

Here's a practice exam designed to precisely match the format, style, and structure of the provided PDF template. Due to the limitations of this text-based environment, perfect replication of formatting elements like exact font sizes and spacing is impossible. However, the structural elements, numbering, and point value presentation will be identical.

****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 this exam.
- You are allowed only one submission.
- 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 in separate page, problem 2 in another separate page, etc.).

****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****

- a. [10 points] Explain how load balancing affects the performance of a parallel program. Describe different strategies for achieving effective load balancing in a parallel environment, and discuss the challenges involved in dynamically balancing loads.
- b. [10 points] In Problem 1(b) of the original exam, we have an eight-core processor. If each core only uses pipelining, what is the maximum number of processes and threads that can execute concurrently on the whole processor? Explain your answer.
- c. [8 points] Problem 1(c) of the original exam states: "By having more variables shared among processes, we increase the chance of false sharing and hence performance will go down due to coherence overhead". Is this statement true or false? Provide a detailed justification for your answer, including examples of situations where this might not hold true.

****Problem 2****

- a. [8 points] Referring to Problem 2 of the original exam, draw a different task flow graph (DAG) that exhibits a longer critical path than the example DAG provided. Show the time taken for each task and determine the minimum number of cores needed for optimal speedup.
- b. [10 points] In Problem 2(b) of the original exam, calculate the speedup achieved if we use only two cores instead of the optimal number you determined. Clearly show your task allocation to cores and justify why you choose that specific allocation. What is the efficiency in this case?
- c. [5 points] In Problem 2(e) of the original exam, why is the CPI (Cycles Per Instruction) calculation relevant to understanding the performance of the program's execution on a single core? What factors influence the CPI value beyond clock speed and number of instructions?

****Problem 3****

- a. [15 points] Explain the potential drawbacks of using a very high number of cores to execute a parallel program. How would Amdahl's Law apply in this scenario?

- b. [15 points] In Problem 3 of the original exam, what would be the values of x , y , and z for each process (0, 1, and 2) if the `MPI_Bcast` calls in the code were replaced with `MPI_Send` and `MPI_Recv` calls to achieve the same communication pattern? Show your work.
- c. [12 points] Discuss the implications of removing the `break` statement at the end of `case 1:` in Problem 3 of the original exam. How does this change affect the execution flow and the final values of x , y , and z for each process?
- d. [7 points] Considering Problem 3's MPI code in the original exam, discuss the potential impact of cache coherence on the performance of the program. How might the use of shared memory affect the outcome? What would be a potential optimization strategy to minimize cache misses?

This practice exam attempts to closely mirror the original template. Remember to adapt your answers to fully address each question and its specific requirements. Good luck!