GANPAT UNIVERSITY									
FACULTY OF ENGINEERING AND TECHNOLOGY									
Programme	Bachelor of Technology					Branch/Spec.	Computer Science & Engineering (CBA/BDA)		
Semester	VI					Version	1.0.0.0		
Effective from Academic Year			2022-23			Effective for the batch Admitted in			June 2021
Subject code	2CSE60E25		Subject Name			High Performance Computing			
Teaching scheme						Examination scheme (Marks)			
(Per week)	Lecture (DT)		Practical (Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	0	1	0	4	Theory	40	60	100
Hours	3	0	2	0	5	Practical	30	20	50

Pre-requisites:

Students should have knowledge of the following concepts to learn this subject. Operating System, Computer Organization and Architecture, Microprocessor and Architecture, Data structure and algorithms.

Objectives of the Course:

- Understand High Performance Computing (HPC) system architectures and various computational models.
- Learn basics of CUDA programming.
- Apply parallel execution models and methodologies for parallel programming and parallel applications development.
- Design and implement compute intensive applications on HPC platform.

Theory syllabus

Unit	Content	Hrs
1	**Parallel Programming & Computing - Introduction** Era of Computing, Parallel Computing, Multiprocessors and Multicomputer Architectures, Scalar VS Vector Processing, Multivector and Superscalar Machines, Pipelined Processors, SIMD Computers, Conditions of parallelism, Program flow mechanisms, Types of Parallelism – ILP, PLP, LLP, Program Partitioning and scheduling.	8
2	**Introduction to High Performance Computing** Era of Computing, Scalable Parallel Computer Architectures, towards low-cost computing, Network of Workstations project by Berkeley, Cluster Computing Architecture, Components, Cluster Middleware and SSI, Need of Resource Management and Scheduling, Programming Environments	7
3	**Cluster Computing** Clustering Models, Clustering Architectures, Clustering Architectures key factors, types of clusters, Mission critical Vs Business Critical Applications, Fault Detection and Masking Algorithms, Check pointing, Heartbeats, Watchdog Timers, Fault recovery through Failover and Failback Concepts	8
4	**High Speed Networks & Message Passing** Introduction to High-Speed Networks, Lightweight Messaging Systems, Xpress Transport Protocol, Software RAID and Parallel File systems, Load Balancing Over Networks – Algorithms and Applications, Job Scheduling approaches and Resource Management in Cluster	7

5	**CUDA Programming:** Introduction to CUDA architecture for parallel processing, CUDA Parallelism Model, Foundations of Shared Memory, Introduction to CUDA-C, Parallel programming in CUDA-C, Thread Cooperation and Execution Efficiency, Constants memory and events, memory management, CUDA C on multiple GPUs, Hashing and Natural Parallelism, Scheduling and Work Distribution, Atomics, Barriers and Progress, Transactional Memory	**10**
6	**Open CL Programming** Introduction to OpenCL, OpenCL Setup, Basic OpenCL, Advanced OpenCL	**3**
7	**Shared-memory programming** OpenMP: Introduction to OpenMP, Parallel Programming using OpenMP	**2**

Self-Study:

Case study

1. NCR Life keeper and Oracle Failsafe
2. Linux Network Load Balancing
3. Legion – Object based Meta System
4. Web Flow - framework for the wide-area distributed computing and meta computing

Practical content

Practicals will be based on topics like MPI, HA cluster, HP cluster, Job Scheduler.

Mooc Courses

1. Course Name: High Performance Computing
   Link: https://nptel.ac.in/courses/106/108/106108055/
2. Course Name: High Performance Computing Architecture
   Link: https://nptel.ac.in/courses/106/105/106105033/

Text Books

1	Rajkumar, High Performance Cluster Computing: Architectures and Systems, Vol. 1 Pearson Education
2	Georg Hager and Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, CRC Press

Reference Books

1	Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill International Editions

Course Outcomes:

COs	Description
CO1	Understand High Performance Computing (HPC) system architectures and various computational models.
CO2	Learn basics of CUDA programming.
CO3	Apply parallel execution models and methodologies for parallel programming and parallel applications development.
CO4	Design and implement compute intensive applications on HPC platform.

Mapping of CO and PO:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	2	2	1	2	3	2	3
CO2	2	2	3	2	2	2	3	2	3	2	2	2
CO3	2	3	3	3	2	2	3	2	2	2	2	2
CO4	3	3	2	2	2	3	3	2	3	3	3	3