CSC 225 SPRING 2013
ALGORITHMS AND DATA STRUCTURES I
MIDTERM EXAMINATION I
UNIVERSITY OF VICTORIA

1. Student ID: ________________________
2. Name: ___________________________
3. DATE: 1 FEBRUARY 2013
   DURATION: 45 MINUTES
   INSTRUCTOR: V. SRINIVASAN
4. THIS QUESTION PAPER HAS FIVE PAGES (INCLUDING THE COVER PAGE).
5. THIS QUESTION PAPER HAS FOUR QUESTIONS.
6. ALL ANSWERS TO BE WRITTEN ON THIS EXAMINATION PAPER.
7. THIS IS A CLOSED BOOK EXAM. NO CALCULATORS ARE ALLOWED.
8. KEEP YOUR ANSWERS SHORT AND PRECISE.

Q1 (10)	
Q2 (10)	
Q3 (10)	
Q4 (10)	
TOTAL (40) =	

1. The two parts of Question 1 test the basics of **asymptotic analysis**. All logarithms in this question are to the base 2.

   (a) Order the following functions by increasing growth rates. [5 Marks]
   n^n, $(\log n)^2$, $\sqrt{n}$, n^3, $2^{2^{\log n}}$, $4^{\log 8}$.

   (b) Show that $f(n) = 4 \log n + \log \log n = \Theta(\log n)$. [5 marks]

2. Question 2 checks if we can solve **recurrence equations**.

   Solve the following recurrence equation to get a closed-formula for $T(n)$. You can assume the n is a power of two. [10 Marks]

$$\begin{aligned} T(n) &= 1 \text{ if } n = 1 \\ &= T\left(\frac{n}{2}\right) + n \text{ if } n \geq 2 \end{aligned}$$

3. Question 3 is based on **Proof by Induction**. [10 Marks]

   Use induction to show that for all $n \geq 1$:

$$2! * 4! * 6! * \ldots * (2n)! \geq [(n+1)!]^n$$

4. Question 4 is about **Sorting Algorithms**.

   (a) Suppose that your Quick-Sort algorithm uses the following pivot rule that picks the element in the "middle" - For an array $A[0, 1, \ldots, n-1]$ of size n, it uses the element in $A[n/2]$ as pivot if n is even and the element in $A[(n-1)/2]$ as pivot if n is odd. Give an input array of size 7, with values 1 to 7, on which your quick-sort algorithm that run the slowest. [5 Marks]

   (b) Describe how Insertion-Sort Algorithm works by writing its pseudo-code. [5 Marks]

END OF EXAM