Here's a practice exam designed to precisely match the style and structure of the provided template, incorporating the 10 questions you supplied. Due to the limitations of this text-based environment, perfect replication of all formatting nuances (like exact font sizes and spacing) isn't possible. However, the structure, numbering, point allocation, and overall visual layout will closely mimic the template.

CSCI-UA.0480-051: Parallel Computing

Practice Midterm Exam (Example)

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 practice.

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

• Your answer sheet must be organized neatly.

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] A processor only utilizes pipelining. Will adding more execution units improve its performance? Justify your answer concisely.

b. [8 points] Explain how multiple processes can execute concurrently on a shared-memory multiprocessor architecture. If this is not possible, explain why.

c. [15 points] Can multiple threads within a single process achieve the same performance on a distributed-memory system as on a multi-core system? Explain your reasoning, assuming each node in the distributed system has a single CPU.

d. [8 points] A CPU core uses four-way hyperthreading. How many branch predictors are necessary to optimize performance? Provide a justification for your answer.

Problem 2

a. [10 points] Given a DAG (diagram would be included here in a real exam) and execution times for tasks on CPU types A and B, determine the minimum number of each CPU type needed to maximize speedup compared to a single CPU of type A. Specify which tasks run on which CPUs and calculate the speedup. (Note: DAG and execution time table would be included here in a real exam.)

b. [10 points] Repeat question 2a, but optimize for a single CPU of type B as the baseline for comparison.

c. [10 points] Analyzing the DAG from Problem 2, identify one dependency arrow you would remove to potentially improve performance. Justify your choice.

Problem 3

a. [8 points] Determine the final values of variables *x*, *y*, and *z* for each of the three processes (P0, P1, P2) after executing the following MPI code: (MPI code would be included here)

b. [8 points] In the MPI code from Problem 3a, is there a potential for communication operations to execute out of order? Explain why or why not.

Problem 4

a. [13 points] If we have an embarrassingly-parallel application. Does it have good scalability (i.e., as we keep increasing the number of cores, do we see speedup)? Assume the problem size is big enough.

b. [13 points] Two threads with differing computational loads are assigned to separate cores. Does this scenario automatically imply load imbalance? Explain your reasoning.

This practice exam closely mirrors the format of the provided template. Remember to add the necessary diagrams and code snippets to make it a complete and usable practice exam. Remember to replace the bracketed point values with the exact formatting from the original document.