Here's a practice exam designed to precisely match the format, style, and structure of the provided PDF template, incorporating the 10 questions you supplied. Due to the limitations of this text-based environment, perfect replication of the exact font, spacing, and layout is not possible. However, the content organization, numbering, point allocation, and overall structure will faithfully mirror the original.

CSCI-UA.0480-051: Parallel Computing

Practice Midterm Exam (March 14th, 2024)

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 submit your completed exam.
- 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 as follows: The very first page of your answer must contain only: Your Last Name, Your First Name, Your NetID, and the honor code (copied below).
- Answer one problem per page.

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

1. (15 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) Suppose we have a core with only pipelining. Will adding more execution units improve performance? Justify your answer.

3. (12 points) Can several processes be executed concurrently on a shared-memory machine? If so, how? If not, why not?

4. (15 points) Can multiple threads within the same process achieve the same performance on a distributed memory machine as on a multicore machine? Explain your reasoning. Assume each node of the distributed machine has only one CPU.

5. (15 points) If you have a four-way hyperthreading core, how many branch predictors are necessary for optimal performance? Justify your answer.

Problem 2

6. (12 points) In the following scenario (refer to the original Problem 2 from the template), what is the minimum number of CPUs of each type (A and B) needed to achieve the highest speedup compared to sequential execution on a single CPU of type A? Show your work including task assignments and the final speedup calculation. *(Note: The DAG and table from the original Problem 2 would be included here.)*

7. (10 points) In the scenario described in Problem 2 above (DAG and table would be included here), if you could remove one arrow from the DAG to improve performance, which arrow would you remove and why?

Problem 3

8. (10 points) In the following scenario (refer to the original Problem 3 from the template, including the MPI code), what are the final values of x, y, and z for each of the three processes (P0, P1, P2) after executing the provided MPI code? Show your work. *(Note: The MPI code from the original Problem 3 would be included here.)*

9. (12 points) In the scenario described in Problem 3 above (MPI code would be included here), is there a possibility that the communication among the three processes will execute out of order? Explain your reasoning.

Problem 4

10. (-6 points) If we have an embarrassingly parallel application, does it guarantee good scalability as the number of cores increases? Explain and justify your answer.

Remember to include your name, NetID, and the honor code statement on the first page of your submission. Good luck!