Course title	**Parallel Scientific Computing**									Course No	**ID5130**			
Department	Mechanical Engineering	New Credits	L	T	E	P	O	C	T H	Old Credits	L	T	P	C
			3			1	6	10			3			3
Offered for	BTech/DD third year onward, MTech, MS and PhD scholars3									Status	New			
Faculty	**Kameswararao Anupindi, Rupesh Nasre**									Type	Theory			
Pre-requisite	Programming experience is expected in one of the languages.									To take effect from	01-01-2021			
Submission date	Date of approval by DCC		Date of approval by BAC							Date of approval by Senate				

Objectives:
1. To learn parallel programming using distributed-memory, shared-memory and graphics processing unit (GPU) based systems.

2. To understand and implement numerical methods to be run using parallel environments.

Course Contents:
1. Introduction (1 week): Motivation and need for parallelization, Examples and applications in scientific computing, Parallel programming paradigms, Terminology, Non-determinism and dealing with floating-point errors.

2. OpenMP Programming (2 weeks): Basics, scope of variables, parallel loop directives, scheduling, critical directives.

3. MPI Programming (2 weeks): Basics, point-to-point and collective communication, MPI derived data types, performance evaluation, advanced function calls.

4. Numerical Methods using OpenMP and MPI (5 weeks): Numerical integration, explicit and implicit finite-differences, solution of system of linear equations, solution of partial differential equations.

5. OpenACC (2 weeks): Motivation, Compute Constructs (Kernel, Parallel, Loop, Routine), Data Directives, Reductions, Atomics, Data Transfers, Asynchronous Processing, Multi-Device Programming.

6. Numerical Methods using OpenACC (2 weeks): Same applications as for OpenMP and MPI, with focus on optimizing for GPUs.

Time permitting, new topics such as Programming in Julia can be covered.

Text Books:
1. An Introduction to PARALLEL PROGRAMMING, Peter S. Pacheco, Morgan Kaufmann, 2011

2. Parallel programming in C with MPI and OpenMP, Michael Quinn, McGraw Hill Education, 2017

3. OpenACC for Programmers: Concepts and Strategies, Sunita Chandrasekaran, Guido Juckeland, Addison Wesley, 2017

4. Parallel Scientific Computing in C++ and MPI, George Em Karniadakis, and Robert Kirby II, Cambridge Universities Press, 2003

Reference Books:
1. Using MPI, William Gropp, Ewing Lusk, Anthony Skjellum, The MIT Press, 2014
2. Using OpenMP, Barbara Chapman, Gabriele Jost, Ruud van der Pas, The MIT Press, 2008