

GRIFFITH COLLEGE DUBLIN

**QUALITY AND QUALIFICATIONS IRELAND
EXAMINATION**

**POSTGRADUATE DIPLOMA IN SCIENCE IN COMPUTING
PARALLEL & DISTRIBUTED PROGRAMMING
Module code: PGDC-PDP**

**MASTER OF SCIENCE IN COMPUTING
PARALLEL & DISTRIBUTED PROGRAMMING
Module code: MSCC-PDP**

ONLINE EXAMINATION

Lecturer(s):

Osama Abushama

External Examiner(s):

Dr John Cardiff

Date: 25th May 2020

Time: 9.45-12.45

**THIS PAPER CONSISTS OF FOUR QUESTIONS
ALL QUESTIONS TO BE ATTEMPTED
ALL QUESTIONS CARRY EQUAL MARKS**

HONOUR CODE

By submitting my exam script via Moodle, I certify that my answers contained in this Examination Script document are entirely composed of my own original work.

During the exam period, which began when I received the exam paper document, I did not work with anyone else on the exam or discuss the examination with anyone else.

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QUESTION 1

- (a) Implement a barrier in Java using a countdown latch. Make sure that your barrier is reusable.

(15 marks)

- (b) Suppose we have the following 3 threads, with initial variables and values, initially $x = 0$, $y = 0$, and $z = 0$, and $r1$, $r2$ and $r3$ are local variables.

Thread 1	Threads 2	Thread 3
$r=10;$ $\text{int } r1 = z;$	$y=8;$ $\text{int } r2 = x;$	$z=6;$ $\text{int } r3 = y;$

Give the results of the variables $r1$, $r2$ and $r3$ for all possible combinations of execution.

(10 marks)

Total (25 marks)

QUESTION 2

Given the following java class called Parcel_Delivery,

```
class Parcel_Delivery {  
    private int[] b;  
    public Parcel_Delivery(int n) {  
        b = new int[n];  
        for (int i = 0; i < n; i++) {  
            b[i] = 0;  
        }  
    }  
    public void deliver(int i, int parcels) {  
        b[i] = b[i] + parcels;  
    }  
    public int empty(int i) {  
        int result = b[i];  
        box = 0;  
        return result;  
    }  
}
```

- (a) Make a thread safe version of class Parcel_Delivery in such a way that delivery deliver parcels at same time and do not block each other. **(5 marks)**
- (b) Add a transfer function, which transfer parcels from one box to another that is thread safe. **(10 marks)**
- (c) Give a lock-free thread safe version of Parcel_Delivery. **(10 marks)**

Total (25 marks)

QUESTION 3

Given the OpenMP code below with different possible schedule options, the code is executed on a 4 core machine to initializes a an upper triangle of 100x100 matrix size with zeros.

```
#pragma omp parallel for private(j) schedule( ... )
for (i = 0; i < 99; i++)
for (j = i+1; j < 100; j++)
{
    a[i][j] = 0.0;
}
```

Describe each option of the schedule in relation to speed, In particular, since each iterate of the inner loop above does just one assignment, we can estimate the execution time by counting how many assignments each thread does (notice that all together, there are exactly 4,950 assignments). So for each schedule clause, estimate how long the parallelized loop will run. Explain how you arrived at your estimates.

- schedule(static)
- schedule(static, 10)
- schedule(static, 1)
- schedule(dynamic, 1)
- schedule(dynamic, 10)
- schedule(dynamic, 20)

(25 marks)

QUESTION 4

- (a) The program given below uses a critical section to synchronize the loop below:

```
#pragma omp parallel for
for (i = 0; i < n; i++) {
#pragma omp critical
sum = sum + data[i];
}
```

The program does not get any speedup. Explain why and how to fix it.

(10 marks)

- (b) Write a complete MPI program to find how many zeros there are in an integer array A[N] using a scatter/gather pattern. Define N as a constant with a value 100,000. the number of nodes as P and set to 10 nodes. Each node is sent one group of N/P numbers from the array.

(15 marks)

Total (25 marks)