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**

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| **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)

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| 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.

**Name and Signature of Student and Date**

Mohika Jugele - 9/9/25

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| **Session** | **2025-26 (ODD)** | **Course Name** | **HPC Lab** |
| **Semester** | **7** | **Course Code** | **22ADS706** |
| **Roll No** | **12** | **Name of Student** | **Purvaja Sawalakhe** |

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| Practical  Number | 5 |
| Course  Outcome | Upon successful completion of the course the students will be able to: 1. Understand and Apply Parallel Programming Concepts 2. Analyze and Improve Program Performance.  3. Demonstrate Practical Skills in HPC Tools and Environments. |
| Aim | Basics of MPI Programming |
| Problem  Definition | MPI Programming Examples |
| Theory  (100 words) | The Message Passing Interface (MPI) is a standardized and portable message-passing library specification, widely used for parallel programming on distributed memory systems. It enables multiple processes to communicate and coordinate by explicitly sending and receiving messages.  **1. Core Concepts:**  **A. Processes and Ranks:**  An MPI program consists of multiple independent processes, each with its own local memory. Each process within a communicator (a group of processes) is assigned a unique integer identifier called a "rank," typically starting from 0.  **B. Communicators:**  Communicators define groups of processes that can communicate with each other. MPI\_COMM\_WORLD is the default  communicator encompassing all processes launched in an MPI program.  **C. Message Passing:**  Processes exchange data by sending and receiving messages. This is the fundamental mechanism for data sharing in MPI.  **2. Basic MPI Routines:**  **A. Initialization and Finalization:**  • MPI\_Init(&argc, &argv): Initializes the MPI environment. Must be called before any other MPI functions.  • MPI\_Finalize(): Cleans up the MPI environment. Should be called at the end of the MPI program. |



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|  | **B. Process Information:**  • MPI\_Comm\_size(MPI\_Comm comm, int \*size): Returns the total number of processes in a given communicator (comm).  • MPI\_Comm\_rank(MPI\_Comm comm, int \*rank): Returns the rank (unique ID) of the calling process within a given communicator. **C. Point-to-Point Communication:**  • MPI\_Send(void \*buf, int count, MPI\_Datatype datatype, int dest, int tag, MPI\_Comm comm): Sends a message from the calling process to a specified destination process (dest).  a. buf: Pointer to the send buffer.  b. count: Number of elements to send.  c. datatype: MPI datatype of the elements.  d. dest: Rank of the destination process.  e. tag: Integer tag to differentiate messages.  f. comm: Communicator.  • MPI\_Recv(void \*buf, int count, MPI\_Datatype datatype, int source, int tag, MPI\_Comm comm, MPI\_Status \*status): Receives a message from a specified source process (source).  a. buf: Pointer to the receive buffer.  b. count, datatype, tag, comm: Similar to MPI\_Send.  c. source: Rank of the source process, or MPI\_ANY\_SOURCE to receive from any process.  d. status: Status object providing information about the received message.  **3. Execution Model:**  An MPI program is typically launched as a set of identical processes. Each process executes the same program code, but their behavior diverges based on their rank and the logic within the program that utilizes MPI functions for communication and coordination. This allows for parallel execution of tasks across multiple processors or compute nodes. |
| Procedure and Execution (10 0 Words) | Algorithm:  **1. Hello World (Basic MPI Program)**  A. Start the MPI environment.  B. Get the total number of processes.  C. Get the unique rank (ID) of the current process.  D. Print "Hello" message along with process rank and total processes. E. End the MPI environment.  **2. Point-to-Point Communication (Send/Receive)**  A. Start the MPI environment.  B. Get the process rank and total number of processes. |



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|  | C. If the process rank = 0:  a. Create a data value.  b. Send the data to process 1.  D. If the process rank = 1:  a. Receive the data from process 0.  b. Print the received value.  E. End the MPI environment.  **3. Broadcast Communication**  A. Start the MPI environment.  B. Get the process rank and total number of processes.  C. If the process rank = 0 (root process):  a. Create a data value.  D. Broadcast the data from root to all processes.  E. Each process prints the received value.  F. End the MPI environment.  **4. Reduction (Summation Example)**  A. Start the MPI environment.  B. Get the process rank and total number of processes.  C. Each process creates a local data value (for example: rank + 1). D. Perform a Reduce operation to sum all local values.  E. Store the result in the root process (rank 0).  F. If rank = 0, print the total sum.  G. End the MPI environment. |
| Code:  ❖ **Install MPI:**  ❖ **Hello World (Basic MPI Program):**  1. Code |

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|  | 2. Compile & Run  3. Result    ❖ **Point-to-Point Communication (Send/Receive):**  1. Code  2. Compile & Run  3. Result    ❖ **Broadcast Communication:**  1. Code |



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|  | 2. Compile & Run  3. Result    ❖ **Reduction (Summation Example):**  1. Code  2. Compile & Run  3. Result  ❖ **All Files:** |

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|  | Output:  **1. Hello World (Basic MPI Program)**  **2. Point-to-Point Communication (Send/Receive)**  **3. Broadcast Communication**  **4. Reduction (Summation Example)** |
| Output  Analysis | **1. Hello World (Basic MPI Program):**  When the program runs with 4 processes, each process prints a message showing its rank (0, 1, 2, or 3) and the total number of processes (4). The order of messages may not always be 0,1,2,3 because all processes run at the same time.  **2. Point-to-Point Communication (Send/Receive):**  When the program runs with 2 processes, process 0 sends the data (for example, 100) to process 1. The output shows that process 0 sent the data, and process 1 successfully received it. This verifies message transfer between two processes.  **3. Broadcast Communication:**  When the program runs with 4 processes, process 0 broadcasts a value (for example, 42) to all processes. The output shows that each process, including 0, prints the same data value. This proves that a single process can share data with all others.  **4. Reduction (Summation Example):**  When the program runs with 4 processes, each process contributes a local value (rank + 1 → values 1, 2, 3, 4). MPI combines these values using the reduce operation, and the root process (rank 0) prints the total sum (1+2+3+4 = 10). Only process 0 shows the final result. |

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| Link ofstudent Github profile where lab  assignment has been uploaded | https://github.com/Mohikaaa18/HPC-Lab |
| Conclusion | **1. Hello World (Basic MPI Program):** The program confirmsthat MPI is working and multiple processes can run in parallel, each with its own unique ID.  **2. Point-to-Point Communication (Send/Receive):** Point-to-point communication works correctly in MPI, where one process can send data and another can receive it.  **3. Broadcast Communication:** Broadcast communication works properly in MPI, allowing one process to distribute the same data to every other process at once.  **4. Reduction (Summation Example):** The reduce function in MPI successfully collects and combines data from all processes, proving that MPI can perform parallel computations and gather results at a single process. |
| Plag Report  (Similarity  index < 12%) |  |
| Date | 09/09/2025 |