

**MPI programming for distributed memory systems:** MPI basic communication routines (Introduction to MPI and basic calls, MPI calls to send and receive data, MPI call for broadcasting data, MPI Non-blocking calls, Introduction to MPI Collectives, Types of interconnects (Characterization of interconnects, Linear arrays, 2D mesh and torus, cliques)

**Unit 4**

**Applications:** Matrix-matrix multiply, Odd-Even sorting, distributed histogram, Breadth First search, Dijkstra’s algorithm.

**References**

- 1. Grama, A., Gupta, A., Karypis, G., Kumar, V., *Introduction to Parallel Computing*, 2<sup>nd</sup> edition, Addison-Wesley, 2003.
- 2. Quinn, M., *Parallel Programming in C with MPI and OpenMP*, 1<sup>st</sup> Edition, McGraw-Hill, 2017.
- 3. Revdikar, L., Mittal, A., Sharma, A., Gupta, S., *A Naïve Breadth First Search Approach Incorporating Parallel Processing Technique For Optimal Network Traversal*, International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 5, May 2016

**Additional references**

- (i) B. Parhami, *Introduction to Parallel Processing: Algorithms and Architectures*, Plenum, 1999, Springer.

**Suggested Practical List**

- 1. Implement Matrix-Matrix Multiplication in parallel using OpenMP
- 2. Implement distributed histogram Sorting in parallel using OpenMP
- 3. Implement Breadth First Search in parallel using OpenMP
- 4. Implement Dijkstra’s Algorithm in parallel using OpenMP

**DSC19/GE7d/DSE8e: CLOUD COMPUTING**

Credit distribution, Eligibility and Pre-requisites of the Course

	Credits	Credit distribution of the course		
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Course title & Code		Lecture	Tutorial	Practical/ Practice	Eligibility criteria	Pre-requisite of the course
Cloud Computing	4	3	0	1	Pass in Class XII	NIL

### Course Objective:

The objective of an undergraduate cloud computing course is to provide students with a comprehensive understanding of cloud computing technologies, services, and applications.

### Course Learning Outcomes:

Learning outcomes for an undergraduate course on cloud computing may include:

1. Knowledge of the fundamental concepts and principles of cloud computing, including virtualization, scalability, reliability, and security.
2. Ability to design, develop, and deploy cloud-based applications using popular cloud platforms and services.
3. Familiarity with cloud computing architectures, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).
4. Visualize the economic, legal, and ethical implications of cloud computing, including issues related to data privacy, ownership, and security.
5. Ability to evaluate and select cloud-based solutions based on their technical, economic, and business requirements.
6. Understanding of the broader societal and environmental impacts of cloud-based services and applications.

### Syllabus:

#### Unit 1: Overview of Computing Paradigm

Recent trends in Computing : Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing,

#### Unit 2: Introduction to Cloud Computing

Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers, Benefits and limitations of Cloud Computing,

**Unit 3: Cloud Computing Architecture**

Comparison with traditional computing architecture (client/server), Services provided at various levels, Service Models- Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), How Cloud Computing Works, Deployment Models- Public cloud, Private cloud, Hybrid cloud, Community cloud, Case study of NIST architecture.

**Unit 4: Case Studies**

Case study of Service model using Google Cloud Platform (GCP), Amazon Web Services (AWS), Microsoft Azure, Eucalyptus.

**Unit 5: Cloud Computing Management**

Service Level Agreements(SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling.

**Unit 6: Cloud Computing Security**

Infrastructure Security- Network level security, Host level security, Application level security, Data security and Storage- Data privacy and security Issues, Jurisdictional issues raised by Data location, Authentication in cloud computing.

**References:**

1. Thomas Erl, Ricardo Puttini and Zaigham Mahmood, Cloud Computing: Concepts, Technology and Architecture, Publisher: PHI, 2013.
2. Rajkumar Buyya, James Broberg, and Andrzej Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2013.
3. Boris Scholl, Trent Swanson, and Peter Jausovec, Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications, Publisher : Shroff/O'Reilly, 2019.

**Additional References:**

1. *Cloud Computing Bible*, Barrie Sosinsky, Wiley-India, 2010
2. *Cloud Computing: Principles and Paradigms*, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011

3. *Cloud Computing: Principles, Systems and Applications*, Editors: Nikos Antonopoulos, Lee Gillam, *Springer*, 2012
4. *Cloud Security: A Comprehensive Guide to Secure Cloud Computing*, Ronald L. Krutz, Russell Dean Vines, *Wiley-India*, 2010

**Suggested Practical List:**

1. Create virtual machines that access different programs on same platform.
2. Create virtual machines that access different programs on different platforms .
3. Working on tools used in cloud computing online-
  - a) Storage
  - b) Sharing of data
  - c) manage your calendar, to-do lists,
  - d) a document editing tool
4. Exploring Google cloud
5. Exploring microsoft cloud
6. Exploring amazon cloud