22. Write a program to determine the total of a large array using all processes available on a cluster. Assume a large array and a cluster of around 10 processes. Hint: Use loop splitting discussed in class where each process computes the partial sums of some of the elements.

Parallel Execution

```
#include <stdio.h>
#include <iostream>
#include <mpi.h>
using namespace std;
int main(int argc, char** argv)
{
int size, node,i,sum=0, n1=0;
MPI_Status status;
MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &node);
MPI_Comm_size(MPI_COMM_WORLD, &size);
int a[]= {1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30};
int g= sizeof(a)/sizeof(a[1]);
for(i=node; i< g; i=i+size)
{
sum=sum+a[i];
}
MPI_Reduce(&sum,&n1,1,MPI_INT,MPI_SUM,0,MPI_COMM_WORLD);
if(node==0)
cout<<"Total sum at node"<<node<<" "<<n1<<endl;
MPI_Finalize();
return 0;
}
```

23. Write the sequential Rank Sort algorithm. Write the necessary outline to implement it on oscar.calstatela.edu assuming the array size is equal to the cluster size. i.e., each process determines the rank of an element that is sent to the head node to compile the sorted array.

Sequential

```
#include <stdio.h>
#include <iostream>
#include <mpi.h>
using namespace std;
int main(int argc, char** argv)
{
int size, node,i,sum=0, n1=0;
MPI_Status status;
MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &node);
MPI_Comm_size(MPI_COMM_WORLD, &size);
int a[]= {23,32,0,2,45,67,90,76,212};
int g= sizeof(a)/sizeof(a[1]);
```

```
int b[g];
int rank=0;
for(int x=0;x<g;x++)
{
        rank=0;
        for(int y=0;y<g;y++)
        if(a[x]>a[y])
        rank++;
        b[rank]=a[x];

}
for(i=0; i< g; i=i++)
{
cout<<"Node has Sum "<<b[i]<<endl;
}
MPI_Finalize();
return 0;
}
```

Parallel:

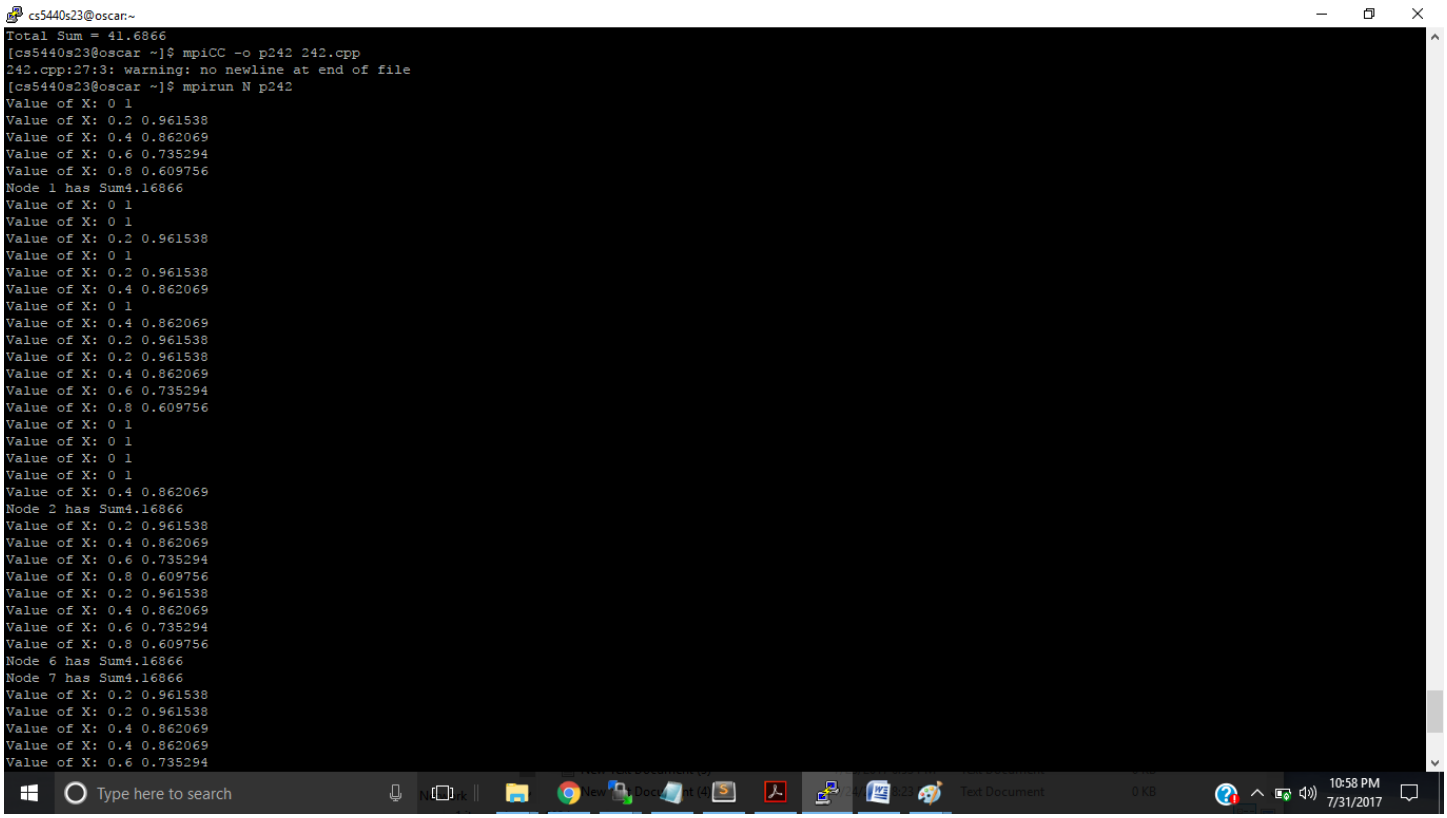
```
#include <stdio.h>
#include <iostream>
#include <mpi.h>
using namespace std;
int main(int argc, char** argv)
{
int size, node,sum=0, n1=0;
MPI_Status status;
MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &node);
MPI_Comm_size(MPI_COMM_WORLD, &size);
int a[]= {23,32,0,2,45,67,90,76,212};
int g= sizeof(a)/sizeof(a[1]);
int rank=0;
for (int i = 0; i < g; i++)
{
        if(a[node]>a[i])
                rank++;
}
if(node!=0)
MPI_Send(&rank,1,MPI_INT,0,0,MPI_COMM_WORLD);
else{
        int b[9];
        b[rank]=a[node];
        for(int x=1;x<g;x++)
        {
                MPI_Recv(&rank,1,MPI_INT,x,0,MPI_COMM_WORLD,&status);
                b[rank]=a[x];
        }
        cout<<"Sorted Array ";
        for (int r = 0; r < g; r++)
```

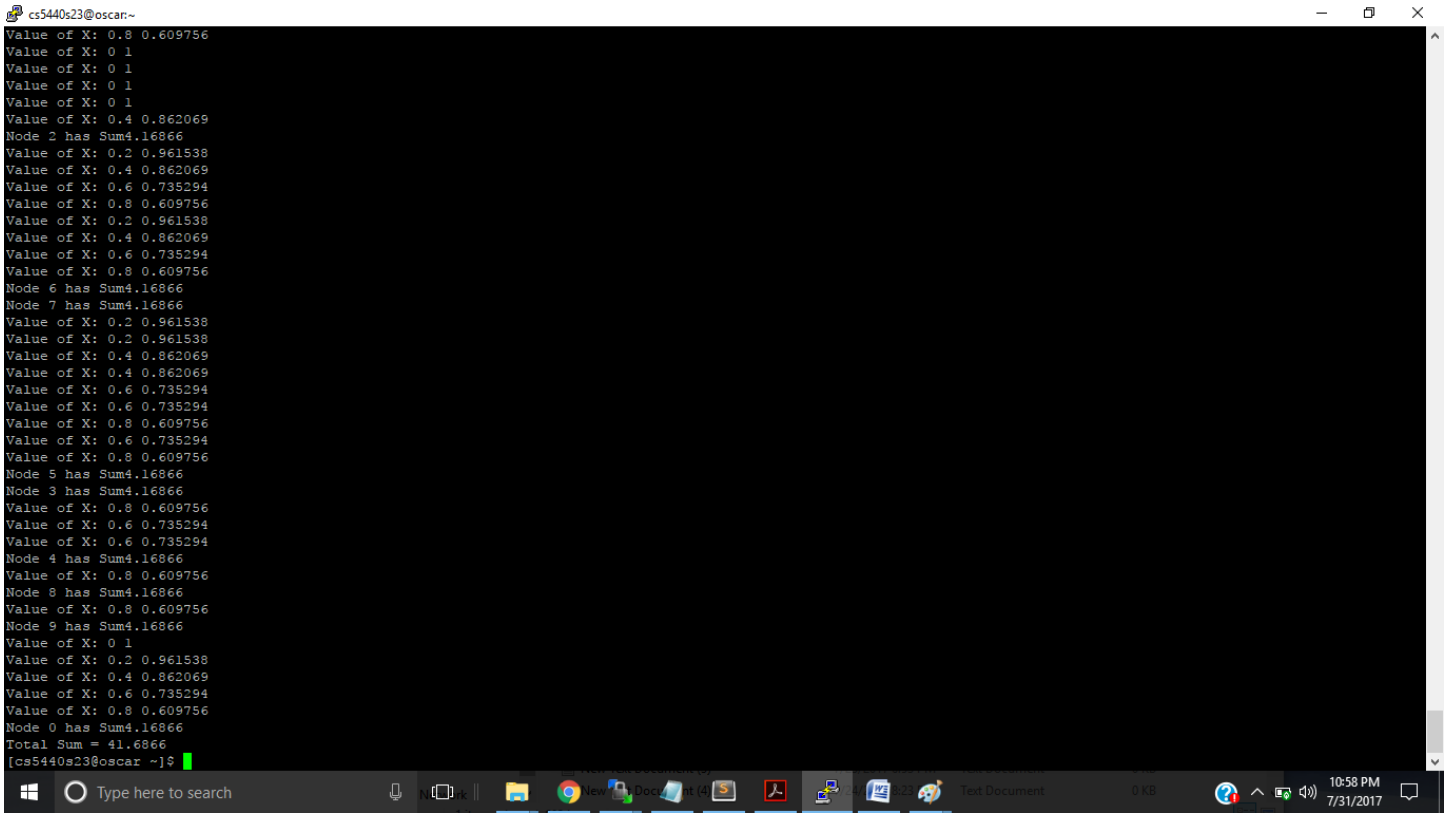
```
                cout<<b[r]<<" ";
                cout<<endl;

}
MPI_Finalize();
return 0;

}
```

24. Compute ∑ 1 / (1 + x2) starting with x=0 and intervals of 0.02 until x=1 (use loop splitting with n processes).

Parallel:

```
#include <stdio.h>
#include <iostream>
#include <mpi.h>
using namespace std;
int main(int argc, char** argv)
{
int size, node;
MPI_Status status;
MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &node);
MPI_Comm_size(MPI_COMM_WORLD, &size);
double sum=0, v=0, r, sum1=0;

for (int i = 0; i < 1/0.02; i=i+size)
{
        r=0.02*i;
        sum1=(1/(1+(r*r)));
        v=v+sum1;
        cout<<"Value of X: "<<r<<" "<<sum1<<endl;
}
cout<<"Node "<<node<<" has Sum"<<v<<endl;
MPI_Reduce(&v,&sum,1,MPI_Double,MPI_Sum,0,MPI_COMM_WORLD);
if(node==0)
cout<<"Total Sum = "<<sum<<endl;
MPI_Finalize();
return 0;
}
```





25 : e x is evaluated as a series given below. The result is more accurate for a large number (say 100) of terms. Write the factorial as a real number (rather than an integer as it will result in an overflow error).

Sequential

```
#include <stdio.h>
#include <iostream>
#include <mpi.h>
#include <math.h>
using namespace std;
double fact1(double x){
        double fact=1;
        while(x>=1){
                fact=fact*x;
                x--;
        }
        return fact;
}
int main(int argc, char** argv)
{
int size, node;
MPI_Status status;
MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &node);
MPI_Comm_size(MPI_COMM_WORLD, &size);
double v=0, r=2,sum=0,sum1=0;
for (double i=0;i<=100;i++)
{
        sum1= pow(r,i);
        sum=sum1/fact1(i);
        v=v+sum;
        cout<<" "<<i<<"has Value"<<sum<<""<<endl;

}
cout<<"Total Value is " <<v<<endl;
MPI_Finalize();
return 0;
}
```

Parallel

```
#include <stdio.h>
#include <iostream>
#include <mpi.h>
#include <math.h>
using namespace std;
double fact1(double x){
        double fact=1;
        while(x>=1){
                fact=fact*x;
                x--;
        }
        return fact;
}
int main(int argc, char** argv)
{
int size, node;
MPI_Status status;
MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &node);
```

```
MPI_Comm_size(MPI_COMM_WORLD, &size);
double v=0, r=2,sum=0,sum1=0, t;
for (double i=0;i<=100;i=i+size)
{
        sum1= pow(r,i);
        sum=sum1/fact1(i);
        v=v+sum;
        cout<<" "<<i<<"has Value"<<sum<<""<<endl;

}
cout<<"Node has  " <<node<<"value "<<v<<endl;
MPI_Reduce(&v,&t,1,MPI_DOUBLE,MPI_SUM,0,MPI_COMM_WORLD);
if(node==0)
        cout<<"Total Value is " <<t<<endl;
MPI_Finalize();
return 0;
}
```