Name:_____Student Number:_____

Plagiarism will earn you an F in the course and a recommendation of expulsion from the university. You may not refer to any material outside of this exam. That is, you may **not** refer to notes, books, papers, calculators, phones, classmates, classmates' exams, and so forth. 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) Prove that $\sum_{k=1}^{n} \frac{1}{k} = \Theta(\log n)$ by the method of approximating a summation by integrals.

Q2 (6 pts) Given n values stored in the global memory of a CREW PRAM, give a cost-optimal algorithm of minimal running time to determine the sum of these n values. Justify your result.

Q3 (6 pts) Given n values, evenly distributed amongst the processors of a linear array, give a cost-optimal algorithm of minimal running time to determine the sum of these n values. Justify your result.

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Q4 (6 pts) Given *n* pieces of data to be sorted on a RAM, justify your answer for each of the following.

    a. What is the running time of Insertion Sort?
    b. What is the running time of Merge Sort?
    c. What is the running time of Quicksort?
    d. When is it better to use Merge Sort over Quicksort?

Q5 (6 pts) Given *n* values stored in the global memory of a CREW PRAM with *n* processors, give an algorithm to compute the parallel prefix of these *n* values. Efficiency counts. Justify your result.

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Bonus Question 1 (1 pt). Who wrote "One and one don't make two, one and one make one."? (Choose one.)

    a) Freddie Mercury
    b) Paul McCartney
    c) Jimmy Page
    d) Pete Townshend

Bonus Question 2 (1 pt). What is the name of the algorithm that Dr. Miller and colleagues developed? (Choose one.)

    a) Turn 'n Burn
    b) Twiss 'n Miss
    c) Shake 'n Bake
    d) Algorithm March

Bonus Question 3 (1 pt) Who has Prof. Miller not spent time with? (Choose one.)

    a) Mark Zuckerberg
    b) Hillary Clinton
    c) Chuck Schumer
    d) George Pataki