



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

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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)

| | | | |
|------|-----------------------------|--|--|
| PEO1 | Preparation | P: Preparation | Pep-CL abbreviation pronounce as Pep-si-IL 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

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

| | |
|--|---|
| Practical Number | 8 |
| Course Outcome | 1. Understand and Apply Parallel Programming Concepts 2. Analyse and Improve Program Performance |
| Aim | Introduction to GPU Programming (CUDA on CentOS) |
| Problem Definition | This guide provides a simple step-by-step introduction to GPU programming using CUDA on CentOS. |
| Theory (100 words) | CUDA (Compute Unified Device Architecture) is a GPU programming environment that facilitates general-purpose computing on GPU hardware, leveraging large parallel processing power. CUDA was developed by NVIDIA as a parallel computing platform and programming model, operations and consume more disk space. Pickle is fast but it is Python specific and not suitable for cross-platform HPC environments. Parquet is a modern columnar binary format which stores data in compressed, vectorizable columns. This improves caching, minimizes storage size and supports parallel read operations. Therefore selection of the right serialization format is important for HPC pipelines. Parquet achieves high throughput and low memory usage, making it suitable for large scale data analysis and distributed computational systems. |
| Procedure and Execution (100 Words) | Steps of Implementation:- <ul style="list-style-type: none"> • Install NVIDIA Driver and CUDA Toolkit on CentOS. • Verify CUDA installation using nvcc --version command. • Write CUDA program in C/C++ using .cu extension. • Define kernel function with global keyword for GPU execution. • Allocate memory on host (CPU) and device (GPU). • Transfer data from host to device using cudaMemcpy(). • Launch kernel with specified grid and block dimensions. • Copy results back from device to |

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host memory.

- Free allocated GPU memory using cudaFree().
- Compile and run program using nvcc filename.cu -o output && ./output.

Output:

```

Untitled23.ipynb ☆ ⚙
Edit View Insert Runtime Tools Help
Cells + Code + Text Run all ↗

GPU: Nvidia-smi

Tue Oct 28 05:37:53 2025
+-----+-----+-----+
| NVIDIA-SMI 550.54.15 | Driver Version: 550.54.15 | CUDA Version: 12.4 |
+-----+-----+-----+
| GPU Name Persistence-M Bus-Id Disp.A Volatile Uncorr. ECC |
| Fan Temp Perf Pwr:Usage/Cap | Memory-Usage | GPU-Util Compute M. |
| | Mhz | % | % / | % / | % | % / |
+-----+-----+-----+
| 0 Tesla T4 Off 00000000:00:04.0 Off | 0% | Default N/A |
| N/A 45C PB 5W / 70W | 0MB / 15360MB | | |
+-----+-----+-----+
Processes:
GPU GE CI PID Type Process name GPU Memory Usage
ID ID
+-----+
| No running processes found |
+-----+
Cells Terminal ↗

```



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```
nvcc --version

nvcc: NVIDIA (R) Cuda compiler driver
Copyright (c) 2005-2024 NVIDIA Corporation
Built on Thu Jun  6 02:18:23 PDT 2024
Cuda compilation tools, release 12.5, V12.5.82
Build cuda_12.5.r12.5/compiler.34385749_0

vector_add.cu
#include <iostream>
#include <cuda_runtime.h>

__global__ void vectorAdd(int *A, int *B, int *C, int n) {
    int idx = blockIdx.x * blockDim.x + threadIdx.x;
    if (idx < n)
        C[idx] = A[idx] + B[idx];
}

int main() {
    int n = 5;
    int size = n * sizeof(int);
    int h_A[] = {1, 2, 3, 4, 5};
    int h_B[] = {10, 20, 30, 40, 50};
    int h_C[n];
    Terminal
    int *d_A, *d_B, *d_C;
    cudaMalloc((void **)&d_A, size);
    cudaMalloc((void **)&d_B, size);
    cudaMalloc((void **)&d_C, size);

    cudaMemcpy(d_A, h_A, size, cudaMemcpyHostToDevice);
    cudaMemcpy(d_B, h_B, size, cudaMemcpyHostToDevice);

    // <<<number of blocks, threads per block>>>
    vectorAdd<<<1, n>>>(d_A, d_B, d_C, n);
    cudaDeviceSynchronize();

    cudaMemcpy(h_C, d_C, size, cudaMemcpyDeviceToHost);

    std::cout << "Result of vector addition:\n";
    for (int i = 0; i < n; i++) {  

Terminal
```



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```
for (int i = 0; i < n; i++) {
    std::cout << h_A[i] << " + " << h_B[i] << " = " << h_C[i]
}

cudaFree(d_A);
cudaFree(d_B);
cudaFree(d_C);

return 0;
```

→ Overwriting vector_add.cu





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|---|---|-------------|---------------|-----|--------|------------|---------------|--|--|-----------|-----------------|-------------|---------------|-----------------------|------------------------|--|--|
| Output Analysis | This output shows the sum value of corresponding elements from two vectors. Each thread performs one addition, while the GPU executes these additions in parallel. The final result demonstrates both the successful transfer of data to the GPU as well as the successful execution of a kernel on the GPU. | | | | | | | | | | | | | | | | |
| Link of student Github profile where lab assignment has been uploaded | https://github.com/sakshi-gokhale/Lab-HPC | | | | | | | | | | | | | | | | |
| Conclusion | The program demonstrates parallel computation using CUDA for efficient vector addition | | | | | | | | | | | | | | | | |
| Plag Report (Similarity index < 12%) | <p>Plagiarism Scan Report</p> <table><tr><td>3%</td><td>Exact Match</td><td>97%</td><td>Unique</td></tr><tr><td>Plagiarism</td><td>Partial Match</td><td></td><td></td></tr><tr><td>Words 226</td><td>Characters 1461</td><td>Sentences 9</td><td>Paragraphs 14</td></tr><tr><td>Read Time 2 minute(s)</td><td>Speak Time 2 minute(s)</td><td></td><td></td></tr></table> <p>Content Checked For Plagiarism</p> <p>CUDA (Compute Unified Device Architecture) is a GPU programming environment that facilitates general-purpose computing on GPU hardware, leveraging large parallel processing power. CUDA was developed by NVIDIA as a parallel computing platform and programming model,</p> | 3% | Exact Match | 97% | Unique | Plagiarism | Partial Match | | | Words 226 | Characters 1461 | Sentences 9 | Paragraphs 14 | Read Time 2 minute(s) | Speak Time 2 minute(s) | | |
| 3% | Exact Match | 97% | Unique | | | | | | | | | | | | | | |
| Plagiarism | Partial Match | | | | | | | | | | | | | | | | |
| Words 226 | Characters 1461 | Sentences 9 | Paragraphs 14 | | | | | | | | | | | | | | |
| Read Time 2 minute(s) | Speak Time 2 minute(s) | | | | | | | | | | | | | | | | |
| Date | 28/10/25 | | | | | | | | | | | | | | | | |



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