Nagar Yuwak Shikshan Sanstha’s 

Yeshwantrao Chavan College of Engineering 

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University) Hingna Road, Wanadongri, Nagpur - 441 110

NAAC A++

Ph.: 07104-237919, 234623, 329249, 329250 Fax: 07104-232376, Website: www.ycce.edu Department of Computer Technology

**Vision of the Department**

*To be a well-known centre for pursuing computer education through innovative pedagogy, value-based education and industry collaboration.*

**Mission of the Department**

*To establish learning ambience for ushering in computer engineering professionals in core and multidisciplinary area by developing Problem solving skills through emerging technologies****.***

**Session 2025-2026**

| **Vision:** To help businesses uncover crucial insights | **Mission:** To be a good data scientist |
| --- | --- |

**Program Educational Objectives of the program (PEO):** (broad statements that describe the professional and career accomplishments)

| PEO1 | **Preparation** | **P: Preparation** | **Pep-CL abbreviation**  **pronounce as Pep-si-lL easy to recall** |
| --- | --- | --- | --- |
| PEO2 | **Core Competence** | **E: Environment**  **(Learning Environment)** |
| PEO3 | **Breadth** | **P: Professionalism** |
| PEO4 | **Professionalism** | **C: Core Competence** |
| PEO5 | **Learning**  **Environment** | **L: Breadth (Learning in diverse areas)** |

**Program Outcomes (PO):** 1. Understand and Apply Parallel Programming Concepts 2. Analyse and Improve Program Performance.

3. Demonstrate Practical Skills in HPC Tools and Environments.

**Keywords of POs:**

Engineering knowledge, Problem analysis, Design/development of solutions, Conduct Investigations of Complex Problems, Engineering Tool Usage, The Engineer and The World, Ethics, Individual and Collaborative Team work, Communication, Project Management and Finance, Life-Long Learning

**PSO Keywords:** Cutting edge technologies, Research

“I am an engineer, and I know how to apply engineering knowledge to investigate, analyse and design solutions to complex problems using tools for entire world following all ethics in a collaborative way with proper management skills throughout my life.” *to contribute to the development of cutting-edge technologies and Research*.

**Integrity:** I will adhere to the Laboratory Code of Conduct and ethics in its entirety.

**Name and Signature of Student and Date**

Mohika Jugele – 24/10/2025

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| **Sessi**  **on** | **2025-26 (ODD)** | **Course Name** | **HPC Lab** |
| --- | --- | --- | --- |
| **Seme**  **ster** | **7** | **Course Code** | 22ADS706 |
| **Roll**  **No** | 3 | **Name of Student** | Debasrita Chattopadhyay |

| Practical  Number | 7 |
| --- | --- |
| Course  Outcome | 1. Understand and Apply Parallel Programming Concepts  2. Analyse and Improve Program Performance |
| Aim | Hybrid Programming with MPI + OpenMP Practical |
| Problem Definitio n | Hybrid Programming with MPI + OpenMP Practical |
| Theory  (100  words) | The approach of hybrid programming using MPI (Message Passing Interface) and OpenMP (Open Multi-Processing) applies the benefits of distributed and shared memory parallel programming approaches to achieve higher levels of performance and scalability on new high-performance computing (HPC) platforms. MPI focuses on communication between nodes in a cluster (inter-node parallelism) while OpenMP offers support for parallel execution on a per-node (or intra-node) basis. This hybrid programming model allows each MPI process to then use OpenMP threads to efficiently exploit multicore processors. The hybrid programming model reduces the communication overhead between processes while capitalizing on shared memory within a node. Hybrid programming is particularly useful for large-scale scientific or engineering applications in which computationally intense portions of the task are passed to MPI processes, leaving each process to exploit the OpenMP threads. There are many performance benefits to using hybrid programming in relation to memory utilization, latency, and scalability in comparison to either pure MPI or pure OpenMP programs. |



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| Code: | #include <stdio.h>  #include <stdlib.h>  #include <mpi.h>  #include <omp.h>  #define N 8 // Size of matrix and vector  int main(int argc, char\* argv[]) {  int rank, size;  MPI\_Init(&argc, &argv);  MPI\_Comm\_rank(MPI\_COMM\_WORLD, &rank);  MPI\_Comm\_size(MPI\_COMM\_WORLD, &size);  int rows\_per\_proc = N / size;  double A[rows\_per\_proc][N];  double x[N];  double y\_local[rows\_per\_proc];  double y[N];  // Initialize vector x and matrix A  if(rank == 0) {  for(int i = 0; i < N; i++)  x[i] = i + 1; // Example vector: 1,2,3...  }  MPI\_Bcast(x, N, MPI\_DOUBLE, 0, MPI\_COMM\_WORLD); // Broadcast vector to all processes  // Initialize local part of matrix A  for(int i = 0; i < rows\_per\_proc; i++) {  for(int j = 0; j < N; j++) {  A[i][j] = (rank \* rows\_per\_proc + i + 1) \* (j + 1);  }  }  // Parallel computation using OpenMP  #pragma omp parallel for  for(int i = 0; i < rows\_per\_proc; i++) {  y\_local[i] = 0.0;  for(int j = 0; j < N; j++) {  y\_local[i] += A[i][j] \* x[j];  }  } |
| --- | --- |



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|  | // Gather results to root process  MPI\_Gather(y\_local, rows\_per\_proc, MPI\_DOUBLE, y, rows\_per\_proc, MPI\_DOUBLE, 0, MPI\_COMM\_WORLD);  // Print result in master process  if(rank == 0) {  printf("Result vector y:\n");  for(int i = 0; i < N; i++) {  printf("%lf ", y[i]);  }  printf("\n");  }  MPI\_Finalize();  return 0;  } |
| --- | --- |
| Output |  |



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|  |  |
| --- | --- |
| Output  Analysis | The output confirms correct task division among ranks and threads, balanced workload distribution, and reduced total execution time, validating the efficiency of the hybrid parallelization approach. |
| Link of  student  Github  profile  where  lab  assignme nt has  been  uploaded | **https://github.com/Mohikaaa18/HPC-Lab** |
| Conclusi  on | Hybrid Programming with MPI + OpenMP Practical implemented successfully. |



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| Plag  Report  (Similarit y index < 12%) |  |
| --- | --- |
| Date | 28/10/2025 |