Nagar Yuwak Shikshan Sanstha's
Yeshwantrao Chavan College of Engineering
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Department of Artificial Intelligence & Data Science

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: Dream of where you want.	**Mission:** Means to achieve Vision

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
Sakshi Gokhale
28/10/25

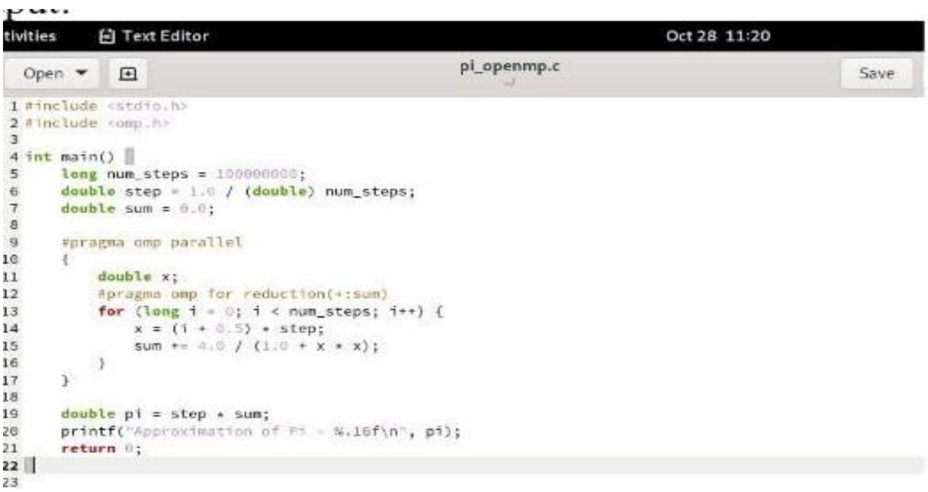
Session	2025-26 (ODD)	**Course Name**	HPC Lab
Semester	7 AIDS	**Course Code**	22ADS706
Roll No	16	**Name of Student**	Sakshi Gokhale

Practical Number	6
Course Outcome	1. Understand and Apply Parallel Programming Concepts 2. Analyse and Improve Program Performance
Aim	Hybrid Programming with MPI + OpenMP Practical
Problem Definition	Hybrid Programming with MPI + OpenMP Practical
Theory (100 words)	The value of π (Pi) can be approximated using numerical integration of the function f(x)=41+x2 f(x)=1+x over the interval [0,1]. By dividing the interval into n subintervals, the area under the curve can be estimated as the sum of small rectangles, where each rectangle's height is evaluated at the midpoint. In parallel computing with MPI, this computation is distributed among multiple processes, with each process calculating a partial sum for its assigned subintervals. The partial results are then combined using MPI_Reduce to obtain the final value of π. This approach allows the workload to be shared efficiently, reducing execution time and demonstrating speedup and efficiency compared to sequential computation.
Procedure and Execution (100 Words)	Steps of Implementation:- Algorithm: • Save code as pi_mpi.c. • Compile: mpicc pi_mpi.c -o pi_mpi • Run with multiple processes: mpirun -np 4 ./pi_mpi • Observe output and record execution times for different np.

Code:

```
#include <stdio.h> #include <mpi.h>

int main(int argc, char* argv[]) { int rank, size, n = 1000000, i; double
h, x, local_sum = 0.0, pi;
  MPI_Init(&argc, &argv);
  MPI_Comm_rank(MPI_COMM_WORLD,                    &rank);
  MPI_Comm_size(MPI_COMM_WORLD, &size);

  h = 1.0 / (double)n;

  for (i = rank; i < n; i += size) { x = h * (i +
  0.5); local_sum += 4.0 / (1.0 + x * x);
  } local_sum *= h;

  MPI_Reduce(&local_sum, &pi, 1, MPI_DOUBLE, MPI_SUM, 0,
MPI_COMM_WORLD);

  if (rank == 0) printf("Calculated value of Pi = %.16f\n",
  pi);

  MPI_Finalize();
  return 0;
}
```

Output:



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	`[lab1@localhost ~]$ gcc -fopenmp -o pi_openmp pi_openmp.c`
	`[lab1@localhost ~]$ ./pi_openmp`
	`Approximation of Pi = 3.1415926535898824`
	`[lab1@localhost ~]$ export OMP_NUM_THREADS=4`
	`[lab1@localhost ~]$ history`
	The computed π closely matches the true value

Output Analysis	Execution time **decreases** as the number of processes increases. Shows **parallel speedup** and good **efficiency**.
Link of student Github profile where lab assignment has been uploaded	https://github.com/sakshi-gokhale/Lab-HPC
Conclusion	MPI successfully distributes work among processes to compute π. Parallel execution significantly reduces computation time. Speedup and efficiency improve with more processes, demonstrating the benefits of **parallel computing**.
Plag Report (Similarity index < 12%)	

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	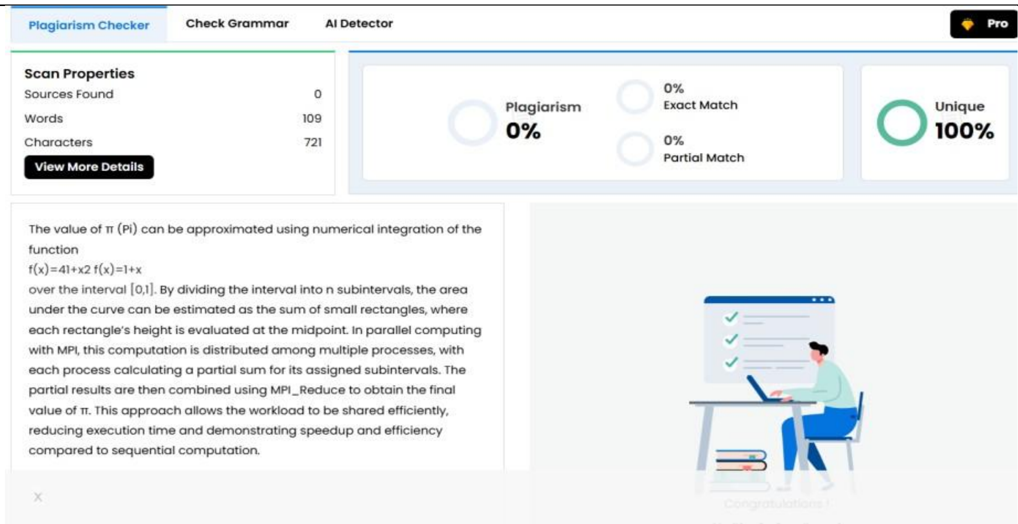
Date	28/10/25