# 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

1. Analyse and Improve Program Performance.
2. 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 – 01/09/2025

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| **Session** | **2025-26 (ODD)** | | **Course Name** | **HPC Lab** |
| **Semester** | **7** | | **Course Code** | 22ADS706 |
| **Roll No** | 07 | | **Name of Student** | Mohika Jugele |
|  | | | | |
| 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:**   * 1. Using Linux time command   2. Using built-in timing functions in code (e.g., OpenMP, MPI timing functions)   3. 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 | | |

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| 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** |

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#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;

}

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|  |  |
| --- | --- |
| Output |  |

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| 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/Mohikaaa18/HPC-Lab |
| Conclusion | Using OpenMP drastically improve the performance of a program. |
| Plag Report (Similarity index < 12%) | A screenshot of a chat  AI-generated content may be incorrect. |
| Date | 01/09/2025 |