

Course Code	Course Title	L	T	P	C
BCSE414L	High Performance Computing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
Course Objectives					
<ol style="list-style-type: none"> 1. Understand the modern architecture, data structures and algorithms for high-performance computing. 2. Create fast, powerful, energy-efficient programs that scale to tackle big data. 3. Engineering and computing to utilize high-performing heterogeneous resources. 					
Course Outcomes					
<ol style="list-style-type: none"> 1. Appraise modern high performance architectures. 2. Investigate the inherent potential and limitations of programs/applications. 3. Design high performance applications for multi-core processors. 4. Develop high performance applications for distributed systems. 5. Examine tools and resources for Exa-scale performance 					
Module:1	Introduction	5 hours			
High-Performance Computing Disciplines, Impact of Supercomputing on Science, Society, and Security, Anatomy of a Supercomputer, Computer Performance, A Brief History of Supercomputing					
Module:2	HPC Architecture: Systems and Technologies	6 hours			
Key Properties of HPC Architecture, Parallel Architecture Families—Flynn's Taxonomy, Accelerating Technologies: Symmetric Multi-Processor (SMP), Massively Parallel Processor (MPP), Graphical Processor Units (GPU) and Tensor Processing Unit (TPU)					
Module:3	Commodity Clusters and Essential Resource Management	7 hours			
Introduction to Commodity Cluster, Beowulf Cluster Project, Hardware Architecture, Programming Interfaces, Software Environment, Basic Methods of Use, Managing Resources, The Essential SLURM, Summary of Commands, The Essential Portable Batch System, Overview of Grid and Cloud Technologies					
Module:4	HPC Peripherals and Algorithms	6 hours			
Amdahl's Law, Memory Hierarchy, PCI Bus, External I/O Interfaces, Fork-Join, Divide and Conquer, Manager-Worker, Embarrassingly Parallel, Halo Exchange, Permutation: Cannon's Algorithm, Task Dataflow					
Module:5	Operating Systems and Performance Monitoring	6 hours			

Operating System Structures and Services, Process Management, Threads, Memory Management, Time Measurement, Performance Profiling, Monitoring Hardware Events, Integrated Performance Monitoring Toolkits, Profiling in Distributed Environments			
Module:6	Debugging HPC Applications		6 hours
Tools, Debugging OpenMP Example: Accessing an Unprotected Shared Variable, Debugging MPI Example: Deadlock, Compiler Flags for Debugging, System Monitors to Aid Debugging			
Module:7	Mass Storage and MapReduce		7 hours
Storage Device Technology, Aggregated Storage, Storage Area Networks, Network Attached Storage, Tertiary Storage, Role and Function of File Systems, Network File System, General Parallel File System, Lustre File System, Map and Reduce Distributed Computation, Overview of Hadoop.			
Module:8	Recent Trends		2 hours
Guest lectures from Industry and, Research and Development Organizations			
Total Lecture hours:			45 hours
Text Book(s)			
1.	Thomas Sterling, Matthew Anderson, MaciejBrodowicz, High Performance Computing: Modern Systems and Practices, 2018, 1 st Edition, Morgan Kaufmann publication.		
Reference Books			
1.	Vadim Levchenko, High Performance Computing, 2020, 1st Edition, Excelic Press, USA		
2.	Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, 2019, 1st Edition, CRC Press, USA		
Mode of Evaluation: CAT / written assignment / Quiz / FAT			
Recommended by Board of Studies		12-05-2023	
Approved by Academic Council		No. 70	Date 24-06-2023