



Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

Shri Vaishnav Institute of Information Technology

Choice Based Credit System (CBCS) in the light of NEP-2020

B. Tech (CSE/ IT) - All Programs

SEMESTER-VI (2024-28)

COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME					L	T	P	CREDITS
			THEORY			PRACTICAL					
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
BTCS601N	DCC	Compiler Design	60	20	20	30	20	2	1	2	4

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P – Practical; C - Credit; *Teacher Assessment shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

COURSE OBJECTIVES:

The student will have ability:

1. To introduce the major concept areas of language translation and compiler design
2. To enrich the knowledge in various phases of compiler and its use
3. To provide understanding of steps of programming necessary for constructing a compiler

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Ability to apply the knowledge of lex tool & yacc tool to develop a scanner & parser
2. Ability to design and develop software systems for backend of the compiler
3. Ability to comprehend and adapt to new tools and technologies in compiler design

SYLLABUS

UNIT I

8 HOURS

Introduction: Compiler, Compilers analysis of the source program, Phases of a compiler, Cousins of the Compiler, Grouping of Phases and Compiler construction tools, Lexical Analysis, Role of Lexical Analyzer, Input Buffering and Specification of Tokens.

UNIT II

10 HOURS

Syntax Analysis: Role of the parser, Writing Grammars, Context-Free Grammars, Top-Down parsing, Recursive Descent Parsing, Predictive Parsing, Bottom-up parsing, Shift Reduce Parsing, Operator Precedent Parsing, LR Parsers, SLR Parser – Canonical LR Parser – LALR Parser.

UNIT III

9 HOURS

Intermediate Code Generation: Syntax Directed Definitions, Evaluation Orders for Syntax Directed Definitions, Intermediate languages, Declarations, Assignment Statements, Boolean Expressions, Case Statements, Three Address code, Back patching, Procedure calls.

UNIT IV

9 HOURS

Code Optimization and Run Time Environments: Introduction, Principal Sources of Optimization, Optimization of basic Blocks, DAG representation of Basic Blocks - Introduction to Global Data Flow Analysis, Runtime

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Environments, Source Language issues, Storage Organization, Storage Allocation strategies, Access to non-local names, Parameter Passing, Error detection and recovery.

UNIT V

9 HOURS

Code Generation: Issues in the design of code generator, The target machine, Runtime Storage management, Basic Blocks and Flow Graphs, Next-use Information, A simple Code generator, Peephole Optimization.

TEXTBOOKS:

1. A. V. Aho and J. D. Ullman, *Compilers: Principles, Techniques and Tools*. Singapore: Pearson Education Asia, 2012.
2. J. P. Tremblay and P. G. Sorenson, *The Theory and Practice of Compiler Writing*. Hyderabad, India: BS Publications, 2005.

REFERENCE:

1. D. M. Dhamdhare, *Compiler Construction: Principles and Practice*, 2nd ed. New Delhi, India: Macmillan India Ltd., 2008.
2. A. I. Holub, *Compiler Design in C*. New Delhi, India: Prentice Hall of India, 2003.
3. C. N. Fischer and R. J. LeBlanc, *Crafting a Compiler with C*. Redwood City, CA, USA: Benjamin Cummings, 2003.
4. H. Alblas and A. Nymeyer, *Practice and Principles of Compiler Building with C*. New Delhi, India: Prentice Hall of India, 2001.
5. K. C. Loudon, *Compiler Construction: Principles and Practice*. Pacific Grove, CA, USA: Thomson Learning, 2003.

LIST OF PRACTICALS

1. To study the Lex Tool.
2. To study the Yacc Tool.
3. Write a program to implement Lexical Analyzer to recognize few patterns of C.
4. Write a program to implement the Recursive Descent Parser.
5. Write a program to implement the Computation of FIRST and FOLLOW of variables of grammar.
6. Write a program to compute the leading and trailing symbols of grammar.

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7. Write a program to implement Operator Precedence Parser.
8. Write a program to implement SLR parser.
9. Write a program to check the data types.
10. Write a program to implement the generation of three address codes.
11. Write a program to implement the computation of postfix notation.
12. Write a program to implement the computation of Quadruple.

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BTCS602N	DCC	Object Oriented Analysis and Design	60	20	20	30	20	3	0	2	4

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COURSE OBJECTIVES:

The student will have ability:

1. To learn the concept of Object-Oriented Software Development Process
2. To get acquainted with UML Diagrams
3. To understand Object Oriented Analysis Processes

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Understand Object Oriented Software Development Process
2. Gain exposure to Object Oriented Methodologies & UML Diagrams
3. To apply Object Oriented Analysis Processes for projects

SYLLABUS

UNIT I

10 HOURS

Introduction: About Object Oriented Technology, Development and OO Modeling History. Modeling Concepts: Modeling design Technique, Three models, Class Model, State model and Interaction model.

UNIT II

9 HOURS

Class Modeling: Object and class concepts, link and association, Generalization and Inheritance, Advanced class modeling- aggregation, Abstract class meta data, constraints. State Modeling: Event, state, Transition and conditions, state diagram, state diagram behavior, concurrency, Relation of Class and State models. Interaction Modeling: Use case Models, sequence models, activity models

UNIT III

8 HOURS

Analysis and Design: Development Life cycle, Development stages, Domain Analysis-Domain class model, Domain State Model, Domain Interaction Model, Iterating and Analysis. Application Interaction Model, Application Class Model, Application State Model, Adding Operation.

UNIT IV

9 HOURS

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System Design: Estimating Performance, Making a Reuse Plan, Breaking System into Sub Systems Identifying Concurrency, Allocation of Subsystems, Management of Data Storage, Handling Global Resources, Choosing a Software Control Strategy, Handling Boundary Condition, Common Architectural Style.

UNIT V

9 HOURS

Class design: Overview of Class Design, Designing Algorithms Recursing Downward, Refactoring, Design Optimization, Adjustment of Inheritance, Rectification of Behavior.

TEXTBOOKS:

1. M. Blaha and J. Rumbaugh, *Object-Oriented Modeling and Design with UML*. Singapore: Pearson Education, 2005.

REFERENCE:

1. J. W. Satzinger, R. B. Jackson, and S. D. Burd, *Object-Oriented Analysis and Design with the Unified Process*. Boston, MA, USA: Cengage Learning, 2007.
2. B. O'Docherty, *Object-Oriented Analysis and Design: Understanding System Development with UML 2.0*. New Delhi, India: Wiley India, 2005.

LIST OF PRACTICALS

1. Identify the problem statement.
2. Perform the system analysis: Requirement analysis, SRS.
3. Perform the function-oriented diagram: DFD and Structured chart.
4. Perform the user's view analysis: Use case diagram.
5. Draw the structural view diagram: Class diagram, object diagram.
6. Draw the behavioral view diagram: Sequence diagram, Collaboration diagram.
7. Draw the behavioral view diagram: State-chart diagram, Activity diagram.
8. Draw the implementation view diagram: Component diagram.
9. Draw the environmental view diagram: Deployment diagram.

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Choice Based Credit System (CBCS) in the light of NEP-2020

B.Tech CSE with Specialization in FullStack Development & Blockchain (in association with IBM)

SEMESTER-VI (2024-2026)

COURSE CODE	CA TE GO RY	COURSE NAME	TEACHING & EVALUATION SCHEME					L	T	P	C R E D I T S
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BTIBMC701	DCC	Web Services	60	20	20	-	-	2	0	0	2

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COURSE OBJECTIVES:

The student will have ability to:

1. To explain the importance of Web Services and Use of XML JAXB and using SOAP and REST Web Services.
2. To learn the importance of Spring Boot and JAVA in Web Services.
3. To be able to use POSTMAN accessing dummy URLs as well as self-created URLs.
4. To be able to Secure Web Service using Transport layer and Application-Level Security.

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Understand the use of SOAP and REST web services in Enterprises from a global context.
2. To understand and Write SOAP web services from industry perspective of Web Services.
3. Applying and analysing Restful Web Services.
4. To evaluate the application of REST Web Services in university environment by Using JAX-RS and JAX-WS API's in java.
5. Creating and Securing Web Services by Using Transport and Application-level Security. Creating projects and research activities based on SOAP & REST API.

SYLLABUS

UNIT I

8 HOURS

WEB SERVICES INTRODUCTION:

Introduction to XML what is Web Services? Why Web Services? Web Services Fundamentals Services Oriented Architecture; HTTP and XML and SOAP WSDL; UDDI; REST; SOAP vs REST JAXB Overview; JAXB Binding Process;

UNIT II

8 HOURS

INTRODUCTION TO SOAP:

SOAP Overview; SOAP Message Exchange Model; Data Encoding, Installing and Configuring Apache SOAP; Server and Client Program; Deployment Descriptor, Describing Web Services with Example; Anatomy of a services; Defining Data types and structures with XML Schemas; Describing Web Services Interface and Implementation; Understanding Message patterns.

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BTIBMC701	DCC	Web Services	60	20	20	-	-	2	0	0	2

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UNIT III	10 HOURS
JAVA API FOR RESTFUL SERVICES: Introduction to JAVA API; REST and HTTP; Resource URI; Collection URIs; Method Idempotence; What is JAX-RS Introduction to UDDI; UDDI Registry; Technical Architecture; Using UDDI with WSDL. Dispatching Request to Methods: Creating a Resource; Returning XML Responses; Installing REST API Client; Building Services Stubs; Accessing Path Params; Returning JSON Response; Implementing POST Update and Delete Methods; Pagination and Filtering	
UNIT IV	8 HOURS
REST API USING JAVA CLIENT JAX-RS: The Param Annotation; Sending Status codes and location Headers; Handling Exception; Using Web-Application Exception; Content Negotiation and Content Negotiation using HTTP Headers; Content Negotiation using URIs Patterns JAX-RS Client; Creating JAVA Client using JAX-RS; Sending GET/POST Request using JAVA Client.	
UNIT V	8 HOURS
WRITING SOAP SERVICES: Initialize a Spring Web Service Application with Spring Boot; Overview of creating SOAP Web Service using Contract First Approach; Define Request and Response XML Structure; Define XSD for Request and Response; Introduction to JAXB and configuration. What are Secure Web Services?; Transport Level Security and Application-Level Security. Future of Web Development; Future of SOAP WSDL and UDDI. PROJECT: Create and execute a SOAP project using WSDL. Following should be done on the project: I. Creating SOAP project- adding WSDL during creation or after it is created. II. Request and Response verification.	
TEXTBOOKS:	
1.	IBM Courseware .
2.	IBM Knowledge Center.
3.	L. Richardson and S. Ruby, Restful Web Services. O'Reilly Media, 2008
REFERENCE:	
1.	Core Java, Collection Framework IBM Knowledge Center.

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COURSE OBJECTIVES:

The student will have ability:

1. To understand what Edge AI is and why running smart models on tiny gadgets is better than sending data to the cloud.
2. To learn how to compress a standard AI model so it can fit onto small, cheap computer chips.
3. To build real, physical projects that can see, hear, and feel movements without needing the internet.

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Explain the basic differences between a computer, a smartphone, and a tiny microcontroller chip.
2. Shrink a Python-trained AI model down to a tiny fraction of its size using basic optimization tricks.
3. Program a smart physical gadget to detect voices, gestures, or objects completely offline.

SYLLABUS

UNIT I

8 HOURS

Introduction: Introduction to Edge AI and Tiny Machine Learning (TinyML), Cloud Computing vs. Edge Computing vs. TinyML Benefits of On-Device Processing: Privacy, Latency, Bandwidth, and Power, Introduction to Microcontrollers (MCUs) vs. CPUs and GPUs, Hardware Constraints: Millivolt Power Budgets, Flash Memory, and Static RAM (SRAM), Overview of Low-Power Hardware Ecosystems (ARM Cortex-M, ESP32, Arduino Nano)

UNIT II

10 HOURS

TinyML Software Pipeline: The Lifecycle of a TinyML Application, Specialized Edge Software Frameworks (TensorFlow Lite for Microcontrollers, Edge Impulse), Model Compilation: Converting Desktop Models (.h5/.pt) to Flatbuffer Binaries (.tflite), Converting Binaries to Static C-Byte Arrays (.cc format) for Bare-Metal Deployment, Interpreter-Free Code Generation Platforms, Static Memory Allocation and Memory Workspace Safety

UNIT III

9 HOURS

Model Optimization and Compression Techniques: Floating-Point Arithmetic (32-bit Float) vs. Integer Constraints (8-bit Integer), Post-Training Quantization (PTQ): Dynamic Range, Full Integer, and Float16 Quantization, Quantization-Aware Training (QAT) Basics, Mathematical Core of Quantization: Scales, Offsets, and Zero-Points, Weight Pruning: Structural vs. Unstructural Matrix Thinning, Knowledge Distillation and Weight

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Clustering Basics.

UNIT IV

9 HOURS

Sensory Inputs and Signal Processing at the Edge: Interfacing and Sampling Raw Data from Low-Power Physical Sensors, Motion Processing: Multi-Axis Accelerometer and Gyroscope Stream Ingestion, Audio Processing: Time-Domain Waveforms to 2D Spectrograms via Fast Fourier Transforms (FFT), Mel-Frequency Cepstral Coefficients (MFCC) Extraction for Edge Audio, Vision Processing: Low-Resolution Camera Frame Buffering, Color-Space Conversions (RGB to Grayscale) and Downsampling for Tiny Vision Models.

UNIT V

9 HOURS

Real-World Applications, Edge MLOps, and Security: Industrial Use Cases: Vibration Anomaly Detection and Predictive Maintenance, Environmental and Consumer Use Cases: Smart Agriculture Sensors and Wearable Trackers, Introduction to Edge MLOps: Remote Firmware Updates and Over-The-Air (OTA) Deployments, Managing Performance Degradation and Device Drift in Changing Environments, Physical Security Vulnerabilities of Edge Endpoints, Data Privacy and Prompt Guardrails for Local Micro-Inference Loops.

TEXTBOOKS:

1. P. Warden and D. Situnayake, *TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers*, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2020.
2. G. M. Iodice, *TinyML Cookbook: Combine Artificial Intelligence with Microcontrollers to Create Smarter Edge Devices*, 2nd ed. Birmingham, UK: Packt Publishing, 2024. .

REFERENCE:

1. B. Fowler, *Hands-on AI Agents and Edge Projects with Python*, 1st ed. Boston, MA, USA: O'Reilly Media, 2025.
2. J. Williams, *Generative AI and Edge Blueprint: Designing Tools and Workflows*, New York, NY, USA: McGraw-Hill, 2025.
3. A. Patel, *Introduction to Embedded Systems and TinyML Workflows*, San Francisco, CA, USA: Morgan Kaufmann, 2025.
4. Google LLC, "TensorFlow Lite for Microcontrollers Guide," 2026. [Online]. Available: <https://www.tensorflow.org/lite/microcontrollers>

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- Edge Impulse Inc., "TinyML Course and Tutorials for Beginners," 2026. [Online]. Available: <https://docs.edgeimpulse.com/>
- Harvard John A. Paulson School of Engineering, "Introduction to TinyML (CS249r) Open Resources," 2025. [Online]. Available: <https://tinymml.harvard.edu/>

LIST OF PRACTICALS

- The Math Magic (Sine Wave Project): Train a basic Python model to draw a perfect curve, convert it into an 8-bit integer file, and view it as raw C-code.
- The Model Shrinker: Take an AI model and use a simple slider tool or script to reduce its size from megabytes to kilobytes. Observe the size difference!
- The Data Collector: Shake a hardware sensor (or your smartphone) to collect data for three actions: a wave, a circle, and a rest state. Export this as a clean dataset.
- The Gesture Detector: Put your custom motion data into a simple builder, train it, and make an on-board LED light flash blue when you wave your hand.
- Visualizing Sound: Record a 2-second audio file of yourself speaking and use a Python script to instantly transform it into a frequency image (Spectrogram).
- The Voice Switch: Load a small audio model onto a device. Make an LED turn ON when you say "Go" and turn OFF when you say "Stop" entirely offline.
- Is Someone There? (Person Detector): Hook up a tiny dollar-store camera to a microcontroller and deploy an AI model that flashes a red light if a human steps into frame.
- The Speedometer Test: Write a simple line of code to count exactly how many milliseconds your tiny chip takes to make a single prediction.
- Battery-Saver Mode: Program your device to "sleep" when nothing is happening, waking up only when the sensor detects a sharp movement.
- Final Capstone Build: Assemble a quick, practical prototype (e.g., a "Smart Mailbox" that blinks when mail is dropped in, or a "Pet Feed Detector"). Present a short demo video of your working gadget.

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BTIBM621	DCC	DevOps & Agile Development	60	20	20	30	20	3	0	2	4

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P – Practical; C - Credit; *Teacher Assessment shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

COURSE OBJECTIVES:

The student will have ability to:

1. Understand the fundamental concepts of Agile methodologies, Scrum framework, DevOps lifecycle, and modern software development practices.
2. Apply Agile and DevOps tools, techniques, CI/CD pipelines, and Scrum practices for effective project development and deployment.
3. Analyze and evaluate Agile and DevOps practices to improve software quality, collaboration, scalability, and continuous delivery in real-world projects.

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Explain Project Management methodologies, Agile principles, Scrum practices, DevOps lifecycle, and CI/CD concepts for software development processes.
2. Apply Scrum techniques, Agile practices, DevOps tools, and CI/CD pipelines to develop and manage software projects in collaborative environments.
3. Analyze and evaluate Agile and DevOps strategies, metrics, cloud services, and automation practices for improving software delivery and operational performance.

SYLLABUS

UNIT I

10 HOURS

Introduction to Project Management, Agile and DevOps: What is a Project, Project Management Basics, Relationship between Project, Program and Portfolio, Project Execution Methodologies, Waterfall Model, V-Model, Agile Methodology, Introduction to Agile, Introduction to DevOps, Need for DevOps, DevOps vs Traditional IT, DevOps vs Agile, DevOps Principles and Lifecycle.

UNIT II

8 HOURS

Agile Frameworks and Scrum Fundamentals: Introduction Agile Deep Dive, Agile Manifesto and Principles, Agile Frameworks (XP, RUP, FDD, TDD, Scrum, Kanban), Agile vs Waterfall, Scrum Framework, Scrum Roles and Responsibilities, Sprint Concepts, Scrum Artifacts, Product Backlog, Sprint Backlog, Product Increment.

UNIT III

9 HOURS

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Scrum Practices and DevOps Tools: Scrum Ceremonies, Sprint Planning, Daily Scrum, Sprint Review, Sprint Retrospective, User Stories and Estimation, Definition of Done, Scrum Metrics, Team Velocity, Sprint Burndown Chart, Defect Density, Introduction to CI/CD, DevOps Tools (Git, Maven, Jenkins, Docker, Puppet, JUnit, Nagios, Grafana & Graphite)

UNIT IV

9 HOURS

CI/CD Pipeline, Advanced DevOps and Cloud: Setup CI/CD Pipeline from Scratch, DevOps Use Cases, Benefits of DevOps in Industries, Advanced DevOps Concepts, Automatic Rollback, Automatic Provisioning, Infrastructure as Code, Scalability, Clustering, Introduction to Cloud Computing, DevOps on Cloud, IBM Cloud Services, Tool chain, DevOps Insights, CI/CD Pipeline on IBM Cloud.

UNIT V

9 HOURS

Agile Scaling, Case Studies and Industry Applications: Scaling Scrum, Distributed Scrum Practices, Agile Environment and Tools, Kanban vs Scrum, XP vs Scrum, Agile Release Planning, Sprint Execution, Team Roles and Responsibilities, Agile Case Studies, IT Projects, Non-IT Projects, Industry Applications of Agile and DevOps.

TEXTBOOKS:

1. K. Schwaber and J. Sutherland, *The Scrum Guide: The Definitive Guide to Scrum*. Scrum.org, 2020.
2. G. Kim, J. Humble, P. Debois, and J. Willis, *The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations*. Portland, OR, USA: IT Revolution Press, 2021.

REFERENCE:

1. K. Beck, *Extreme Programming Explained: Embrace Change*, 2nd ed. Boston, MA, USA: Addison-Wesley, 2004.
2. M. Fowler, *Agile Software Development: Principles, Patterns, and Practices*. Boston, MA, USA: Addison-Wesley, 2002.
3. J. Humble and D. Farley, *Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation*. Boston, MA, USA: Addison-Wesley, 2010.
4. N. Forsgren, J. Humble, and G. Kim, *Accelerate: The Science of Lean Software and DevOps*. Portland, OR, USA: IT Revolution Press, 2018.
5. E. Kim, M. Behr, G. Spafford, and K. Allspaw, *The Phoenix Project: A Novel about IT, DevOps, and Helping*

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Your Business Win, 5th Anniversary ed. Portland, OR, USA: IT Revolution Press, 2018.

LIST OF PRACTICALS

1. Study and comparison of Waterfall, V-Model, Agile and DevOps methodologies
2. Create Product Backlog, Sprint Backlog and User Stories for a sample project
3. Conduct Scrum ceremonies including Sprint Planning, Daily Scrum and Retrospective
4. Installation and configuration of Git for version control management
5. Build automation using Maven for a Java/Python application
6. Setup Continuous Integration pipeline using Jenkins
7. Containerization of an application using Docker
8. Configure Continuous Testing and Monitoring using JUnit and Nagios/Grafana
9. Develop and deploy a complete CI/CD pipeline using DevOps tools
10. Mini Project/Case Study on Agile and DevOps implementation using IBM Cloud or similar cloud platform

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BTDSE622	DSE	Blockchain and Distributed Systems	60	20	20	30	20	3	0	2	4

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COURSE OBJECTIVES:

The student will have ability:

1. To introduce the foundational concepts of distributed systems, including transparency, system models, and classical synchronization challenges.
2. To understand the structural components of blockchain networks, including cryptographic primitives, immutability, and distributed ledgers.
3. To design, write, deploy, and debug secure decentralized applications (DApps) and smart contracts using contemporary industry frameworks.

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Contrast centralized, distributed, and decentralized network architectures while identifying classical failure modes and consistency issues.
2. Explain the underlying mechanics of cryptographic hashing, digital signatures, consensus protocols (PoW, PoS), and state transitions in block structures.
3. Construct, test, and programmatically interface with autonomous smart contracts to execute transactions and query immutable states.

SYLLABUS

UNIT I

8 HOURS

Introduction: Introduction to Distributed Systems: goals, characteristics, and hardware/software architectures. The spectrum of networks: Centralized vs. Distributed vs. Decentralized topologies. Fundamental challenges: the CAP Theorem (Consistency, Availability, Partition tolerance) and FLP Impossibility. Concurrency and Synchronization: Physical clocks, Logical Clocks (Lamport Timestamps), and Vector Clocks. Understanding system failures: Crash-stop vs. Byzantine faults.

UNIT II

10 HOURS

Classical Consensus and Cryptographic Building Blocks: Introduction to classical distributed consensus: Paxos and Raft algorithms. Fundamental Cryptography for Blockchains: Cryptographic hash functions (SHA-256 properties), collision resistance, and preimage resistance. Data integrity verification: Merkle Trees and Merkle Proofs. Identity and authentication: Asymmetric Key Cryptography (Public/Private key pairs) and the Digital

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Signature Algorithm (ECDSA).

UNIT III

9 HOURS

Introduction to Blockchain & Distributed Ledgers: What is a Blockchain? Detailed block anatomy: header, nonce, difficulty targets, timestamp, and transaction root. Ledger properties: immutability, append-only architecture, and transparency. Blockchain categorizations: Public, Private, and Permissioned networks (Ethereum vs. Hyperledger Fabric). Modern Decentralized Consensus mechanisms: Proof of Work (PoW) mining loops vs. Proof of Stake (PoS) validator pools.

UNIT IV

9 HOURS

Smart Contracts and Decentralized Applications: Evolution of programmable block networks: Bitcoin script vs. Ethereum Virtual Machine (EVM). Introduction to Smart Contracts: life cycle, execution models, and state variables. Programming Language Essentials: Fundamentals of Solidity (variables, visibility modifiers, control structures, mappings, functions, and events). Gas mechanics: execution costs, base fees, priority fees, and preventing out-of-gas termination loops.

UNIT V

9 HOURS

Enterprise Solutions, Security, and Future Web3 Trends: Tokenization and standard interfaces: Fungible assets (ERC-20) vs. Non-Fungible Tokens (ERC-721 / ERC-1155). Introduction to Permissioned Blockchains: Hyperledger Fabric architecture, channels, and chaincode configurations. Smart Contract vulnerabilities and security: Reentrancy bugs, arithmetic overflows, and front-running risks. Future Directions: Layer-2 scaling (Rollups, State Channels), cross-chain interoperability protocols, and decentralized storage systems (IPFS).

TEXTBOOKS:

1. I. Bashir, *Mastering Blockchain: Deeper Insights into Decentralization, Cryptography, Smart Contracts, and Distributed Ledgers*, 4th ed. Birmingham, UK: Packt Publishing, 2023.
2. A. S. Tanenbaum and M. Van Steen, *Distributed Systems: Principles and Paradigms*, 4th ed. Amsterdam, Netherlands: distributed-systems.net, 2023.

REFERENCE:

1. A. M. Antonopoulos and G. Wood, *Mastering Ethereum: Building Smart Contracts and DApps*, 1st ed.

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Sebastopol, CA, USA: O'Reilly Media, 2018.

2. M. Swan, *Blockchain: Blueprint for a New Economy*, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2015.
3. C. Cachin, R. Guerraoui, and L. Rodrigues, *Introduction to Reliable and Secure Distributed Programming*, 2nd ed. Berlin, Germany: Springer, 2011.

LIST OF PRACTICALS

1. The Hash Machine: Write a Python script to compute the SHA-256 hashes of varying text inputs. Demonstrate how modifying a single character changes the output hash entirely (Avalanche Effect).
2. Merkle Tree Constructor: Implement a functional Merkle Tree structure in Python. Take an array of transaction strings, hash them sequentially into pairs, compute the Merkle Root, and generate a validation proof for a target transaction.
3. Cryptographic Identity Workshop: Generate an asymmetric cryptographic key pair using Python or a CLI utility. Write a short text payload, sign it using the private key, and write a verification routing check using the public key.
4. My First Blockchain: Build an abstract 3-node blockchain prototype in Python. Each block must link back to the previous block's hash, keep an array of records, and recalculate its own hash validly.
5. Remix IDE Environment Setup: Initialize a workspace using the online Remix IDE. Write and execute a fundamental "Hello World" smart contract containing read/write global string parameters, observing storage variable changes.
6. State and Access Controller: Write a Solidity contract representing a simple university grading index. Restrict execution patterns using custom structural statements (e.g., standard require or modifier wrappers) so only an assigned owner address can log scores.
7. The Bank Contract & Gas Tracer: Create a contract in Solidity mimicking a simplified digital vault where users can track personal balances, deposit assets, and withdraw values safely. Analyze and record the execution gas fees of each transaction type.
8. Token Deployment (ERC-20 Prototype): Implement and deploy a custom, standards-compliant ERC-20 utility token contract onto a local virtual blockchain testing network (e.g., Hardhat, Foundry, or Ganache).
9. DApp Interfacing Lab (Web3.js / Ethers.js): Build a basic local HTML webpage interface. Connect the client-side system to a Web3 wallet extension (e.g., MetaMask) to query on-chain block numbers and pull live data metrics from your deployed token contract.
10. Capstone Decentralized Application Prototype: Build an end-to-end decentralized application tracking

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system (e.g., an unalterable product supply chain log or a decentralized voting ballot box). Deliverables include clear, audited smart contract components, a working client browser interface, and a localized execution walkthrough demonstration.

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BTDSE621	DSE	Agentic AI & Multi-Agent Systems	60	20	20	30	20	3	0	2	4

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COURSE OBJECTIVES:

The student will have ability:

1. To understand the transition from traditional, prompt-based LLM interactions to autonomous, goal-oriented AI agents.
2. To learn how to equip AI models with external tools, APIs, and basic memory structures to solve real-world problems.
3. To master the basics of stateful agent tracking and visual workflow design using beginner-friendly graph concepts.
4. To explore how multiple AI agents can collaborate, take on distinct roles, and communicate within a team framework.
5. To understand practical methods for testing, debugging, securing, and deploying simple AI agent applications.

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Differentiate between passive LLMs and autonomous agents and construct basic prompt-based reasoning loops.
2. Create functional single agents that interact safely with web APIs, databases, and local file systems.
3. Build controllable, step-by-step agent workflows using basic state-management and human-approval checks.
4. Design a collaborative multi-agent squad where individual agents work together to execute a multi-step task.
5. Troubleshoot agent loops, measure execution costs, and apply simple guardrails to prevent unexpected behaviors.

SYLLABUS

UNIT I

8 HOURS

Introduction to Agents & Prompt-Based Reasoning: What is an AI Agent? The basic loop: Perception → Reasoning → Action. Limitations of standard LLMs. Introduction to the ReAct (Reason + Action) pattern, Structured reasoning patterns: Chain-of-Thought (CoT), Self-Reflection (asking the model to check its own work). Introduction to Tool Calling: How an LLM decides when and how to call a simple function.

UNIT II

10 HOURS

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Empowering Agents with Tools and Basic Memory: Understanding Tools: Wrapping Python functions into tools an LLM can understand. Connecting agents to external APIs (Weather APIs, Google Search, Wikipedia). Introduction to Agent Memory: The difference between short-term (current conversation) and long-term memory. Basic Vector Stores and Simple Retrieval-Augmented Generation (RAG) for localized document access. Managing context window: Memory Overflow.

UNIT III

9 HOURS

Introduction to Stateful Workflows and Flow Control: The danger of running agents on "autopilot": infinite loops, runaway API costs, and erratic behavior. Introduction to State Management: Keeping track of what an agent has done, step-by-step. Foundations of Graph-Based Workflows: Understanding Nodes (actions) and Edges (decisions/paths). Building basic state machines using LangGraph for structured, non-linear workflows. Human-in-the-Loop Basics: How to pause an agent and wait for explicit human approval before proceeding

UNIT IV

9 HOURS

Foundations of Multi-Agent Collaboration: Multiple Agents, Role-based multi-agent design. Introduction to Multi-Agent Frameworks (CrewAI and AutoGen/AG2 basics), Communication Styles: Sequential task hand-offs (Agent A passes to Agent B) vs. Group Chats (conversational debate), Common Multi-Agent challenges: Token consumption, message looping, and handling conflicting instructions between agents.

UNIT V

9 HOURS

Testing, Safety, and Deploying Your Agent: Basic evaluation, tracking operational metrics: Counting input/output tokens and tracking API costs per run, Introduction to Agent Safety: Simple guardrails to block offensive inputs or unintended tool execution, Preventing prompt injection: Keeping users from hijacking your agent's system instructions, Building a clean web interface for your agent using beginner-friendly tools like Streamlit and deploying it locally using FastAPI.

TEXTBOOKS:

1. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 4th ed. Hoboken, NJ, USA: Pearson, 2020.
2. B. Fowler, *Hands-on AI Agents: A Practical Guide to Building Intelligent Systems with Python*, 1st ed. Boston, MA, USA: O'Reilly Media, 2025.

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REFERENCE:

- Williams, *Generative AI Blueprint: Designing Tools, Memory, and Workflows with Open Source Frameworks*, New York, NY, USA: McGraw-Hill, 2025.
- A. Patel, *Introduction to LLM Engineering: Prompts, RAG, and Agentic Workflows*, San Francisco, CA, USA: Morgan Kaufmann, 2025.
- LangChain Inc., "LangGraph Conceptual Guides for Beginners," 2026. [Online]. Available: <https://langchain-ai.github.io/langgraph/concepts/>
- DeepLearning.AI, "AI Agents in LangChain & Multi-Agent Systems Short Courses," 2025. [Online]. Available: <https://www.deeplearning.ai/>

LIST OF PRACTICALS

- Prompt Engineering to Agent Loop: Write a native Python loop that takes user input, sends it to an LLM using a structured prompt template, parses the model's intended action, and prints out the "thought process."
- Building a ReAct Loop from Scratch: Implement a simple calculator agent loop without external frameworks. The agent must parse whether the user wants to add or multiply, call a local Python math function, and return the final answer.
- LangChain Quickstart: Build a basic search assistant using LangChain that reads a user query, automatically decides to use a provided Wikipedia tool, and delivers a clean summary.
- Creating Custom Local Tools: Write a custom Python tool that reads, writes, or edits a local text file based on an LLM agent's commands.
- Conversational Agent with Memory: Build a chat assistant that retains conversation history across multiple turns using LangChain's memory utilities.
- My First RAG Agent: Load a short university policy PDF into a local vector store (e.g., ChromaDB) and construct an agent that answers student queries by pulling relevant text snippets first.
- The Runway Interrupter: Write an agent loop that automatically stops and alerts the user if it has tried to call tools more than 5 times without finding an answer, preventing infinite loops.
- Basic LangGraph Workflow: Create a simple 3-node graph workflow (Input Node →Processing Node →Output Node) using LangGraph to process a user's request.
- The Human-Gatekeeper Node: Implement an approval workflow using LangGraph where an agent wants to draft an email but pauses execution until a human types "Y" in the terminal to authorize sending.
- The Content Crew: Build a 2-agent team using CrewAI. Agent 1 (Researcher) scrapes information on a topic

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BTDSE621	DSE	Agentic AI & Multi-Agent Systems	60	20	20	30	20	3	0	2	4

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and saves it; Agent 2 (Writer) reads the research and drafts a blog post.

11. The Debate Team: Build a simple two-agent conversation using AutoGen/AG2 where a "Code Generator" agent writes a script and a "Code Reviewer" agent checks it for basic syntax errors, passing feedback back and forth.
12. The Mini Software Team: Implement a 3-agent pipeline (Planner → Coder → Tester) where tasks flow sequentially from one specialized agent to the next to build a basic Python function.
13. Token Counter and Cost Estimator: Write a wrapper function around your agent that calculates and displays the exact cost of each interaction based on current LLM API pricing.
14. Implementing Simple Guardrails: Write a Python validation layer that scans an agent's output for sensitive or blacklisted words before showing it to the user.
15. The Streamlit Agent Dashboard: Build an interactive, user-friendly frontend dashboard using Streamlit that displays your agent's conversational UI along with a side panel showing its internal "Thoughts and Tool Calls."
16. Final Capstone Presentation: Package an end-to-end single or multi-agent application (e.g., a smart personal study assistant or an automated social media planner) with a working local UI, a basic safety filter, and a short presentation.

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BTCS607N	SEC	Minor Project	0	0	0	60	40	0	0	4	2

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COURSE OBJECTIVES:

The student will have ability to:

1. Enable students to identify real-world, complex engineering problems and apply systematic research methodologies to formulate viable technical solutions.
2. Train students in designing, engineering, testing, and validating a complete product, system module, or computing architecture using modern engineering tools and industry-standard practices.
3. Foster collaborative engineering management skills, technical report writing, and the professional defense of engineered solutions before an evaluation panel.

COURSE OUTCOMES:

Upon completion of the subject, students will be able to:

1. Formulate a well-defined problem statement by critically reviewing contemporary research literature, identifying technical gaps, and establishing clear engineering requirements.
2. Design and develop an architectural framework, hardware prototype, or software system by incorporating sustainable design methodologies, algorithm design, and resource optimization.
3. Implement and deploy the proposed system using modern development environments, programming paradigms, cloud infrastructure, or advanced technical tools.
4. Evaluate the performance, scalability, and security parameters of the developed system against standard benchmark metrics, interpreting the results through rigorous testing.
5. Compile comprehensive, industry-grade technical project reports and documentation compliant with standard engineering formats, defending the work effectively through oral presentations.

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Project Timeline

Phases
Phase 1: Planning & Requirement Analysis (Weeks 1–2) Focus: Defining the scope, setting up infrastructure, and identifying functional requirements. Week 1: Project Initiation - Form teams and define the problem statement. Tooling: Set up Jira boards (Scrum or Kanban), create Backlog, and initialize Git repositories. Deliverable: Project Vision document and initial Product Backlog. Week 2: Functional Modeling - Identify Actors and Use Cases. UML Deliverables: * Use Case Diagram: To define system boundaries. Use Case Descriptions: Detailed text for each primary flow. Tooling: Map Use Cases to Jira User Stories.
Phase 2: Object-Oriented Analysis (Weeks 3–4) Focus: Understanding the "What" of the system without focusing on implementation. Week 3: Static Analysis - Identify domain entities and their relationships. UML Deliverables: Object Diagram: To model specific instances and data snapshots. Initial Class Diagram (Domain Model): Focus on attributes and relationships (1:1, 1:N, M:N) without methods. Week 4: Dynamic Analysis - Model how the system reacts to events. UML Deliverable: Activity Diagram: To model complex business logic and parallel workflows.
Phase 3: Object-Oriented Design (Weeks 5–7) Focus: Defining the "How" – architecture, patterns, and component interactions.

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Week 5: Interaction Modeling UML Deliverable: * Sequence Diagram: Detailed logic showing how objects communicate over time to fulfill a use case.
Week 6: Detailed Class Design & Packaging - Apply SOLID principles and Design Patterns. UML Deliverables: Detailed Class Diagram: Including methods, visibility, and interfaces. Package Diagram: Organizing classes into logical modules/subsystems.
Week 7: System Architecture UML Deliverables: Component Diagram: Visualizing physical modules (API, Database, UI). Deployment Diagram: Mapping software components to hardware/nodes (Cloud, Servers).
Phase 4: Implementation & CI/CD Integration (Weeks 8–10) Focus: Coding, version control, and automated pipelines. Week 8: Sprint 1 - Core Features - Develop core logic based on the Class and Sequence diagrams. Git Strategy: Use branching (Feature branches → Develop → Main).
Week 9: CI/CD Pipeline Setup - Configure GitHub Actions or GitLab CI. - Automate build triggers on every git push.
Week 10: Sprint 2 - Integration - Develop UI and connect to the database. Jira: Move stories to "In Progress" and "Testing."
Phase 5: Testing & Deployment (Weeks 11–12) Focus: Quality assurance and final delivery. Week 11: Testing Phase

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○ Unit Testing: (JUnit, PyTest) ensuring methods work as intended. ○ Integration Testing: Testing the flow between components. ○ Tooling: Integrate test reports into the CI/CD pipeline.
● Week 12: Deployment & Final Review ○ Finalize the Deployment Diagram to match the production environment. ○ Deploy to a staging/production environment (Heroku, AWS, or Azure). ○ Project Demo and handover.

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Jira Backlog and a Git Branching Strategy

1. Jira Backlog & Sprint Structure

The project is divided into **six 2-week Sprints**. **Sample Jira Epic & Story Structure:**

Epic	Sample User Stories (Tasks)	Status
Requirements & Design	Create Use Case Diagrams; Draft System Architecture; Set up Jira Board.	Done/Sprint 1
Infrastructure	Initialize Git Repo; Configure CI/CD Pipeline; Setup Database.	Sprint 2
User Management	Design User Class; Implement Login/Auth; Sequence Diagram for Auth.	Sprint 3
Core Features	[Project Specific Logic]; Unit Tests for Core Logic.	Sprint 4-5
Deployment	Final Deployment Diagram; Production Hosting; Documentation.	Sprint 6

2. Git Branching Strategy

Students should avoid pushing directly to the main branch. A **Feature Branch Workflow** is best for academic teams to prevent code conflicts.

- **main branch:** Contains stable, production-ready code.
- **develop branch:** The integration branch where all features are merged before going to main.
- **feature/feature-name branches:** Created for every individual Jira task (e.g., feature/user-login).

3. Testing & CI/CD Pipeline

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To meet your requirement for testing software and CI/CD, the students should implement a pipeline that triggers on every **Pull Request** to the develop branch.

The Pipeline Flow:

1. **Build:** Compile the code to ensure there are no syntax errors.
2. **Unit Test:** Automatically run tests (e.g., JUnit, PyTest, or Jest). If tests fail, the merge is blocked.
3. **Static Analysis:** Use tools like SonarQube or ESLint to check for code "smells."
4. **Deploy:** Automatically deploy to a staging environment (like Vercel, Netlify, or AWS).

4. UML to Code Mapping (Object-Oriented Focus)

Students must ensure that their diagrams are not just "drawings" but blueprints:

- **Class Diagram** → Directly maps to the Classes and Attributes in their code.
- **Sequence Diagram** → Maps to the logic inside their methods (which object calls which method).
- **Package Diagram** → Maps to the Folder Structure of their project.

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Project Grading Rubric (Total 100%)

1. Analysis & Design (30%)

- **UML Consistency:** Do the diagrams match the actual code implementation?
 - *Check:* Does the **Class Diagram** reflect the actual inheritance and associations in the source code?
- **Behavioral Accuracy:** Do **Sequence Diagrams** correctly identify method calls between objects?
- **Architectural Soundness:** Does the **Deployment Diagram** accurately map to the cloud/server infrastructure used?

2. Object-Oriented Implementation (25%)

- **Encapsulation:** Are attributes private? Are getters/setters used appropriately?
- **Inheritance/Polymorphism:** Are these used to reduce code redundancy?
- **Solid Principles:** Is the code modular? (e.g., Single Responsibility Principle).
- **Design Patterns:** Did the team implement at least one recognizable pattern (e.g., Singleton, Factory, or Observer)?

3. DevOps & Tooling (20%)

- **Jira Management:** Is the backlog updated? Are stories assigned to specific members?
 - *Check:* Do commit messages reference Jira ticket IDs?
- **Git Workflow:** Is there evidence of Pull Requests and Code Reviews?
 - *Check:* Avoid "Mega-commits" (one giant commit at the end of the week).
- **CI/CD Pipeline:** Does the pipeline automatically trigger on pushes? Is the build status visible (Green/Red)?

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4. Testing & Quality (15%)

- **Unit Testing:** Is there a significant percentage of code coverage?
- **Integration Testing:** Are API endpoints or database connections tested?
- **Documentation:** Is the README.md clear, including setup instructions and a system overview?

5. Final Deployment (10%)

- **Accessibility:** Is the project hosted on a live URL?
- **Stability:** Does the system handle basic "unhappy path" errors without crashing?

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Definition of Done (DoD) Checklist

A Jira ticket is only considered **Done** when it meets the following criteria:

1. Design & Modeling

- **UML Alignment:** Any changes to the code structure are reflected in the **Class Diagram**.
- **Logic Validation:** For complex logic, a **Sequence Diagram** has been updated or created.
- **Documentation:** Public methods and classes are documented using standard docstrings (e.g., Javadoc, Docstring).

2. Code Quality & Standards

- **OO Principles:** Code follows Encapsulation and avoids "God Classes" (Single Responsibility Principle).
- **No Hardcoding:** Configuration values (like API keys or DB URLs) are in environment variables.
- **Peer Review:** At least one other team member has reviewed the **Pull Request (PR)** on Git.

3. Testing & CI/CD

- **Unit Tests:** New logic has corresponding unit tests.
- **CI Pipeline:** The CI/CD build is **Green** (passing) on the feature branch.
- **Zero Regressions:** Existing functionality still works as expected.

4. Integration

- **Git Merge:** The feature branch has been merged into the develop branch.
- **Jira Update:** The ticket is moved to the "Done" column and the "Actual Time Spent" is logged.

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Evaluation Schedule

Phase	Milestone	Expected Artifacts
Month 1	Foundation	Use Case, Activity, and Object Diagrams. Jira Backlog setup.
Month 2	Design	Sequence, Class, and Package Diagrams. Git Feature branches active.
Month 3	Execution	Component and Deployment Diagrams. Working CI/CD pipeline and Unit Tests.

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Weekly Progress Report Template

Project Title: [Project Name]

Team ID: [ID]

Date: [Date Range]

1. Executive Summary

- **Current Sprint:** [Sprint # of 6]
- **Sprint Goal:** (e.g., Finalize Sequence Diagrams and setup Database connection)
- **Status:** ● On Track | ● At Risk | ● Delayed

2. UML & OOAD Progress

- **Diagrams Completed this week:** (e.g., Package Diagram, Component Diagram)
- **Diagrams Revised:** (List any changes made based on implementation feedback)
- **OO Concept Applied:** (e.g., "Implemented Interface Inheritance for the Payment module")

3. Technical Execution (DevOps & Git)

- **Jira Tasks Completed:** [Link to Jira tickets]
- **Git Activity:**
 - Active Branches: [List branch names]
 - Merged Pull Requests: [List PR IDs]
- **CI/CD Status:** [e.g., Build Passing / 85% Code Coverage]

4. Testing Summary

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- **Total Unit Tests:** [Number]
- **Pass Rate:** [Percentage]%
- **Key Bug Identified:** [Brief description of one technical challenge overcome]

5. Goals for Next Week

- [Goal A]
- [Goal B]

Project Guide Signature

Project In-charge Signature

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