

## Practical No 7

PRN: 22520005

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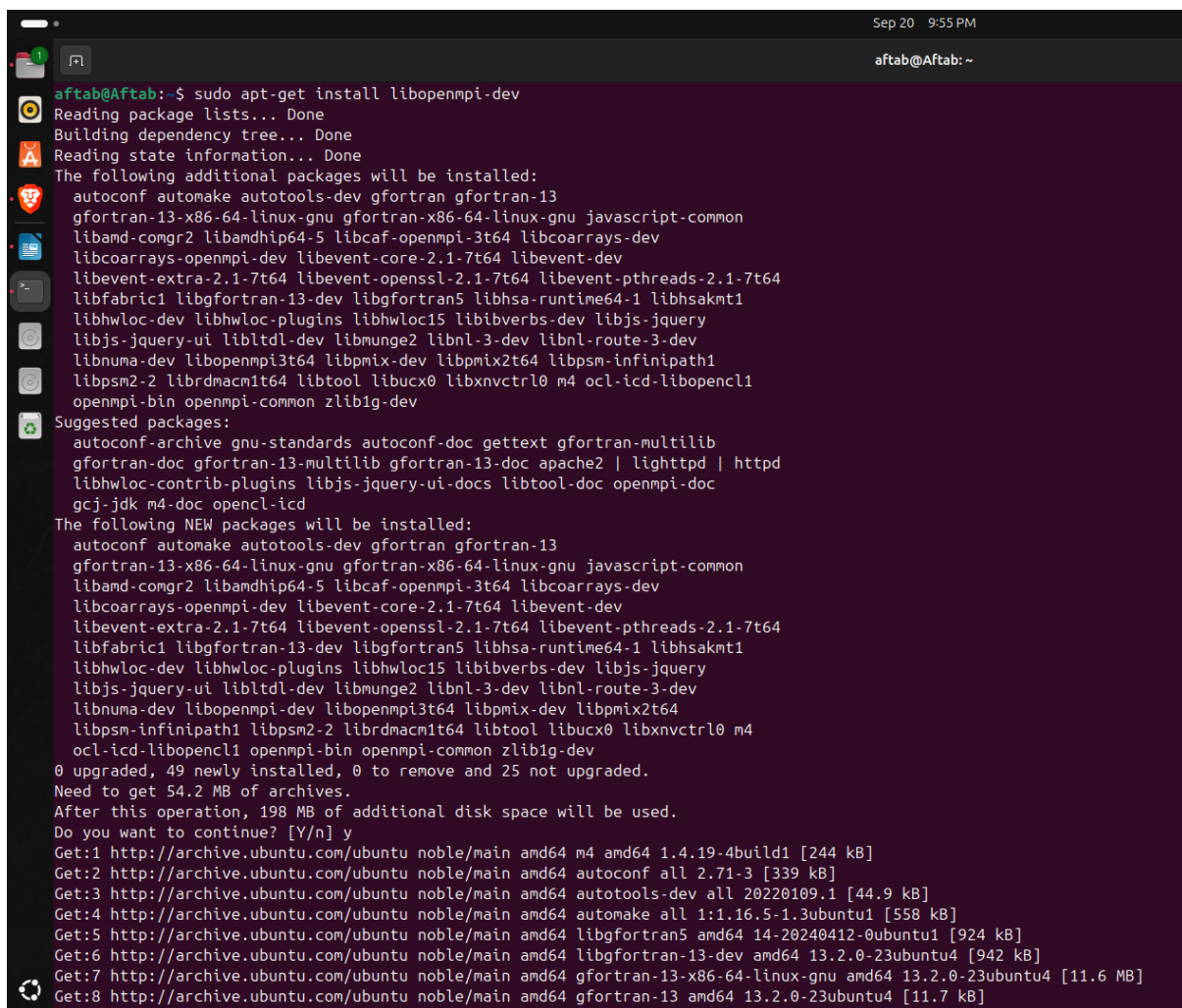
Batch: B6

Course: High Performance Computing Lab

### Title of practical:

Installation of MPI & Implementation of basic functions of MPI

### Screenshot:



```
aftab@Aftab:~$ sudo apt-get install libopenmpi-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  autoconf automake autotools-dev gfortran gfortran-13
  gfortran-13-x86-64-linux-gnu gfortran-x86-64-linux-gnu javascript-common
  libamd-comgr2 libamdhip64-5 libcaf-openmpi-3t64 libcoarrays-dev
  libcoarrays-openmpi-dev libevent-core-2.1-7t64 libevent-dev
  libevent-extra-2.1-7t64 libevent-openssl-2.1-7t64 libevent-pthreads-2.1-7t64
  libfabric1 libgfortran-13-dev libgfortran5 libhsa-runtime64-1 libhsakmt1
  libhwloc-dev libhwloc-plugins libhwloc15 libibverbs-dev libjs-jquery
  libjs-jquery-ui libltdl-dev libmunge2 libnl-3-dev libnl-route-3-dev
  libnuma-dev libopenmpi3t64 libpmix-dev libpmix2t64 libpsm-infinipath1
  libpsm2-2 librdmacm1t64 libtool libucx0 libxnvctrl0 m4 ocl-icd-libopencl1
  openmpi-bin openmpi-common zlib1g-dev
Suggested packages:
  autoconf-archive gnu-standards autoconf-doc gettext gfortran-multilib
  gfortran-doc gfortran-13-multilib gfortran-13-doc apache2 | lighttpd | httpd
  libhwloc-contrib-plugins libjs-jquery-ui-docs libtool-doc openmpi-doc
  gcj-jdk m4-doc opencl-icd
The following NEW packages will be installed:
  autoconf automake autotools-dev gfortran gfortran-13
  gfortran-13-x86-64-linux-gnu gfortran-x86-64-linux-gnu javascript-common
  libamd-comgr2 libamdhip64-5 libcaf-openmpi-3t64 libcoarrays-dev
  libcoarrays-openmpi-dev libevent-core-2.1-7t64 libevent-dev
  libevent-extra-2.1-7t64 libevent-openssl-2.1-7t64 libevent-pthreads-2.1-7t64
  libfabric1 libgfortran-13-dev libgfortran5 libhsa-runtime64-1 libhsakmt1
  libhwloc-dev libhwloc-plugins libhwloc15 libibverbs-dev libjs-jquery
  libjs-jquery-ui libltdl-dev libmunge2 libnl-3-dev libnl-route-3-dev
  libnuma-dev libopenmpi-dev libopenmpi3t64 libpmix-dev libpmix2t64
  libpsm-infinipath1 libpsm2-2 librdmacm1t64 libtool libucx0 libxnvctrl0 m4
  ocl-icd-libopencl1 openmpi-bin openmpi-common zlib1g-dev
0 upgraded, 49 newly installed, 0 to remove and 25 not upgraded.
Need to get 54.2 MB of archives.
After this operation, 198 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://archive.ubuntu.com/ubuntu noble/main amd64 m4 amd64 1.4.19-4build1 [244 kB]
Get:2 http://archive.ubuntu.com/ubuntu noble/main amd64 autoconf all 2.71-3 [339 kB]
Get:3 http://archive.ubuntu.com/ubuntu noble/main amd64 autotools-dev all 20220109.1 [44.9 kB]
Get:4 http://archive.ubuntu.com/ubuntu noble/main amd64 automake all 1:1.16.5-1.3ubuntu1 [558 kB]
Get:5 http://archive.ubuntu.com/ubuntu noble/main amd64 libgfortran5 amd64 14-20240412-0ubuntu1 [924 kB]
Get:6 http://archive.ubuntu.com/ubuntu noble/main amd64 libgfortran-13-dev amd64 13.2.0-23ubuntu4 [942 kB]
Get:7 http://archive.ubuntu.com/ubuntu noble/main amd64 gfortran-13-x86-64-linux-gnu amd64 13.2.0-23ubuntu4 [11.6 MB]
Get:8 http://archive.ubuntu.com/ubuntu noble/main amd64 gfortran-13 amd64 13.2.0-23ubuntu4 [11.7 kB]
```

```
aftab@Aftab: ~  
aftab@Aftab:~$ mpirun --version  
mpirun (Open MPI) 4.1.6  
  
Report bugs to http://www.open-mpi.org/community/help/  
aftab@Aftab:~$  
  
aftab@Aftab:~$
```

```
File Edit Selection View Go Run Terminal Help  
C hello.c 2 x C P1.c C P2.c 2  
C hello.c > ...  
1 #include <mpi.h>  
2 #include <stdio.h>  
3  
4 int main(int argc, char **argv) {  
5     MPI_Init(&argc, &argv);  
6  
7     int world_size;  
8     MPI_Comm_size(MPI_COMM_WORLD, &world_size);  
9  
10    int world_rank;  
11    MPI_Comm_rank(MPI_COMM_WORLD, &world_rank);  
12  
PROBLEMS 4 OUTPUT DEBUG CONSOLE TERMINAL PORTS  
● aftab@Aftab:~/Desktop/AB/HPC/Assignment 7$ mpicc hello.c -o h1  
● aftab@Aftab:~/Desktop/AB/HPC/Assignment 7$ mpirun ./h1  
Hello from process 1 out of 6 processes  
Hello from process 4 out of 6 processes  
Hello from process 0 out of 6 processes  
Hello from process 3 out of 6 processes  
Hello from process 5 out of 6 processes  
Hello from process 2 out of 6 processes  
○ aftab@Aftab:~/Desktop/AB/HPC/Assignment 7$
```

**Problem Statement 1:**

Implement a simple hello world program by setting number of processes equal to 10

**Code:**

```
#include "mpi.h"
#include <stdio.h>
#include <time.h>

int main(int argc, char** argv) {
    int world_rank, world_size;
    double start_time, end_time, process_start_time, process_end_time;
    MPI_Init(&argc, &argv);
    MPI_Comm_size(MPI_COMM_WORLD, &world_size);
    MPI_Comm_rank(MPI_COMM_WORLD, &world_rank);
    if (world_size != 10) {
        if (world_rank == 0) {
            printf("Please run with 10 processes.\n");
        }
        MPI_Finalize();
        return 0;
    }
    if (world_rank == 0) {
        start_time = MPI_Wtime();
    }
    process_start_time = MPI_Wtime();
    printf("Hello World from process %d\n", world_rank);
```

```
process_end_time = MPI_Wtime();

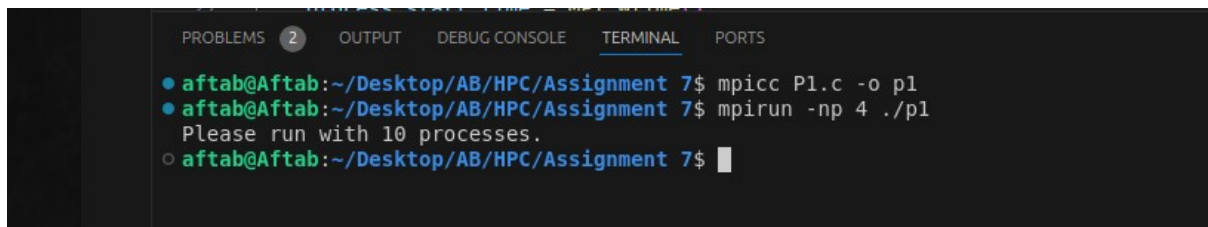
printf("Process %d execution time: %f seconds\n\n", world_rank, process_end_time -
process_start_time);

MPI_Finalize();

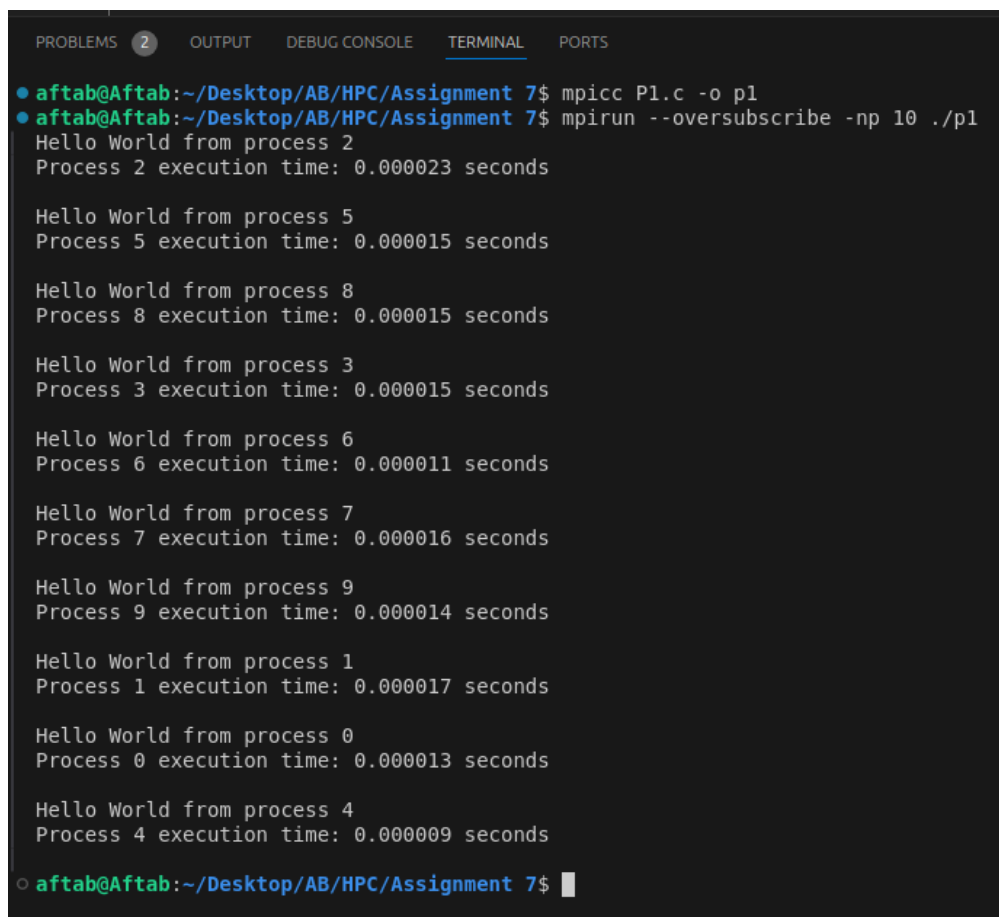
return 0;

}
```

## Output:



```
PROBLEMS 2 OUTPUT DEBUG CONSOLE TERMINAL PORTS
● aftar@Aftar:~/Desktop/AB/HPC/Assignment 7$ mpicc P1.c -o p1
● aftar@Aftar:~/Desktop/AB/HPC/Assignment 7$ mpirun -np 4 ./p1
Please run with 10 processes.
○ aftar@Aftar:~/Desktop/AB/HPC/Assignment 7$
```



```
PROBLEMS 2 OUTPUT DEBUG CONSOLE TERMINAL PORTS
● aftar@Aftar:~/Desktop/AB/HPC/Assignment 7$ mpicc P1.c -o p1
● aftar@Aftar:~/Desktop/AB/HPC/Assignment 7$ mpirun --oversubscribe -np 10 ./p1
Hello World from process 2
Process 2 execution time: 0.000023 seconds

Hello World from process 5
Process 5 execution time: 0.000015 seconds

Hello World from process 8
Process 8 execution time: 0.000015 seconds

Hello World from process 3
Process 3 execution time: 0.000015 seconds

Hello World from process 6
Process 6 execution time: 0.000011 seconds

Hello World from process 7
Process 7 execution time: 0.000016 seconds

Hello World from process 9
Process 9 execution time: 0.000014 seconds

Hello World from process 1
Process 1 execution time: 0.000017 seconds

Hello World from process 0
Process 0 execution time: 0.000013 seconds

Hello World from process 4
Process 4 execution time: 0.000009 seconds
○ aftar@Aftar:~/Desktop/AB/HPC/Assignment 7$
```

### ***Problem Statement 2:***

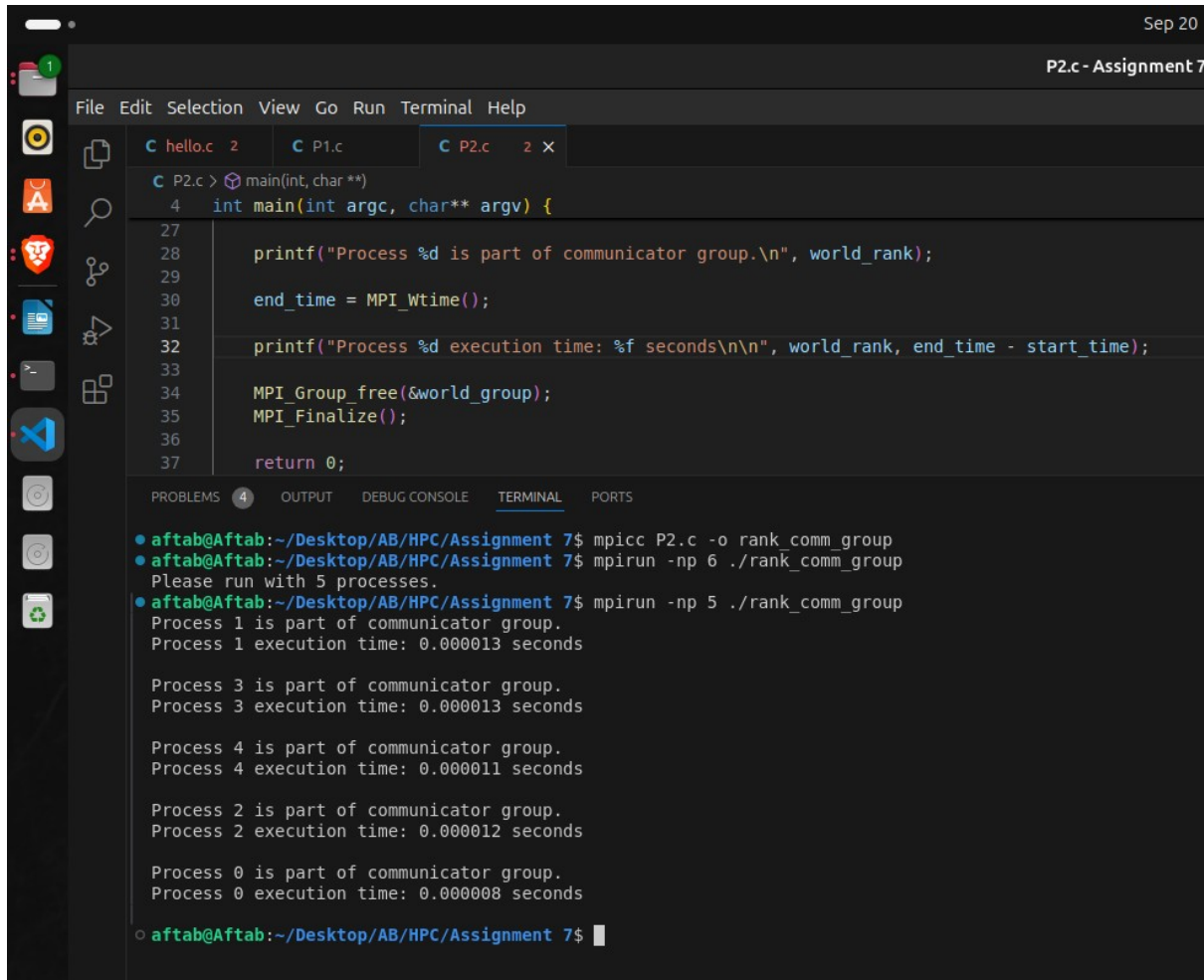
Implement a program to display rank and communicator group of five processes

#### ***Code:***

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

int main(int argc, char** argv) {
    int world_rank, world_size;
    MPI_Group world_group;
    MPI_Comm world_comm = MPI_COMM_WORLD;
    double start_time, end_time;
    MPI_Init(&argc, &argv);
    MPI_Comm_size(world_comm, &world_size);
    MPI_Comm_rank(world_comm, &world_rank);
    if (world_size != 5) {
        if (world_rank == 0) {
            printf("Please run with 5 processes.\n");
        }
        MPI_Finalize();
        return 0;
    }
    MPI_Comm_group(world_comm, &world_group);
    start_time = MPI_Wtime();
    printf("Process %d is part of communicator group.\n", world_rank);
    end_time = MPI_Wtime();
    printf("Process %d execution time: %f seconds\n\n", world_rank, end_time - start_time);
    MPI_Group_free(&world_group);
    MPI_Finalize();
    return 0;
}
```

## Output:



```
File Edit Selection View Go Run Terminal Help
C hello.c 2 C P1.c C P2.c 2 x
C P2.c > main(int, char **)
4 int main(int argc, char** argv) {
27
28     printf("Process %d is part of communicator group.\n", world_rank);
29
30     end_time = MPI_Wtime();
31
32     printf("Process %d execution time: %f seconds\n\n", world_rank, end_time - start_time);
33
34     MPI_Group_free(&world_group);
35     MPI_Finalize();
36
37     return 0;
PROBLEMS 4 OUTPUT DEBUG CONSOLE TERMINAL PORTS
• aftab@Aftab:~/Desktop/AB/HPC/Assignment 7$ mpicc P2.c -o rank_comm_group
• aftab@Aftab:~/Desktop/AB/HPC/Assignment 7$ mpirun -np 6 ./rank_comm_group
Please run with 5 processes.
• aftab@Aftab:~/Desktop/AB/HPC/Assignment 7$ mpirun -np 5 ./rank_comm_group
Process 1 is part of communicator group.
Process 1 execution time: 0.000013 seconds

Process 3 is part of communicator group.
Process 3 execution time: 0.000013 seconds

Process 4 is part of communicator group.
Process 4 execution time: 0.000011 seconds

Process 2 is part of communicator group.
Process 2 execution time: 0.000012 seconds

Process 0 is part of communicator group.
Process 0 execution time: 0.000008 seconds
o aftab@Aftab:~/Desktop/AB/HPC/Assignment 7$
```