelligence and applications, pattern recognition concepts classification. regression. feature selection. supervised learning class conditional probability distributions. Examples of classifiers layers optimal classifier and error, learning classification approaches.

Linear machines: General and lineal discriminants. decision regions. single layer neural network, Linear separability. general gradient descent. perceptron Learning algorithm. mean square criterion and widrow-Hoff learning algorithm; multi-Layer perceptions: two-layers universal approximators, backpropagation learning. on-line, off-line error surface, important parameters.

Unit – II: **15 Hrs.**

Learning decision trees: Inference model, general domains. symbolic decision trees, consistency, learning trees from training examples entropy. mutual information. ID3 algorithm criterion. C4.5 algorithm continuous test nodes, confidence, pruning. learning with incomplete data.

Instance-based Learning: Nearest neighbor classification. k-nearest neighbor, nearest neighbor error probability.

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Unit – III: **15 Hrs.**

Machine learning concepts and limitations: Learning theory, formal model of the learnable. sample complexity, learning in zero-bayes and realizable case, VC-dimension. fundamental algorithm independent concepts, hypothesis class. target class. inductive bias. occam's razor. empirical risk, limitations of inference machines, approximation and estimation errors, Trade-off.

Machine learning assessment and Improvement: Statistical model selection, structural risk minimization. bootstrapping. bagging. boosting.

Unit – IV: **15 Hrs.**

Support Vector Machines: Margin of a classifier, dual perceptron algorithm. learning nonlinear hypotheses with perceptron kernel functions, implicit non-linear feature space. theory, zero-Bayes. realizable infinite hypothesis class. finite covering, margin-based bounds on risk, maximal margin classifier.

Prescribed Books:

1. E. Alpaydin, Introduction to Machine Learning. Prentice Hall of India, 3e/4e, 2020
2. T. M. Mitchell, Machine Learning. McGraw-Hill, 1997.

Reference Books:

1. C. M. Bishop, Pattern Recognition and Machine Learning, Splinger.2006.
2. R. O. Duda, P. E. Hart, and D.G. Stork. Pattern Classification. John Wiley and Sons. 200t.
3. Vladimir N. Vapnik, Statistical Learning Theory, John Wiley, and Sons. 1998.
4. J. Shawe-Taylor and N. Cristiani, Cambridge. Introduction to Support Vector Machines, University Press 2000.

COURSE OUTCOMES: At the end of the course students will be able to:

CS403(C)*CO1: To relate and understand Bayes Decision Theory and linear machines.
CS403(C) CO2: To relate and understand Decision tree and Instance based Learning.
CS403(C) CO3: To relate and understand limitations, Improvements and assessments of machine learning.
CS403(C) CO4: To Analyze and understand Vector machines.

Employability Aspect: Machine learning skills boost employability by empowering the creation of predictive models and data-driven solutions.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: DATA SCIENCE WITH R LAB

PAPER CODE: CS401P | **PPW: 4**
YEAR/SEMESTER: II/IV | **NO. OF CREDITS: 2**

COURSE OBJECTIVE: To enable students with the concepts of Data Visualization Techniques and Machine Learning algorithms using R Programming.

COb1: To understand and apply basic arithmetic, logical operations, loops, conditional statements, and data structures in R.

COb2: To explore data visualization techniques, statistical analysis, handling missing/outlier/invalid values, and implementing machine learning algorithms in R.

Week-1:

I. Download and Install R-Programming Environment and Install packages using install. Packages() command in R.

Week-2:

II. Learn all the basics of R-Programming (Data types, Variables, Operators, Loops, Conditional Statements etc,), Write R scripts to demonstrate the same.

Week-3:

1. a) Perform some arithmetic and logical operations in R.
   b) Write a program to find list of even numbers from 1 to n using R-Loops.
2. a) Write a program to join columns and rows in a data frame using cbind() and rbind() in R.
   b) Implement different String Manipulation functions in R.

Week-4:

3. a) Implement different data structures in R (Vectors, Lists, Data Frames).
   b) Write a program to read a csv file and analyze the data in the file in R.
4. a) Create pie chart and bar chart using R.

Week-5:

5. Demonstrate the process of creating a user defined function in R.
6. a) Write an R script to change the structure of a Data frame.
   b) Write an R script to expand a Data frame.

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Week-6:

7. a) Write an R script to convert a vector to factors.
   b) Write an R script to demonstrate R objects.

Week 7:

8. Demonstrate the following aggregate functions in R: sum. mean. count, min, max

Week-8:

9. Write an R script to read and write different files.

Week-9:

10. a) Write an R script to find subset of a dataset.
    b) Elucidate the process of data exploration in R using read(), summary(), nrow(), ncol(), str().

Week-10:

11. a) Write an R script to handle missing values in a dataset.
    b) Write an R script to handle outliers.
    c) Write an R script to handle invalid values.

Week-11:

12. a) Visualize iris dataset using mosaic plot.
    b) Visualize correlation between sepal length and petal length in iris data set using scatter plot.

Week-12:

13. Linear Regression: Consider the following mice data:
    Height: 140. 142, 150, 147, 139, 152, 154, 135, 149, 147.
    Weight: 59, 61, 66, 62, 57, 68, 69, 58, 63, 62.
    Derive relationship coefficients and summary for the above data.

Week-13:

14. Consider the above data and predict the weight of a mouse for a given height and plot the results using a graph.

Week-14:

15. Time Series: Write R script to decompose time series data into random, trend and seasonal data.

COURSE OUTCOMES: At the end of the course students will be able to:

CS404P CO1: Demonstrate competence in using R for the basic programming tasks, including arithmetic operations, logical operations, loops, and conditional statements.

CS404P CO2: Apply advanced data handling techniques such as handling missing/outlier/invalid values, creating subsets, exploring data using summary statistics, and performing machine learning tasks like linear regression, logistic regression, and time series decomposition.

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PROGRAM NAME: M.Sc. (Computer Science), (w.e.f. 2025-2026)

COURSE NAME: PROJECT WORK

PAPER CODE: CS402P
YEAR/SEMESTER: II/IV

PPW: 12
NO. OF CREDITS: 6

COURSE OBJECTIVE: The main objective is to empower students with opportunities for hands-on experience, encouraging them to apply theoretical knowledge to real-world projects, fostering skill development, innovation and problem-solving capabilities.

The fourth semester is exclusively meant for project work. Each student must complete a project individually or in a group of two or three members over a span of 15 weeks.

By the end of the second week, students must submit a project synopsis in consultation with their guide. The synopsis should include the problem definition, scope of the project, and a plan of action.
After eight weeks, students must give a Project Seminar covering the problem analysis, system design, and implementation details.
At the end of the semester, students will attend a University Viva-Voce. For internal assessment (CIA), a committee of two faculty members and the guide will evaluate the project.
Each student must:

- Submit a one- or two-page synopsis for the notice board.
- Give a 20-minute presentation followed by a 10-minute discussion.
- Submit a technical write-up about the project.

CIA marks will be based on:

- Quality of the synopsis
- Presentation performance
- Technical write-up

The Project Seminar should include:

- Problem definition and specifications
- Literature review and familiarity with current research
- Knowledge of tools and techniques to solve the problem
- A work plan with activity charts (bar or Gantt charts)
- Good oral and written communication skills

Finally, students must submit the final project report, formatted as per the department's guidelines, at the time of the External Viva.

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