NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	Master of Computer Application (2-Years Programme)
Course Code:	3MCAD358
Course Title:	High Performance Computing
Course Type:	Departmental Elective
Year of Introduction:	2021-22

Credit Scheme

L	T	Practical Component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLO):

At the end of the course, students will be able to –

1. summarize various optimization techniques for serial code
2. apply distributed parallel programming concepts to develop applications
3. analyze the functionality of modern processor
4. design applications using the concepts of parallel computing paradigm

Syllabus: **Total Teaching hours: 45**

Unit	Syllabus	Teaching hours
Unit-I	**Modern Processors:** Stored Program Computer Architecture, Architecture of microprocessor based on cache- Performance based metrics and benchmarks, Moore's Law, Pipelining, Super scalarity, SIMD, Different classes of Memory- cache, mapping, pre-fetch ,Introduction to different types of processor such as Multicore processors, Multithreaded processors, Vector Processors	08
Unit-II	**Parallel Computers:** Taxonomy of parallel computing paradigm, Different types of memory computers such as Shared memory computers, Distributed memory computers, Hierarchical systems, Basics of parallelization	08
Unit-III	**Parallel Scalability-** Factors that limit parallel execution- Scalability metrics- Simple scalability laws- parallel efficiency - serial performance Vs Strong scalability- Refined performance models- Choosing the right scaling baseline- Case Study: Can slow processors compute faster- Load balance	08
Unit-IV	**Requirements and General Issues:** Scalable parallel computer Architectures, A cluster computer and its Architecture, clusters classifications, Commodity components for clusters, Network services/Communication SW, Cluster middleware and single system Image(SSI),Resource Management and Scheduling(RMS), Programming environments and Tools, Representative cluster Systems	10
Unit-V	**High speed Networks:** Design issues, Fast Ethernet, High Performance parallel interface (HPPI), Asynchronous transfer mode (ATM), Myrinet	03

Unit-VI	**Distributed memory parallel programming with MPI:** Brief introduction to MPI such as messages and point-to-point communication - collective communication – Non blocking point-to-point communication- virtual topologies, MPI parallelization of Jacobi solver- MPI implementation - performance properties, MPI performance tools, communication parameters, Synchronization, serialization	08

Self-Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/ References:

1. Kai Hwang, Naresh Jotwani, Advanced Computer Architecture, McGraw Hill
2. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series
3. Gene Wagenbreth and John Levesque, High performance Computing: Programming and Application,CRC press, Taylor and francis group
4. MaciejBrodowicz, Matthew Anderson, and Thomas Sterling, High Performance Computing: Modern Systems and Practices, Morgankaufmann publishers

Suggested List of Experiments:

Sr. No.	Title	Hours
1	To study about different modern processors and prepare a report about it.	02
2	To implement a program either in C/C++/Pyhton/Java for calculating Matrix multiplication of N*N.	02
3	To calculate execution time consumed by a program developed in above practical for varying size of rows and columns. Keep record values. (Value of s)	02
4	To create Threads for the above program and assign subtasks in parallel. Calculate execution time for varying number of rows and columns. (Value of g). Also calculate the speed up.	04
5	To configure Metacomputing Simulator Alchemi. Run the application on Metacomputing platform and monitor the utilization of resources. Design your own application and execute it on this Grid platform. Analyse the functioning of RMS.	04
6	To design your own pseudo code for anyone of the following: (Task can be assigned to group of 3 members) Load balancing, Job scheduling, Failure handling	04
7	To study various components of GLOBUS. GLOBUS is an open-source middleware which allows to generate the supercomputing Power.	04
8	To study the use of HPC and prepare a report for variety of projects of healthcare.	02

	9	To verify and analyse the functionality of DSM and work with MPI. Write small routine in MPI using MPI system calls.	04
	10	To write a program using MPI for pi Calculation using point to point communications and collective communications	02
Suggested Case List:	-NA-		