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

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
Samriddhi Kaswa– 01/09/2025

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Session	**2025-26 (ODD)**	**Course Name**	**HPC Lab**
Semester	**7**	**Course Code**	22ADS706
Roll No	17	**Name of Student**	Samriddhi Kaswa

Practical Number	1
Course Outcome	**1.** Understand and Apply Parallel Programming Concepts **2.** Analyse and Improve Program Performance
Aim	Introduction to Linux and HPC Environment
Problem Definition	Introduction to Linux and HPC Environment
Theory (100 words)	**Definition:** High Performance Computing (HPC) refers to the use of supercomputers and parallel processing techniques to solve complex computational problems faster and more efficiently than traditional systems. **Purpose:** To Solve large-scale scientific, engineering, and data-intensive problems. To Reduce processing time. To Improve simulation accuracy. **Key Components of HPC Systems:** Compute Nodes (Processors/CPUs/GPUs) Memory (RAM) Storage (Disks/SSDs) Interconnect (High-speed Network) Software Stack (Compilers, Libraries, Tools) **Parallel Computing – The Core of HPC** **Types of Parallelism:** **Data Parallelism:** Same operation on different data **Task Parallelism:** Different tasks executed simultaneously

Parallel Architectures:

Shared Memory Architecture

Multiple cores sharing the same RAM

Easy programming but limited scalability

2. Distributed Memory Architecture

Each processor has its own memory

Requires message passing (MPI)

Parallel Programming:

It is a programming technique where multiple tasks or computations are performed simultaneously to solve a problem faster and more efficiently.

Purpose:

Speed up execution time

Utilize multi-core and multi-processor hardware

Handle large data sets

Perform complex scientific simulations

Why is Parallel Programming Needed in HPC?

To Solve Large Problems Faster

To Make Full Use of Modern Hardware

To Handle Big Data and Complex Simulations

To Achieve Better Performance and Scalability

Energy and Cost Efficiency

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Energy and Cost Efficiency

Parallel Programming Models:

Shared Memory (OpenMP, Threads): Tasks share the same memory space

Distributed Memory (MPI): Tasks run on different machines and exchange messages

Hybrid: Mix of shared and distributed (used in modern HPC)

GPU-based (CUDA, OpenCL): Thousands of lightweight threads run in parallel on GPUs

Programming Models in HPC:

Message Passing Interface (MPI)

Used in distributed memory systems

OpenMP

Shared memory parallelism using compiler directives

CUDA/OpenCL

Programming for GPUs

Hybrid Models

MPI + OpenMP or MPI + CUDA

	Why Linux in HPC? Linux is the standard OS for HPC clusters Open-source, customizable, lightweight Robust support for networking, process control, and file systems Widely supported by HPC software libraries and tools
Code:	ls cd Downloads pwd mkdir MyDocuments rm -rf MyDocuments top man dnf touch text.txt nano text.txt

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Output

```
[lab1@localhost hpc]$ cp first.txt second.txt
cp: cannot stat 'first.txt': No such file or directory
[lab1@localhost hpc]$ ls
first.sh  prog.txt  second.txt  YCCE
[lab1@localhost hpc]$ cp prog.txt second.txt
[lab1@localhost hpc]$ vi second.txt
[lab1@localhost hpc]$ touch third.txt
[lab1@localhost hpc]$ ls
first.sh  prog.txt  second.txt  third.txt  YCCE
[lab1@localhost hpc]$ rm third.txt
[lab1@localhost hpc]$ ls
first.sh  prog.txt  second.txt  YCCE
[lab1@localhost hpc]$ top
```

```
[lab1@localhost hpc]$ module load
[lab1@localhost hpc]$ module load python/3.8
ERROR: Unable to locate a modulefile for 'python/3.8'
[lab1@localhost hpc]$ python
Python 3.9.21 (main, Feb 10 2025, 00:00:00)
[GCC 11.5.0 20240719 (Red Hat 11.5.0-5)] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> print("hello")
hello
>>> print(5+3)
8
>>> print(8/4)
2.0
>>> print(8%4)
0
>>> a = ["apple","banana","cherry"]
>>> print(a)
['apple', 'banana', 'cherry']
>>> import numpy as np
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ModuleNotFoundError: No module named 'numpy'
>>> import pandas as pd
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ModuleNotFoundError: No module named 'pandas'
>>> n ano
  File "<stdin>", line 1
    n ano
      ^
SyntaxError: invalid syntax
>>> nano
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'nano' is not defined
>>> exit()
[lab1@localhost hpc]$ nano
[lab1@localhost hpc]$ cat YCCE.sh
cat: YCCE.sh: No such file or directory
[lab1@localhost hpc]$ ls
first.sh  Mohika  prog.txt  second.txt  YCCE
[lab1@localhost hpc]$ cat first.sh
[lab1@localhost hpc]$ vi first.sh
[lab1@localhost hpc]$ vi first.sh
[lab1@localhost hpc]$
```

```
top - 11:15:41 up 51 min,  2 users,  load average: 0.26, 0.14, 0.05
Tasks: 390 total,   1 running, 389 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.1 us,  0.1 sy,  0.0 ni, 99.8 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :  15106.0 total,  11439.0 free,   2321.3 used,   1714.8 buff/cache
MiB Swap:   3814.0 total,   3814.0 free,      0.0 used.  12784.7 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
  10612 root       0 -20    0.0g   0.0g   0.0g I   0.0   0.0   0:00.00 kworker/u69:0
  10633 root      20   0    0.0g   0.0g   0.0g I   0.0   0.0   0:00.00 kworker/9:0-events
```

```
top - 11:15:44 up 51 min,  2 users,  load average: 0.23, 0.14, 0.05
Tasks: 390 total,   1 running, 389 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.2 us,  0.1 sy,  0.0 ni, 99.7 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :  15106.0 total,  11432.8 free,   2326.1 used,   1716.1 buff/cache
MiB Swap:   3814.0 total,   3814.0 free,      0.0 used.  12779.9 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
  10612 root       0 -20    0.0g   0.0g   0.0g I   0.0   0.0   0:00.00 kworker/u69:0
  10633 root      20   0    0.0g   0.0g   0.0g I   0.0   0.0   0:00.00 kworker/9:0-mm_percpu_wq
```

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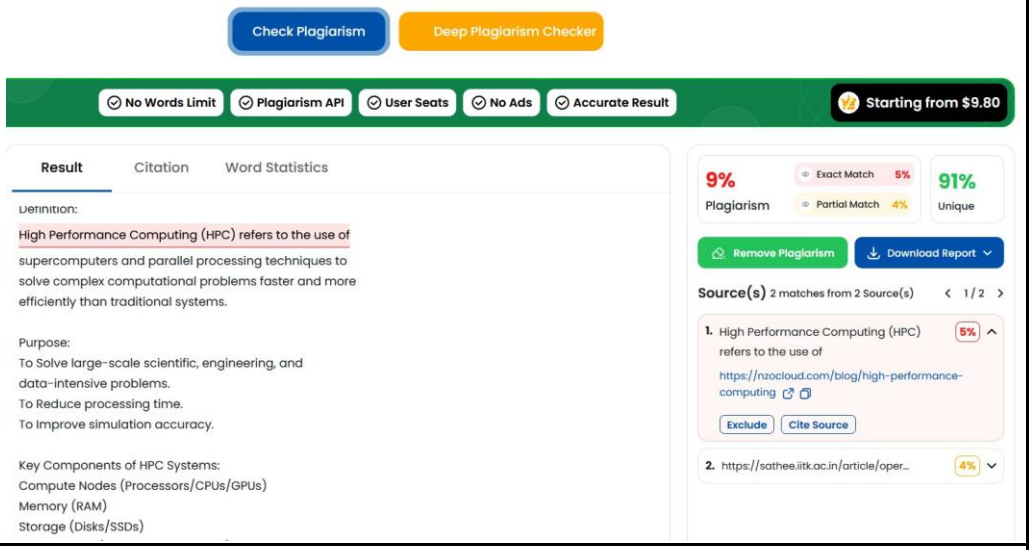
Output Analysis	We have taken a brief overview of the main concepts of HPC and have practices working on a live Linux environment running CentOS Stream 10.
Link of student Github profile where lab assignment has been uploaded	https://github.com/samriddhikaswa/HPC
Conclusion	We have taken a brief overview of the main concepts of HPC and have practices working on a live Linux environment running CentOS Stream 10.
Plag Report (Similarity index < 12%)	
Date	01/09/2025

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