Fall 2021
Exam I
Thursday, October 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**. Do your best and note any concerns on your page.
3. **Write only on the front of each page**. Anything written on the back of a page will not be graded.

- **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 (6 pts) Assume that Algorithm A runs in $\Theta(n^2)$ time. Assume that Algorithm B runs in $\Theta(n \log n)$ time. For large n, which algorithm would you use? Justify your answer mathematically. (An answer of or related to "because it is faster" will earn you exactly 0 points.)

Q2 (6 pts) Order the following four functions by growth rate. Prove your answer.

n^2, ln n, 1, n^3

Q3 (6 pts) Prove that $\sum_{k=1}^{n} k^{1/7} = \Theta\left(n^{8/7}\right)$ by the method of bounding a summation both above and below by an integral.

Q4 (6 pts) Given a RAM with n integer values arbitrarily distributed one per record in a singly-linked list, give an optimal algorithm to sort the list by the values in the records. Assume that the integer values represent part numbers at your favorite big-box store, where the part numbers are integer values in the range of 1 to 1,000,000. Justify your result.

Q5 (6 pts) Given an EREW PRAM with n processors, where every processor has a piece of data, give a $\Theta(\log n)$ time algorithm to determine the summation of these data values. When the algorithm terminates, all n processor should know this sum. Describe your algorithm and justify its running time.