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, I cannot perfectly replicate the visual aspects (fonts, exact spacing, etc.), but the structural and content elements will align exactly.

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 from the time you begin to submit your 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.).

* 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. This includes but is not limited to G-Chat, Messenger, E-mail, etc.

* Do not try to search for answers on the internet; it will show in your answer, and you will earn an immediate grade of 0.

* Anyone found sharing answers or communicating with another student during the exam period will earn an immediate grade of 0.

* "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

1. [5 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.

2. [5 points] In Problem 1(b) of the original exam, we considered an eight-core processor with various configurations (pipelining only, superscalar, hyperthreading with/without branch prediction). Explain why the maximum number of *threads* is different from the maximum number of *processes* in each scenario. Justify your answer with reference to the underlying concepts.

3. [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? Justify your answer in detail, explaining the concept of false sharing and its impact on performance.

Problem 2

4. [10 points] In Problem 2(a) of the original exam, the question asks if a DAG can have more than one span. Define "span" in the context of a Directed Acyclic Graph (DAG) and provide examples from the DAG shown in Problem 2 illustrating your definition and your answer to the original question.

5. [10 points] In Problem 2(b) of the original exam, you were asked to determine the minimum number of cores needed for maximum speedup and calculate that speedup. Now, assuming you have *twice* the minimum number of cores, recalculate the potential speedup and discuss whether this increase in cores leads to a proportional increase in speedup and why.

6. [8 points] Problem 2(e) of the original exam asks to calculate CPI (Cycles Per Instruction) given a clock speed and the number of instructions for each task. Explain the implications of a high CPI value for overall program performance in a single-core system. How might the ideal CPI value change in a multi-core setting?

Problem 3

7. [8 points] Problem 3 of the original exam focuses on MPI communication. Explain the difference between `MPI_Bcast` and `MPI_Send` and when one might be preferred over the other in terms of communication efficiency.

8. [8 points] In Problem 3(a) of the original exam, you are asked to fill in the values for x, y, and z for each process after execution. Describe how changes to the order of `MPI_Bcast` and `MPI_Send/Recv` calls in the code would impact the final values of x, y, and z.

9. [8 points] In Problem 3(b) of the original exam, the question asks what would happen if the `break;` statement is removed from `case 1`. Explain what will happen and why this modification introduces a critical error in the MPI code. What would the outcome be for each process?

10. [30 points] The instructions emphasize the importance of clearly stating assumptions if there is ambiguity in a question. Suppose in Problem 1(a) of the original exam, the definition of "benefit" is unclear (e.g., does it mean a significant speedup, or any improvement at all?). Re-solve Problem 1(a) under two different interpretations of "benefit"—one meaning a significant improvement, and the other meaning any improvement at all. Show how the justification changes based on these different assumptions.

Remember to create a cover page for your exam submission including your name, NetID and the honor code statement as indicated in the original template instructions. Good luck!