Parallel Computing– II part–Tuesday, January 31st, 2023

Polimi ID _____ _____

Surname _____ _____ **Name** _____

- This is a closed-book examination. You cannot use computers, phones, or laptops during the exam.
- Paper will be provided, but you should bring and use writing instruments that yield marks dark enough to be read easily. Erasable pens can be used.
- Total available time: 1h:30m.

Exercise 1 (4   points) _____

Exercise 2 (4   points) _____

Exercise 3 (4   points) _____

Exercise 3 (4   points) _____

Exercise n. 1

Answer the following questions about parallel patterns and briefly explain (without an explanation, the answer will be considered invalid)

A. Please define what a parallel pattern map is: assumptions, complexity, and example. (1)

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B. Please describe how a parallel pattern Split works. (1)

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C. Please describe how merge scatter works. Example? (1)

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D. Can you remove an output-dependency? How? (1)

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Exercise n. 2

Answer the following questions about parallel programming models and architectures (without an explanation, the answer will be considered invalid).

A. Describe briefly the shared memory programming model with threads and two of its implementations. (2)

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B. Describe the trade-off between programmability and energy efficiency across different hardware devices (CPU, GPU, FPGA, ASIC). (2)

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Exercise n. 3

Answer the following questions about the CUDA scan pattern (without an explanation, the answer will be considered invalid).

A. For the work **inefficient** scan kernel based on reduction trees, assume that we have 1024 elements in the input vector, explain how to estimate the number of add operations performed. (2)

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B. For the work **efficient** scan kernel based on reduction trees and inverse reduction trees, assume that we have 1024 elements in the input vector, explain how to estimate the number of add operations performed in both the forward and the reverse phase. (1)

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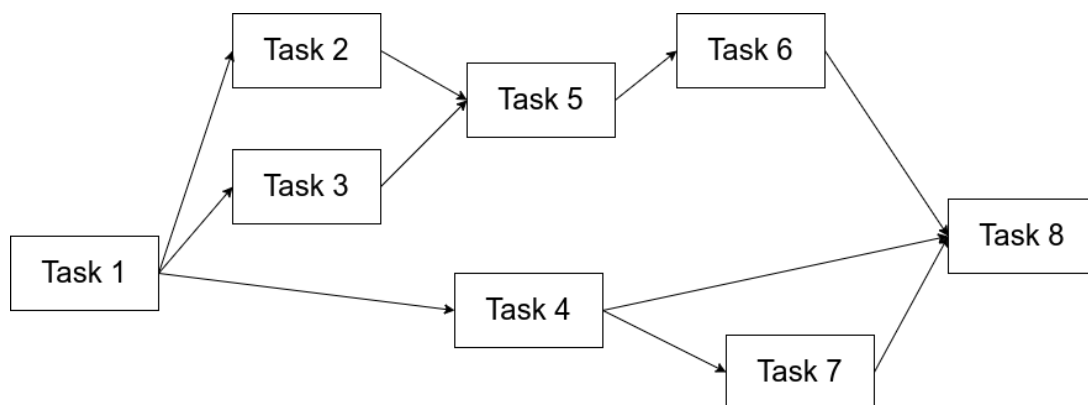
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Exercise n. 4

Answer the following questions about OpenMP (without an explanation, the answer will be considered invalid).

A. List the factors that determine the number of threads in an OpenMP parallel region. (1)

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B. What is the difference between OpenMP sections and tasks? (1)

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C. Consider the following task graph:

W(Task 1) = 50, W(Task 2) = 100, W(Task 3) = 120, W(Task 4) = 20, W(Task 5) = 50, W(Task 6) = 50, W(Task 7) = 30, W(Task 8) = 50

How many threads are needed to achieve the maximum theoretical parallelism? (1)

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How many threads are active during the execution of Task 3? (1)

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