NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF COMPUTER APPLICATIONS

COURSE PLAN – PART I			
Name of the programme and specialization	**M.Sc. Computer Science**		
Course Title	**High Performance Computing**		
Course Code	**CAS762**	**No. of Credits**	**3**
Course Code of Pre-requisite subject(s)	-		
Session	**January 2019**	**Section (if, applicable)**	**NA**
Name of Faculty	**Dr. K.Adlin Suji**	**Department**	**Computer Applications**
Official Email	**adlin@nitt.edu**	**Telephone No.**	**0431-2504652**
Name of Course Coordinator(s) (if, applicable)	**Dr.Michael Arock**		
Official E-mail	**michael@nitt.edu**	**Telephone No.**	**0431-2503736**
Course Type (please tick appropriately**)**	☐ **Core course**	☐ **Elective course**	

Syllabus (approved in BoS)

Modern processors-Stored-program computer architecture - General-purpose cache-based microprocessor architecture - Memory hierarchies-Multicore processors - Multithreaded processors -Vector processors

Parallel computers-Taxonomy of parallel computing -Shared-memory computers-Distributed-memory computers-Hierarchical (hybrid) systems-Networks - Basics of parallelization - Why parallelize? Parallelism-Parallel scalability

Shared-memory parallel programming with OpenMP-OpenMP - Case study: OpenMP-parallel Jacobi algorithm -Advanced OpenMP: Wavefront parallelization- Efficient OpenMP programming-Profiling OpenMP programs -Performance pitfalls. Case study: Parallel sparse matrix-vector multiply

Locality optimizations on ccNUMA architectures-Locality of access on ccNUMA-Case study: ccNUMA optimization of sparse MVM-Placement - ccNUMA issues with C++

Distributed-memory parallel programming with MPI-Message passing –MPI - Example: MPI parallelization of a Jacobi solver - Efficient MPI programming- Hybrid parallelization with MPI and OpenMP-Basic MPI/OpenMP programming models - MPI taxonomy of thread interoperability-Hybrid decomposition and Potential benefits and drawbacks of hybrid programming

COURSE OBJECTIVES
To learn the fundamentals of High Performance Computing.
MAPPING OF COs with POs

Course Outcomes	**Programme Outcomes (PO)** (Enter Numbers only)
1. Deal with Fundamental design issues in HPC	**1,2**
2. Design Parallel Algorithms and handle advance tools ,techniques	**1,2,3,5**

COURSE PLAN – PART II

COURSE OVERVIEW

1. Provide systematic and comprehensive treatment of the hardware and the software high performance techniques invovled in current day computing.
2. Introduce the fundamentals of high performance computing with the graphics processing units and many integrated cores using their architectures and corresponding programming environments.
3. Introduce the learner to develop parallel algorithms and implement through the CUDA and other architectues.

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1	1	Class I: Introduction to High Performance Computing Class II: Modern Processors - Introduction Class III:Stored-program computer architecture	Chalk and Talk
2	2	Class I: General-purpose cache-based microprocessor architecture Class II: Memory hierarchies-Multicore processors Class III Multithreaded processors	Chalk and Talk
3	3	Class I: Vector processors Class II: Parallel computers-Taxonomy of parallel computing Class III Parallel computers-Taxonomy of parallel computing	Chalk and Talk
4	4	Class I: Distributed-memory computers Class II: Hierarchical (hybrid) systems-Networks	Chalk and Talk

		Class III :Basics of parallelization - Why parallelize? Parallelism-Parallel scalability	
5	5	Class I: Shared-memory parallel programming with OpenMP-OpenMP Class II: Shared-memory parallel programming with OpenMP-OpenMP Class III Shared-memory parallel programming with OpenMP-OpenMP	Chalk and Talk
6	6	Class I: Case study: OpenMP-parallel Jacobi algorithm Class II: Advanced OpenMP: Wavefront parallelization- Class III: Efficient OpenMP programming-Profiling OpenMP programs	Chalk and Talk
7	7	Class I: Performance pitfalls. Class II: Locality optimizations on ccNUMA architectures Case study: ccNUMA optimization of sparse MVM-Placement	Chalk and Talk
8	8	Class I: ccNUMA issues with C++ Class II: Distributed-memory parallel programming with MPI-Message passing Class III: Distributed-memory parallel programming with MPI	Chalk and Talk
9	9	Class I: MPI- Message Passing Class II: MPI Message Passing Class III :MPI - Example: MPI parallelization of a Jacobi solver	
10	10	Class I: Efficient MPI Programming Class II: Efficient MPI programming Class III:Hybrid parallelization with MPI and OpenMP	Chalk and Talk
11	11	Class I: Hybrid parallelization with MPI and OpenMP Class II: Basic MPI/OpenMP programming models Class III :Basic MPI/OpenMP programming models	
12	12	Class I: MPI taxonomy of thread interoperability Class II: Hybrid decomposition and Potential benefits and drawbacks of hybrid Programming Class III :Hybrid decomposition and Potential benefits and drawbacks of hybrid Programming	Chalk and Talk

COURSE ASSESSMENT METHODS (shall range from 4 to 6**)**

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Cycle Test 1	4th Week	1 Hr	20
2	Cycle Test 2	8th Week	1Hr	20
3	Assignment	7th to 8th Week		10
CPA	Compensation Assessment*	9th Week	2 Hrs	40
6	Final Assessment *		3 Hrs	50

ESSENTIAL READINGS

1. G.Hager and G.Wellein, “Introduction to High Performance Computing for Scientists and Engineers”, Taylor & Francis, 2017.
2. R.A. Kudale and S.Y.Kulkarni, “High Performance Computing”, Vishwakarma Publications, 2016.
3. T.Sterling, M.Anderson and M.Brodowicz, “High Performance Computing: Modern Systems and Practices”, Morgan Kaufmann, 2018.

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

- The students through the class representative may give their feedback at any time to the course chairman which will be duly addressed.
- The students may also give their feedback during class committee meeting.
- Course Outcome Survey’ form will be distributed on the last working day to all the
- Students and the feedback on various rubrics will be analyzed.
- The COs will be computed after arriving at the final marks.

COURSE POLICY (including compensation assessment to be specified**)**

One compensation assessment will be conducted for the students those who have missed CT1 or CT2 for genuine reason before the final assessment

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- At least 75% attendance in each course is mandatory.
- A maximum of 10% shall be allowed under On Duty (OD) category.
- Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.

- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.
- The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION, IF ANY

The students can get their doubts clarified at any time with their faculty member.

FOR APPROVAL

Course Faculty _____ CC- Chairperson _____ HOD _____