Subject Code: 01DS0211
Subject Name: High Performance Computing
M.Tech. Year –2023-24

Objective:

- 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.

Credits Earned: 3 Credits

Course Outcomes: After completion of this course, student will be able to

- Understanding of Parallel Computing Concepts:
- Understand different types of parallelism, such as task parallelism and data parallelism.
- Understand and implement parallel algorithms for common HPC problems
- Gain knowledge of different HPC architectures, including multi-core processors, GPUs, and accelerators.
- Apply HPC techniques to solve real-world scientific and engineering problems.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	Mid Sem (M)	Internal (I)	Viva (V)	Term work (TW)	
3	0	2	3	50	30	20	25	25	150

Contents:

Unit	Topics	Contact Hours
1	**Cluster Computing and its Architecture** Ease of Computing, Scalable Parallel Computer Architecture, Towards Low Cost Parallel Computing & Motivation, Windows opportunity, A Cluster Computer And Its Architecture, Cluster Classification, Commodity Components for Clusters, Network Services/Communication SW, Cluster	6

	Middleware and Single Systems Image, Resource management & Scheduling (RMS).	
2	**Introduction to Grid and its Evolution:** Introduction to Grid and its Evolution: Beginning of the Grid, Building blocks of Grid, Grid Application and Grid Middleware, Evolution of the Grid: First, Second & Third Generation	8
3	**Cluster Setup and Administration:** Introduction, Setting up the cluster, Security, System Monitoring, System Tuning	5
4	**Parallel Processing Concepts** Levels and model of parallelism: instruction, transaction, task, thread, memory, function, data flow models, demand-driven computation; Parallel architectures: superscalar architectures, multi-core, multi-threaded, server and cloud; Fundamental design issues in HPC: Load balancing, scheduling, synchronization and resource management; Operating systems for scalable HPC	8
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	6
	Total Hours	32

References:

1. "High Performance Computing" by Charles Severance and Kevin Dowd
2. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill International Editions
3. Rajkumar, High Performance Cluster Computing: Architectures and Systems, Vol. 1 Pearson Education
4. Georg Hager and Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, CRC Press

Suggested Theory distribution:

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyse	Evaluate	Create
10%	25%	30%	15%	10%	10%

Instructional Method:

a) The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
b) The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
c) Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
d) Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.

Supplementary Resources:

a) MOOC
   i) https://nptel.ac.in/courses/106/108/106108055/
   ii) https://nptel.ac.in/courses/106/105/106105033/