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 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): (statements that describe what a student should be able to do and know by the end of a program)

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.

Sanskruti. Paunikar 24/10/2025
Name and Signature of Student and Date
(Signature and Date in Handwritten)

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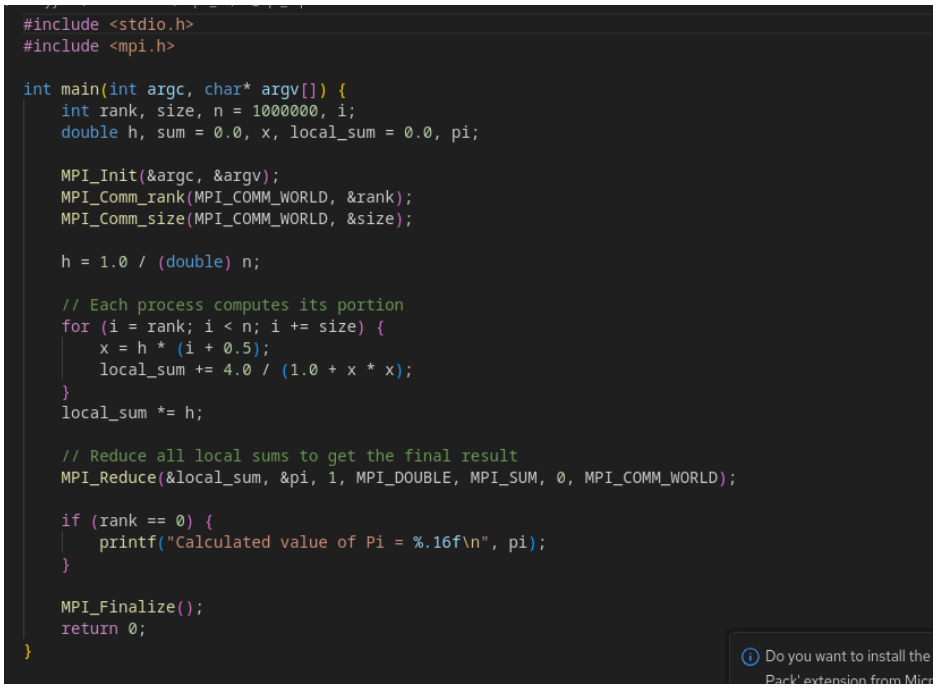
Session	2025-26 (ODD)	**Course Name**	High Performance Computing Lab
Semester	7 AIDS	**Course Code**	22ADS702
Roll No	21	**Name of Student**	Sanskruti. Paunikar

Practical Number	6
Course Outcome	**CO1:-**Understand and Apply Parallel Programming Concepts **CO1:-**Analyze and Improve Program Performance. **CO3:-**Demonstrate Practical Skills in HPC Tools and Environments.
Aim	Parallel Pi Calculation using MPI
Theory (100 words)	The value of π can be approximated using the Monte Carlo method or numerical integration. One common numerical method is based on the integration of the area under a curve: $$\pi = 4\int_0^1 \frac{1}{1+x^2}dx$$ This integral can be approximated by dividing the interval [0,1] into N subintervals and summing the area of rectangles: $$\pi \approx 4 \times \frac{1}{N}\sum_{i=0}^{N-1}\frac{1}{1+x_i^2}$$ Where $x_i = \frac{i+0.5}{N}$. Using MPI, the work of summing these rectangles can be distributed among multiple processes. Each process computes a partial sum, and the master process (rank 0) collects the results to compute the final value of π. Software/Hardware Requirements: Hardware: Multi-core CPU or cluster with multiple nodes Software: o Linux/Unix OS o MPICH or OpenMPI o GCC Compiler

Procedure and Execution (100 Words)	Steps of Implementation:- 1. Initialize MPI environment using MPI_Init. 2. Get the rank (ID) of each process and total number of processes using MPI_Comm_rank and MPI_Comm_size. 3. Divide the range [0,1] among processes. Each process computes a partial sum of π for its assigned range. 4. Use MPI_Reduce to collect and sum all partial results at the root process. 5. The root process prints the final value of π. 6. Finalize MPI using MPI_Finalize.

	Code:
	#include <stdio.h>
	#include <mpi.h>
	
	int main(int argc, char* argv[]) {
	int rank, size, n = 1000000, i;
	double h, sum = 0.0, 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;
	
	// Each process computes its portion
	for (i = rank; i < n; i += size) {
	x = h * (i + 0.5);
	local_sum += 4.0 / (1.0 + x * x);
	}
	local_sum *= h;
	
	// Reduce all local sums to get the final result
	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:
	 
	`#include <stdio.h>`
	`#include <mpi.h>`
	
	`int main(int argc, char* argv[]) {`
	`  int rank, size, n = 1000000, i;`
	`  double h, sum = 0.0, 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;`
	
	`  // Each process computes its portion`
	`  for (i = rank; i < n; i += size) {`
	`  x = h * (i + 0.5);`
	`  local_sum += 4.0 / (1.0 + x * x);`
	`  }`
	`  local_sum *= h;`
	
	`  // Reduce all local sums to get the final result`
	`  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;`
	`}`
	Do you want to install the
	Pack' extension from Micr

Output Analysis	OpenMPI executes the program successfully and gives us the calculated value of Pi.
Github link	https://github.com/sanskruti-1234/HPC.git
Conclusion	The Parallel Pi Calculation using MPI experiment successfully demonstrated that utilizing the Message Passing Interface significantly reduces the computation time compared to a sequential approach by distributing the numerical integration workload among multiple processes.

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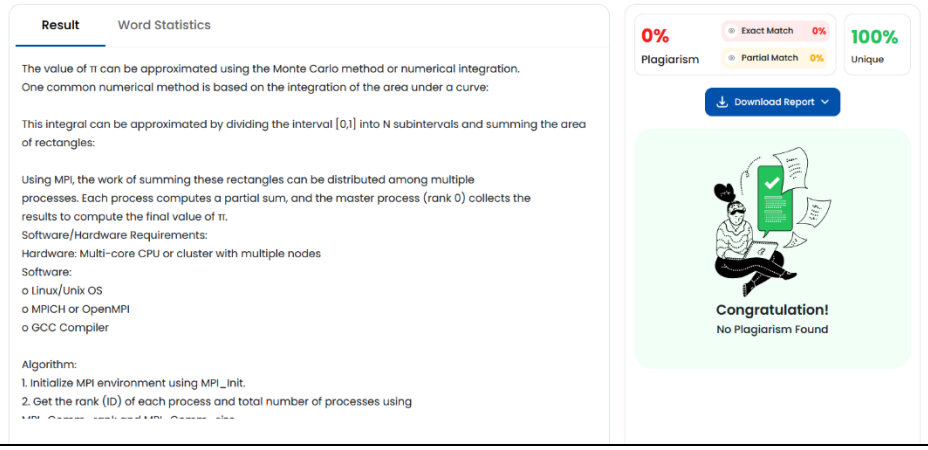
Plag Report (Similarity index < 12%)	
Date	24/10/2025