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Concurrency and Parallelism — 1st Test — 2015-10-20 (Duration: 1h30m)

Number: _____ Name: _____

1 a)	1 b)	1 c)	1 d)	2	3	4	5	6	7	8	9	10	11
0,5 val	*1 val*	*1,5 val*	*1,5 val*	*2 val*	*2 val*	*2 val*	*1,5 val*	*2 val*	*1 val*	*1 val*	*1 val*	*1 val*	*2 val*

Note: this test is written in English, but you may answer in either English or Portuguese, at your preference.

1) Consider the loop "NORMAL" presented in the left column below. Assume all the used/required variables are defined elsewhere and initialized properly.

NORMAL

```
for (i=0; i<n; i++) {
   sum += data[i];
}
```

WITH LOOP UNROLING (see question 1.c)

```
for (i=____; i<____; i+=____) {
   _______ += data[_________];
   _______ += data[_________];
   _______ += data[_________];
   _______ += data[_________];
}
sum = _____________________________________;
```

a) Describe briefly the basic requirement for loop parallelization.

b) Describe briefly what it means to *unroll* a loop.

c) Fill the open ("___") regions in the loop ("WITH LOOP UNROLING") in right column above.

d) Is the loop unrolling strategy used in c) adequate for parallelization with Clilk+ using 4 *cilk_spawn* statements inside the loop? Please be assertive! Answer either "yes" or "no" and then justify you answer.

2) Suppose we have a system with 1 CPU and 4 GPUs. The CPU can reach a performance of 0.5 GFLOPS, while each GPU can reach 1GFLOPS. If you have an application which is 75% parallelizable (i.e. 25% of the application is assigned to CPU and the remainder 75% to the GPUs), what is the average peak performance?

3) Provide a single line definition for each of the following terms related to concurrency/synchronization:

a) Competition
b) Cooperation
c) Barrier
d) Granularity
e) Amdahl's Law
f) Data parallelism
g) Task parallelism
h) Dependency

4) Identify the type of dependency (if any) in the following statements. Justify your choice (one line for each).

a) S1: x = 1 S2: y = x
b) S1: x = y S2: y = 1
c) S1: x = 1 S2: y = 1
d) S1: x = 1 S2: x = y

5) Build a state dependency graph for the following program. Identify clearly each type of dependency.

S1: X = 1
S2: Y = X
S3: W = X
S4: X = Y +1

6) Rewrite the following sequential code in Cilk+ for a producer-consumer task parallelism. Please abstract from the very small details and focus on how redesign the code block to support the parallelization with Cilk+.

```
for (i=0; i<INPUT_SIZE; i++) {
    // TASK 1: Finite Impulse Response (FIR) filter
    for (j=0; j<TAP_SIZE; j++) {
        sum += sample[i+j] * coeff[i];
    }
    data_out[i] = sum;

    // TASK 2: Multiply by coefficient
    final[i] = data_out[i];
    for (j=0; j<n; j++) {
        final[i] *= coeff2[j];
    }
}
```

7) Briefly compare Cilk+ with C/Pthreads by describing the advantages and disadvantages of each language variant.

8) Fliynn's taxonomy classifies computer architectures into 4 (four) main classes. Provide an example of a computing system for each of these classes. You may use the word "*None*" if there are no obvious architectures of that type.

SISD: _____

SIMD: _____

MISD: _____

MIMD: _____

9) What are the major advantages and disadvantages of the crossbar-switching networks and the bus-based networks?

10) Briefly state the main differences between a map operation/pattern and a reduce operation/patter.

11) Consider you have a disk repository with plain text files (e.g., news from an online newspaper). Each file has a unique name in the repository. We aim at providing a search functionality similar to Google's, so we need to index the individual words in the existing files. Which parallel patterns would you use implement a parallel solution for this problem? How would you combine them? (*Provide a brief description of how they are organized and what would each one would do!*)

FIM!!!