Name____________________

Student Number____________________

SFWR TECH 4CC3 – Parallel Programming

EVENING CLASS   Dr. J. Fortuna
DURATION OF EXAMINATION: 2 Hours
McMaster University Sample Midterm Examination   October 2018

This examination paper includes 6 pages and 4 questions. You are responsible for ensuring that your copy of the paper is complete.

SPECIAL INSTRUCTIONS:

Calculators are permitted. Please show ALL work on the given pages. When the question is subdivided into a number of parts, the marks allocated for each section are indicated. This is a **closed book** examination.

The distribution of marks is as follows (do not write in this box !):

Question	Marks Available	Mark Obtained
1	**15**	
2	**10**	
3	**10**	
4	**10**	
Total	**45**	

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Question 1. - Speedup

Amdahl's Law	Gustafson's Law	Efficiency
$S(n) = \frac{t_s}{ft_s + (1-f)t_s/n} = \frac{n}{1+(n-1)f}$	$S(n) = a(p) + n*b(p)$	$E=t_s / (t_p*n) = S(n) / n$

Assume that we have a process where **10%** of the current computational time of the code is sequential and the remainder can be parallelized. Assume that the parallelism does not introduce any **overhead** irrespective of the number of cores used.

(a) (3 marks) Assuming that the exact same algorithm is to be run on a 4 core processor with the same amount of data, use Amdahl's law to predict the speedup over running the algorithm on a single core machine.

(b) (3 marks) What is the efficiency of the parallel implementation as predicted by Amdahl's law?

(c) (3 marks) Assume now that the algorithm is going to be used on problems that involve much more data than the assumption in part **(a)**. Using Gustafson's law, predict the speedup using a 4 core processor on a large amount of data over running the algorithm with the small amount of data on a single core processor. How much faster or slower (as a percentage of the speedup calculated in part (a)) is the prediction using Gustafson's law?

(d) (3 marks) What is the efficiency of the parallel implementation as predicted by Gustafson's law?

(e) (3 marks) If the algorithm takes 2 seconds to run on a single core and 1 second to run on 4 cores, what is the efficiency based on the measured results?

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Question 2 – Mutual Exclusion

For the following attempt at implementing a lock:

Thread A:

```
flag[A] = true
while( flag[B] == true);
CriticalSection();
flag[A] = false;
```

Thread B:

```
flag[B] = true
while( flag[A] == true);
CriticalSection();
flag[B] = false
```

(a) (5 marks) Does the above code provide mutual exclusion? Briefly explain why or why not.

(b) (5 marks) Can the above code deadlock? If so, state the conditions under which it will deadlock.

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Question 3.

Consider the following lock algorithm

```
delay = random( )
while (true)
    // NOTE: test and set returns old value
    if test_and_set (flag) = unlocked
        return
    else
        while (flag == locked);
        pause (delay)
        delay = delay * 2
    end
end
```

(a) (4 marks) Explain the purpose for the random delay in the lock algorithm above.

(b) (6 marks) Explain the purpose for the **else** statement in the algorithm and the reason for **each statement** in the else block.

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Question 4 – Concurrent Objects

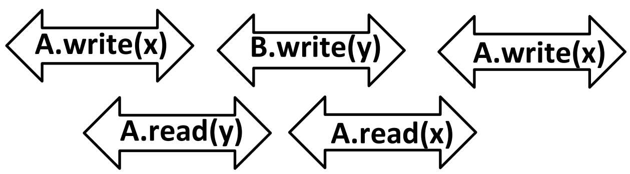
For the following questions, assume that the following operations are defined:

A.write(x) : Writes value x to memory location A

A.read(x): Reads value x from a memory location A. Value x cannot be read from the location unless it was previously written to it.

For the histories in parts (a) and (b), decide whether or not each is linearizable and show possible linearization points if it is linearizable.

(a) (5 marks)



(b) (5 marks)