Fall 2023
Exam II
Thursday, November 9

DO NOT OPEN THIS EXAM UNTIL YOU ARE INSTRUCTED TO DO SO

Name:_____. Student ID No._____

1. **NO TALKING UNTIL YOU LEAVE THE EXAM ROOM, PERIOD. Not now. Not when you are done. Not when you are collecting your things. Not when you are getting ready for the exam. NO TALKING!** Doing so will earn you an F on the exam, at a minimum.
2. You May **NOT ASK ANY QUESTIONS DURING THE EXAM** due to Requirements of Social Distancing. Do your best and note any concerns on your page.
3. **Write the exam with a dark colored pen or pencil.** Light colored pens or pencils do not scan well.

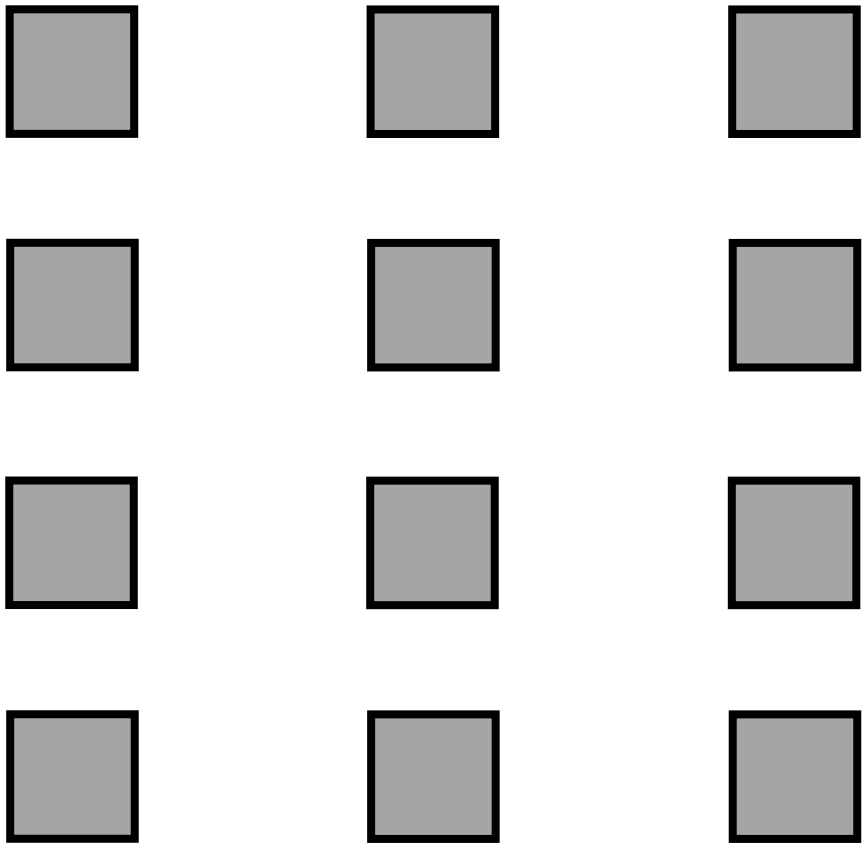
- **Plagiarism** will earn you an F in the course and a recommendation of expulsion from the university.
    - **a.** You may not refer to any material outside of this exam.
    - **b.** That is, you may **not** refer to notes, books, papers, calculators, phones, classmates, classmates' exams, and so forth.
    - **c. Do not talk to fellow students at any time while in the exam room.**
- Answer all questions on these pages. No code or pseudo-code is necessary – just a precise and concise explanation and justification.
- *Unsupported work will receive no credit.*

Q1 (5 pts) Given a tree with n pieces of data distributed evenly amongst the leaf processors, give an asymptotically cost-optimal algorithm to compute the summation of the n values. At the conclusion of the algorithm, all leaf processors should know the result. The algorithm should be one of the most efficient of the cost-optimal algorithms. Efficiency counts! Justify your answer.

Q2 (5 pts) Given a mesh-of-trees of base size n, where each base processor has an integer value in the range of [1..10], give an asymptotically optimal algorithm to sort the data. Define the ordering of the base processors. At the end of the algorithm, the data should be sorted according to the ordering that you have defined. Efficiency counts! Justify your answer.

Q3 (6 pts) (a) Draw a hypercube of size 16. Label each of the processors with binary values. (b) What is the communication diameter of a hypercube of size n? (c) What is the bisection width of a hypercube of size n?

Q4 (5 pts) Draw and label the data flow for a bitonic sequence $<a_1 \ldots a_8>$ to be merged into a monotonic sequence $<c_1 \ldots c_8>$, given the 12 comparison-interchange boxes given below.



Q5 (4 pts) Give a lower bound on sorting 1 piece of data per (base) processor on each of the following.

a. Tree with n leaf processors.
b. Pyramid of base size n.
c. Mesh-of-trees of base size n.
d. Hypercube of size n.

Justify your answer.