

Spring 2024  
Exam I  
Thursday, March 7

**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 (3 pts) Order the following by growth rate:  $n^2$ ,  $n$ ,  $\log n$ . Justify your answer.



Q2 (4 pts) Given  $n$  data items stored in the global memory of a CRCW PRAM with  $n$  processors, give an algorithm with asymptotically optimal running time to determine the sum of all  $n$  values. At the end of the algorithm, all  $n$  processors should know the correct result. Efficiency counts! Justify your answer.



Q3 (4 pts) Given a linear array of size  $\log_2 n$  with  $n$  data items evenly distributed amongst the processors, (a) give an asymptotically optimal algorithm to compute the sum of the  $n$  values. Justify your answer. (b) Discuss whether or not your algorithm is cost-optimal. Justify your answer.





Q4 (5 pts) Suppose that you are given a RAM with  $n$  pieces of data in a linked list.

(a) Describe Quicksort. Give the running time of Quicksort. Justify your answer.

(b) Give optimizations to Quicksort that will positively impact its running time. Justify your answer(s).

(c) Give optimizations to Quicksort that will positively impact the size of the system stack. Justify your answer(s).



Q5 (4 pts) Solve the following precisely. That is, do **not** provide an asymptotic solution. Justify your answer.

$$\sum_{i=1}^n i$$

