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 $\sum_{k=1}^{n} k^{1/7} = \Theta(n^{8/7})$ 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 $n$ processors should know this sum. Describe your algorithm and justify its running time.