National University of Computer and Emerging Sciences, Lahore Campus

	Course Name:	Parallel and Distributed Computing	Course Code:	CS3006
	Program:	BS(Data Science)	Semester:	Spring 2024
	Sections	B	Total Marks:	50
	Due Date:		Weight	
	Exam Type:	Assignment 2	CLO	

Student : Name:_____ Roll No._____ Section:_____

Question 1:

Find the isoefficiency of the following program under the assumptions given below:

```
r = 0;
for (i=0; i < n; i++) {
  r = r + a[i];
}
```

1. When the recurrence is written as:

```
double r[threadCount];
s = 0;
#pragma omp parallel for
for (i=0; i < n; i++) {
  r[omp_get_thread_num( )] = r[omp_get_thread_num( )] + a[i];
}
for (i=0; i < threadCount; i++) {
  s += [i];
}
```

2. When the recurrence is written as:

```
#pragma omp parallel for reduction(+:r)
for (i=0; i < n; i++) {
  r = r + a[i];
}
```

3. When the recurrence is written as:

```
#pragma omp parallel for simd reduction(+:r)
for (i=0; i < n; i++) {
  r = r + a[i];
}
```

Q13:

Q13a: *4 pts* Make the following loop parallel using OpenMP pragmas/directives.

```
for (i = 0; i < 100 * n; i ++) {
    s+= a[i]
}
```

Q13b: *4 pts* If the loop is changed to look like:

```
for (i = 0; i < 100 * n; i ++) {
    s+= a[i]
    b[i] = a;
}
```

Can the technique used in the first loop to perform the parallelization still be used?

Q14: *6 pts*

Make the `i` loop parallel using OpenMP. You cannot make any assumptions as to whether `foo` is associative or commutative.

```
for (i = 0; i < 100 * n; i ++) {
    for (j = 0; j < n; j ++) {
        a[i]+ = b[i][j];
    }
    c = foo(c);
}
```

Question 2

Consider a 4*4 matrix with the following values:

1 3 5 7

2 4 6 8

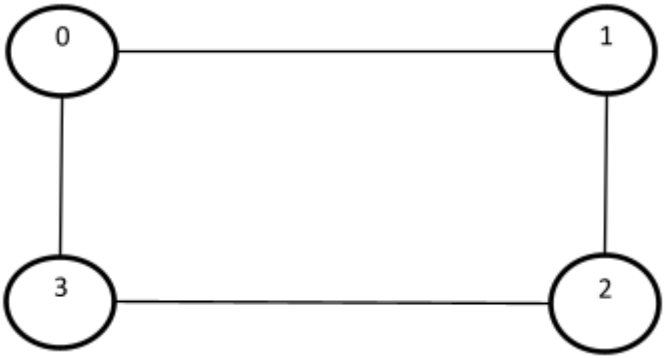
11 13 15 17

12 14 16 18

Assume that each row is initially stored at different processes, row 1 is stored at process P0, row 2 at P1, row 3 at P2, and row 4 at P3 (the processes form a 2-D mesh). The requirement is to do a matrix transpose. Describe:

i. **The Communication operation that needs to take place.**

ii. **Draw the message originating from process P0 and show what happens at each step with this message**



Repeat the above step for each process.

Question 3

Briefly explain the concept of "Prefix-sum". Now consider the following complete binary tree where we have to perform the operation "Prefix-sum". Assume that the value to be contributed by each node is equal to $(8 - ID)$ as given below. Show the calculation at each step and provide the final value at each node at the end of the operation.