# INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

## COURSE CONTENT

| PARALLEL PROGRAMMING | | | | | | | | |
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| **VII Semester: CSE / IT** | | | | | | | | |
| **Course Code** | **Category** | **Hours / Week** | | | **Credits** | **Maximum Marks** | | |
| | | **L** | **T** | **P** | **C** | **CIA** | **SEE** | **Total** |
| **ACSE34** | **Elective** | **3** | **0** | **0** | **3** | **40** | **60** | **100** |
| **Contact Classes:48** | **Total Tutorials: Nil** | **Total Practical Classes: Nil** | | | | **Total Classes: 48** | | |
| **Prerequisites: Software Engineering** | | | | | | | | |

### I. COURSE OVERVIEW:
The Parallel Programming course introduces students to the concepts, techniques, and tools required to write efficient parallel programs. As modern computing systems increasingly feature multi-core processors and distributed computing environments, understanding how to design and implement parallel applications is crucial for improving performance and solving complex problems.

### II. COURSE OBJECTIVES:
**The students will try to learn:**

I. Explore the need for parallel programming
II. Explain how to parallelize on MIMD systems
III. To demonstrate how to apply MPI library and parallelize the suitable programs
IV. To demonstrate how to apply OpenMP pragma and directives to parallelize the suitable programs
V. To demonstrate how to design CUDA program

### III. COURSE OUTCOMES:
**After successful completion of the course, students will be able to:**

CO1: Understand Parallel Programming Concepts.
CO2: Develop Parallel Algorithms.
CO3: Work with Parallel Programming Models.
CO4: Implement Parallel Programming using Libraries.
CO5: Optimize Performance in Parallel Systems.
CO6: Understand Synchronization and Communication.

## IV.COURSE CONTENT:

**MODULE-I:**
Introduction to parallel programming, Parallel hardware and parallel software —Classifications of parallel computers, SIMD systems, MIMD systems, Interconnection networks, Cache coherence, Shared-memory vs. distributed-memory, Coordinating the processes/threads, Shared-memory, Distributed-memory.

**MODULE-II:**
GPU programming, Programming hybrid systems, MIMD systems, GPUs, Performance — Speedup and efficiency in MIMD systems, Amdahl's law, Scalability in MIMD systems, Taking timings of MIMD programs, GPU performance.

**MODULE-III:**
Distributed memory programming with MPI — MPI functions, the trapezoidal rule in MPH, Dealing with I/O, Collective communication, MPI-derived datatypes, Performance evaluation of MPI programs, A parallel sorting algorithm.

**MODULE-IV:**
Shared-memory programming with OpenMP — OpenMP pragmas and directives, The trapezoidal rule, Scope of variables, The reduction clause, loop carried dependency, scheduling, producers and consumers, Caches, cache coherence and false sharing in OpenMP, tasking, tasking, thread safety.

**MODULE-V:**
GPU programming with CUDA - GPUs and GPGPU, GPU architectures, Heterogeneous computing, Threads, blocks, and grids Nvidia compute capabilities and device architectures, Vector addition, returning results from CUDA kernels, CUDA trapezoidal rule I, CUDA trapezoidal rule II: improving performance, CUDA trapezoidal rule III: blocks with more than one warp.

## V. TEXT BOOKS:


1. Peter S Pacheco, Matthew Malensek," An Introduction to Parallel Programming", 2nd edition, Morgan Kauffman.
2. Michael J. Quinn,"Parallel Programming in C with MPI and Open MP", McGraw-Hill Education, 1st Edition, 2003.Calvin Lin, Lawrence Snyder — Principles of Parallel Programming, Pearson
3. Calvin Lin and Lawrence Snyder,"Principles of Parallel Programming",Pearson Education, 1st Edition, 2008.


## VI. REFERENCE BOOKS:


1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar,"Introduction to Parallel Computing",2nd Edition, Pearson Education, 2003.
2. Jason Sanders and Edward Kandrot,"CUDA by Example: An Introduction to General-Purpose GPU Programming",Addison-Wesley Professional, 1st Edition, 2010.


## VII. WEB REFERENCES:

1. https://www.coursera.org/courses?query=parallel%20programming
2. https://books.google.com/books?q=parallel+programming

## VIII. E-Text Books:

1. Course Outline Description
2. Lecture notes
3. PowerPoint presentation
4. Definitions and Terminology
5. Tutorial Question Bank
6. Case Studies
7. Real life Examples
8. Complex Engineering Problems
9. Tech Talk Topics
10. Concept Video Topics
11. Open-ended Exercises
12. Assignments
13. Model Question Paper – I
14. Model Question Paper – II
15. GATE Question Bank
16. Previous Question Papers and Solutions