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
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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
Soham pimpalgaonkar-28/10/2025

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Session	**2025-26 (ODD)**	**Course Name**	**HPC Lab**
Semester	**7**	**Course Code**	22ADS706
Roll No	62	**Name of Student**	Soham pimpalgaonkar

Practical Number	2
Course Outcome	1. Understand and Apply Parallel Programming Concepts 2. Analyse and Improve Program Performance
Aim	Measuring Program Performance
Problem Definition	Measuring Program Performance
Theory (100 words)	**Why measure performance?** 1. To understand how long a program runs. 2. To identify bottlenecks. 3. To optimize code and compare different implementations. 4. To benchmark HPC applications. **Common ways to measure program performance in Linux HPC:** A. Using Linux time command B. Using built-in timing functions in code (e.g., OpenMP, MPI timing functions) C. Using profiling tools (basic overview) **Example: Measuring Performance of Matrix Multiplication** Step 1: Write the serial (single-threaded) matrix multiplication code. Step 2: Compile and run the serial program Step 3: Add OpenMP parallelization and timing Step 4: Compile and run the OpenMP version Step 5: Compare results

Code:

1. **Matmul_serial.c**

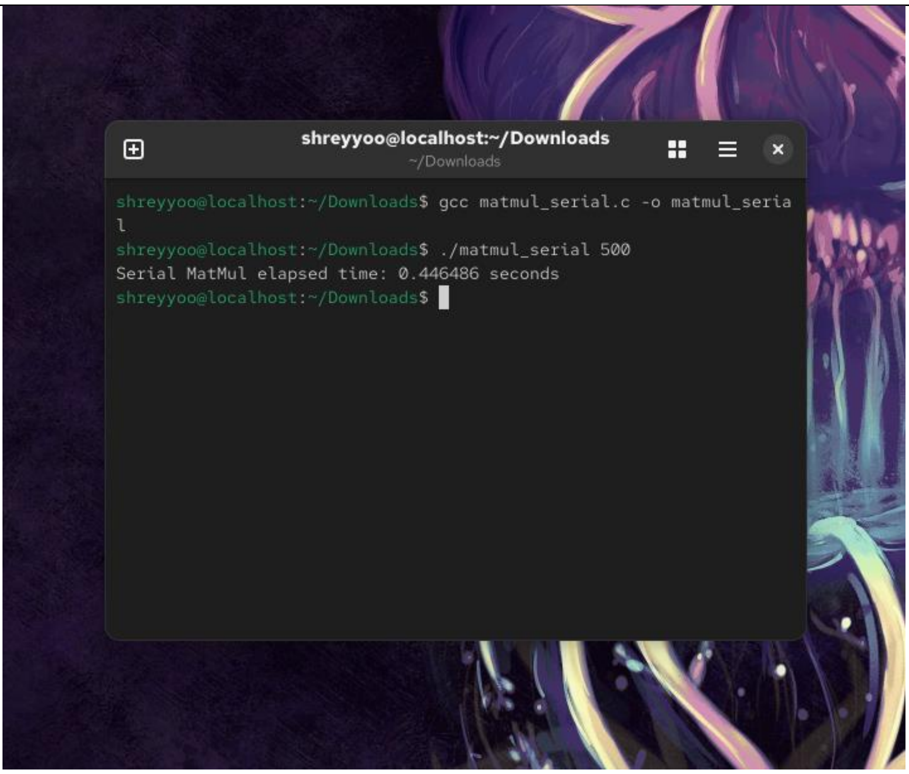
```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

void matmul(int N, double *A, double *B, double *C) {
    for (int i = 0; i < N; i++)
        for (int j = 0; j < N; j++) {
            double sum = 0;
            for (int k = 0; k < N; k++)
                sum += A[i*N+k] * B[k*N+j];
            C[i*N+j] = sum;
        }
}

int main(int argc, char **argv) {
    if (argc < 2) {
        printf("Usage: %s matrix_size\n", argv[0]);
        return 1;
    }
    int N = atoi(argv[1]);
    double *A = malloc(N*N*sizeof(double));
    double *B = malloc(N*N*sizeof(double));
    double *C = malloc(N*N*sizeof(double));

    // Initialize matrices A and B
    for (int i = 0; i < N*N; i++) {
        A[i] = 1.0;
        B[i] = 2.0;
    }

    clock_t start = clock();
    matmul(N, A, B, C);
    clock_t end = clock();

    double time_spent = (double)(end - start) / CLOCKS_PER_SEC;
    printf("Serial MatMul elapsed time: %f seconds\n", time_spent);

    free(A); free(B); free(C);
    return 0;
}
```

2. **Matmul_openmp.c**

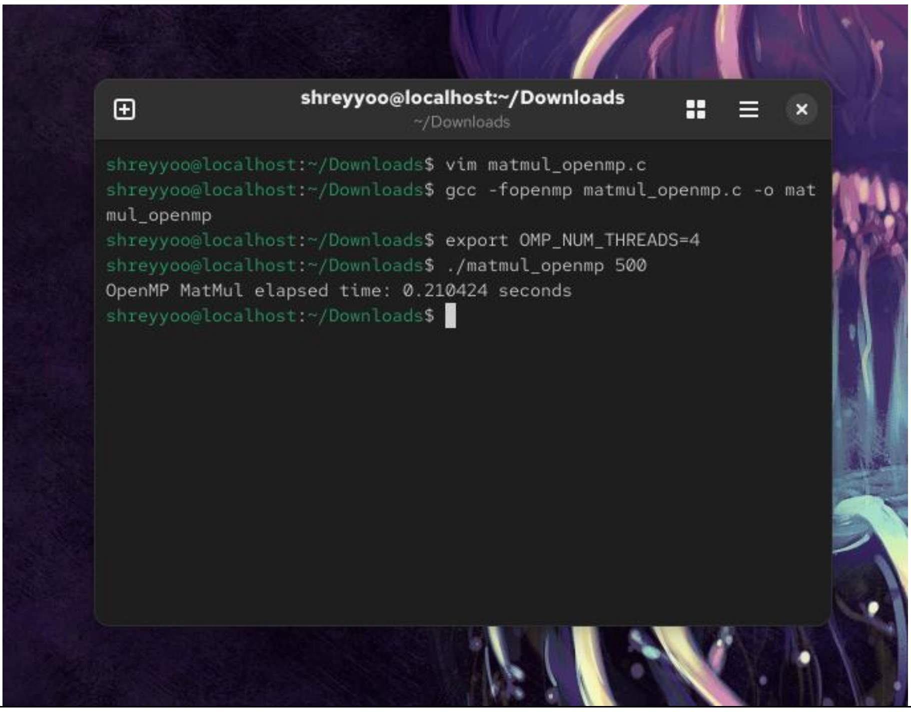
```
#include <stdio.h>
```

```
#include <stdlib.h>
#include <omp.h>

void matmul(int N, double *A, double *B, double *C) {
    #pragma omp parallel for collapse(2)
    for (int i = 0; i < N; i++)
        for (int j = 0; j < N; j++) {
            double sum = 0;
            for (int k = 0; k < N; k++)
                sum += A[i*N+k] * B[k*N+j];
            C[i*N+j] = sum;
        }
}

int main(int argc, char **argv) {
    if (argc < 2) {
        printf("Usage: %s matrix_size\n", argv[0]);
        return 1;
    }
    int N = atoi(argv[1]);
    double *A = malloc(N*N*sizeof(double));
    double *B = malloc(N*N*sizeof(double));
    double *C = malloc(N*N*sizeof(double));

    for (int i = 0; i < N*N; i++) {
        A[i] = 1.0;
        B[i] = 2.0;
    }

    double start = omp_get_wtime();
    matmul(N, A, B, C);
    double end = omp_get_wtime();

    printf("OpenMP MatMul elapsed time: %f seconds\n", end - start);

    free(A); free(B); free(C);
    return 0;
}
```

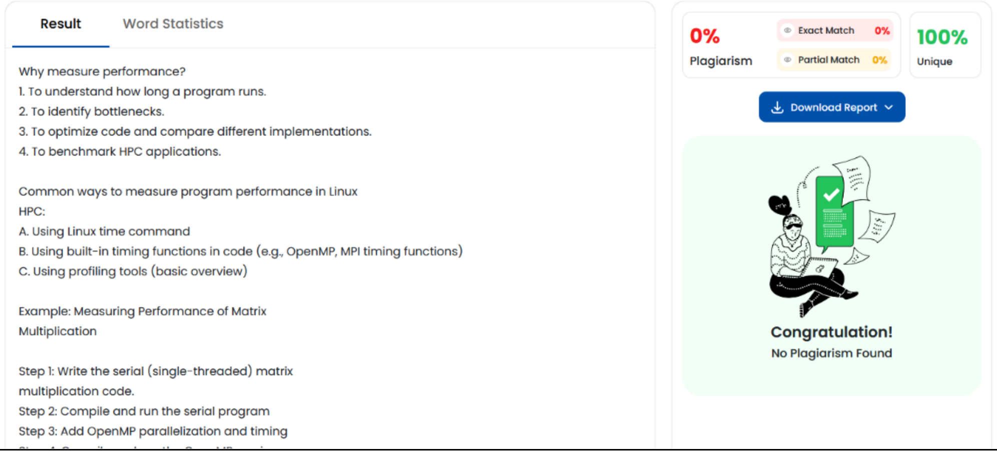
Output



```
shreyyoo@localhost:~/Downloads$ gcc matmul_serial.c -o matmul_seria
l
shreyyoo@localhost:~/Downloads$ ./matmul_serial 500
Serial MatMul elapsed time: 0.446486 seconds
shreyyoo@localhost:~/Downloads$
```



```
shreyyoo@localhost:~/Downloads$ vim matmul_openmp.c
shreyyoo@localhost:~/Downloads$ gcc -fopenmp matmul_openmp.c -o mat
mul_openmp
shreyyoo@localhost:~/Downloads$ export OMP_NUM_THREADS=4
shreyyoo@localhost:~/Downloads$ ./matmul_openmp 500
OpenMP MatMul elapsed time: 0.210424 seconds
shreyyoo@localhost:~/Downloads$
```

Output Analysis	The matmul_serial file executes in 0.4 seconds, whereas the matmul_openmp files executes in 0.2. There’s a significate improvement in execution time.
Link of student Github profile where lab assignment has been uploaded	https://github.com/Sohampimpalgaonkar/HPC
Conclusion	Using OpenMP drastically improve the performance of a program.
Plag Report (Similarity index < 12%)	 Result Word Statistics 0% Plagiarism Exact Match 0% Partial Match 0% 100% Unique Download Report Congratulation! No Plagiarism Found Why measure performance? 1. To understand how long a program runs. 2. To identify bottlenecks. 3. To optimize code and compare different implementations. 4. To benchmark HPC applications. Common ways to measure program performance in Linux HPC: A. Using Linux time command B. Using built-in timing functions in code (e.g., OpenMP, MPI timing functions) C. Using profiling tools (basic overview) Example: Measuring Performance of Matrix Multiplication Step 1: Write the serial (single-threaded) matrix multiplication code. Step 2: Compile and run the serial program Step 3: Add OpenMP parallelization and timing
Date	28/10/2025