
Add-On Course: Basics and Introduction to Distributed Computing

Course Duration: 30 Hours

Module 1: Introduction to Distributed Computing

Duration: 6 Hours

Objectives:

- Understand the fundamental concepts and principles of distributed computing.
- Identify the benefits and challenges of distributed systems.

Topics:

1. **Overview of Distributed Computing** (2 Hours)
 - Definition and history
 - Key concepts: distributed systems, concurrency, and scalability
2. **Types of Distributed Systems** (2 Hours)
 - Client-server model
 - Peer-to-peer model
 - Grid and cloud computing
3. **Benefits and Challenges** (2 Hours)
 - Advantages: scalability, fault tolerance, and resource sharing
 - Challenges: consistency, security, and communication

Activities:

- Group discussion on real-world distributed computing examples.
- Interactive quiz on distributed computing fundamentals.

Module 2: Distributed System Architectures and Models

Duration: 7 Hours

Objectives:

- Explore different architectures and models used in distributed computing.
- Understand how these models address various system requirements.

Topics:

1. **Architectural Models** (3 Hours)
 - Layered architecture
 - Microservices architecture
 - Service-oriented architecture (SOA)
2. **Communication Models** (2 Hours)
 - Remote Procedure Call (RPC)
 - Message passing
 - Publish-subscribe model
3. **Consistency Models** (2 Hours)
 - Strong vs. eventual consistency
 - CAP theorem (Consistency, Availability, Partition Tolerance)

Activities:

- Lab exercise: Design a distributed system architecture for a given application.
- Case study analysis of different distributed architectures in use today.

Module 3: Distributed Algorithms and Protocols

Duration: 8 Hours

Objectives:

- Learn about key distributed algorithms and protocols used in distributed systems.
- Understand their role in ensuring system reliability and consistency.

Topics:

1. **Distributed Algorithms** (3 Hours)
 - Consensus algorithms (e.g., Paxos, Raft)
 - Leader election algorithms
 - Clock synchronization (e.g., Lamport timestamps)
2. **Communication Protocols** (3 Hours)
 - Network protocols (e.g., TCP/IP, HTTP/HTTPS)
 - Middleware protocols
 - Data serialization formats (e.g., JSON, Protocol Buffers)
3. **Fault Tolerance and Recovery** (2 Hours)
 - Replication strategies
 - Checkpointing and recovery
 - Fault detection and handling

Activities:

- Lab: Implement a basic distributed algorithm or protocol.
 - Group activity: Analyze and discuss fault tolerance strategies in various distributed systems.
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Module 4: Distributed Systems Implementation and Tools

Duration: 5 Hours

Objectives:

- Gain practical experience with tools and frameworks for implementing distributed systems.
- Understand how to deploy and manage distributed applications.

Topics:

1. **Distributed Systems Tools** (2 Hours)
 - Overview of frameworks (e.g., Apache Hadoop, Apache Kafka)
 - Containerization and orchestration (e.g., Docker, Kubernetes)
2. **Deployment and Management** (2 Hours)
 - Deployment strategies (e.g., rolling updates, blue-green deployments)
 - Monitoring and scaling distributed systems
3. **Security Considerations** (1 Hour)
 - Authentication and authorization
 - Data encryption and secure communication

Activities:

- Hands-on lab: Deploy a distributed application using a chosen framework or tool.
 - Discussion on security best practices in distributed systems.
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Module 5: Applications and Emerging Trends

Duration: 4 Hours

Objectives:

- Explore real-world applications of distributed computing.
- Stay informed about emerging trends and technologies in distributed systems.

Topics:

1. **Applications of Distributed Computing** (2 Hours)
 - Cloud computing services (e.g., AWS, Azure)

- Big data analytics and processing
- Real-time data processing and streaming
- 2. **Emerging Trends** (1.5 Hours)
 - Edge computing and its relationship with distributed computing
 - Advances in distributed ledger technologies (e.g., blockchain)
- 3. **Future Directions** (0.5 Hours)
 - Predictions and innovations in distributed computing

Activities:

- Case study review of cutting-edge distributed applications.
- Group discussion on emerging trends and their potential impact.

Module 6: Review and Capstone Project

Duration: 4 Hours

Objectives:

- Review key concepts and apply them in a practical project.
- Evaluate and present findings from a capstone project.

Topics:

1. **Course Review and Q&A** (1 Hour)
 - Recap of key concepts
 - Open floor for questions and clarification
2. **Capstone Project Presentation** (3 Hours)
 - Group presentations of distributed computing projects
 - Peer review and feedback

Activities:

- Capstone project: Develop and present a distributed computing solution for a given problem.
- Final review session and course feedback.

Total Duration: 30 Hours