

**Objective:**

This course focuses on High Performance Computing clusters and web services and their applications in federated and economic models of Grid and Cloud computing.

**Theory:****Unit I**

Flynn's Classification, Evolution of Parallel Computers, Scalar and Vector Processors, Pipelining, SMP, MPP, GPU, Moore's Law, Amdahl's Law, Gustafson's Law, LINPACK, LAPACK.

**Unit II**

Introduction to High Performance Clusters, Beowulf, Installation, Load Balancing, Distributed File Systems, Introduction to Message Passing, Programming in MPI, Performance Monitoring, Introduction to Cluster utilities: OSCAR, ROCKS. Applications, Concept of distributed systems : salient features

**Unit III**

Introduction to Java-RMI and Sockets, Introduction to Web Services, Stateful and Stateless Web Services, XML, SOAP, RDF, WSDL, UDDI, REST.

**Unit IV**

Introduction to Grid Computing, Types of Grids, Components of Grids, Virtual Organizations, Volunteer Computing, P2P Computing. Grid utilities: Globus, Condor, BOINC. Applications.

**Unit V**

Introduction to Cloud Computing, Outsourcing of Resources, Service Oriented Architecture, SaaS, PaaS, IaaS Clouds. Popular Cloud Services: Google AppEngine, Amazon EC2, Microsoft Azure.

**Practical:**

1. Understanding the working of an HPC Cluster.
2. Understanding the program structure of a C program with MPI routines.
3. Environment Management Routines in MPI.
4. Write an MPI – C program to approximate PI.
5. Write a Program that prints out 'Hello World from proc X out of Y.
6. Write a program that has all even procs print "even X" and odd procs print "odd y".
7. Write a Program sums the numbers from 1 to N (N should be provided as a command prompt argument).
8. Write a program to demonstrate matrix multiplication.
9. Write a client-server JAVA program with sockets, returning current time by server.
10. Write a client-server JAVA program with sockets, with math operations.
11. Demonstrate RMI in JAVA.
12. Demonstrate using AppEngine.

**Reference books:**

1. Web Services Essentials, Ethan Cerami, O'Reilly.
2. Java Web Services in a Nutshell, Kim Topely, O'Reilly.
3. Linux Clustering, Charles Bookman, New Riders.
4. Using MPI : Portable Parallel Programming With the Message-passing Interface Scientific and Engineering Computation”, Gropp, William *at al.*, MIT Press.
5. An Introduction to Parallel Programming, Peter Pacheco, Morgan Kaufmann.

6. Grid 2, Ian Foster, Carl Kesselman, Morgan Kaufmann.
7. Distributed and Cloud Computing, Kai Hwang, Jack Dongarra, Morgan Kaufmann.

## **Suggested Broad Topics for Research**

- Web solutions in agriculture
- Decision Support/Expert Systems/Information Management Systems in Agriculture
- Software for Statistical Data Analysis
- Modelling and Simulation of Agricultural Systems
- Application Software for GIS and Remote Sensing
- Office Automation and Management System