

**CSCI-UA.0480-051: Parallel Computing**  
**Practice Exam (October 26th, 2023)**  
**Total: 100 points**

**Important Notes- READ BEFORE SOLVING THE EXAM**

\* If you perceive any ambiguity in any of the questions, state your assumptions clearly and solve the problem based on your assumptions. We will grade both your solutions and your assumptions.

\* This exam is take-home.

\* You have up to 24 hours to complete and submit the exam.

\* Your answers must be very focused. You may be penalized for wrong answers and for putting irrelevant information in your answers.

\* You must upload a PDF file.

\* Your answer sheet must have a cover page (as indicated below) and one problem answer per page (e.g., problem 1 on a separate page, problem 2 on another separate page, etc.).

\* You may use the textbook, slides, and any notes you have. But you may not use the internet. You may NOT use communication tools to collaborate with other humans.

Honor code (copy and paste to the first page of your exam)

"I understand the ground rules and agree to abide by them. I will not share answers or assist another student during this exam, nor will I seek assistance from another student or attempt to view their answers."

**Problem 1: (20 points)**

a. [10] Briefly explain the difference between shared memory and distributed memory parallel programming models. Provide one advantage and one disadvantage of each.

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b. [10] What is Amdahl's Law? Explain how it limits the speedup achievable through parallelization.

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**Problem 2: (20 points)**

a. [10] Describe the concept of a critical section in concurrent programming. Explain why mutual exclusion is crucial in protecting critical sections and discuss a mechanism to achieve mutual exclusion.

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b. [10] What are deadlocks? Explain the four necessary conditions for deadlocks to occur. Give an example of a deadlock scenario in a simple program.

**Problem 3: (20 points)**

Consider a parallel program that needs to compute the sum of 100 million numbers.

a. [10] Design a simple parallel algorithm using threads to perform this computation. Describe how you would divide the work and combine the results.

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b. [10] Discuss potential challenges and bottlenecks in your algorithm and suggest ways to improve its performance.

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**Problem 4: (20 points)**

A program uses a message-passing paradigm to communicate between two processes, P1 and P2. P1 sends a message containing an integer value of 10 to P2.

a. [10] Write a simple pseudocode for both processes illustrating the communication using a suitable message-passing library (e.g., MPI).

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b. [10] Discuss what considerations are important for efficient message passing in a distributed system.

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### Problem 5: (20 points)

Multiple Choice: Choose the best answer for each question.

a. [5] Which of the following is NOT a characteristic of a good parallel algorithm?  
(a) Load balancing (b) High communication overhead (c) Scalability (d) Locality of reference

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b. [5] Race conditions occur when:  
(a) Multiple processes access the same shared resource simultaneously without proper synchronization.  
(b) A program runs out of memory.  
(c) Two processes communicate using different protocols.  
(d) A process terminates unexpectedly.

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c. [5] The speedup of a parallel program is defined as:  
(a) The number of processors used.  
(b) The ratio of sequential execution time to parallel execution time.  
(c) The total execution time of the parallel program.  
(d) The number of threads created.

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d. [5] Which parallel programming model allows processes to directly access shared memory?  
(a) Message passing (b) Distributed memory (c) Shared memory (d) Hybrid

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