# University of Waterloo
# CS240, Spring 2021
# Assignment 1 Post Mortem

## Problem 1 [4+4+4+4=16 marks]

- When proving $\mathcal{O}(n)$ (or similar) from first principles, you must explicitly give values for $c$ and $n_0$ that satisfies the relationship.
- Ideally you should arrive at your final $c$ and $n_0$ values, rather than stating them first and proving they are valid. We understand that students often play around with the numbers on scratch paper and find these values beforehand or at least have an educated guess going in. However, for exams we expect you to show more work and we may not be as lenient.

## Problem 2 [4+4+4=12 marks]

- For part a), students applied l'Hôpital's rule to:

$$\lim_{n\to\infty} \frac{f(n)}{g(n)} = \lim_{n\to\infty} \frac{n^4(7+3\cos 2n)}{7n^4+5n^3+3n}$$

  Most trigonometric functions, when taken to the limit of infinity, do not exist. Instead, we were looking for students to bound $f(n)$ below by $f_1(n) = 4n^4$ and above by $f_2(n) = 10n^4$ and apply l'Hôpital's rule to solve those limits and establish upper and lower bounds separately.

## Problem 3 [4+4+4=12 marks]

- Many students did not use the definitions of the order notations. Using the Limit rule for these questions can only earn part marks.
- Many students who used the limit rule concluded a) was true. However, even if the limit of $\frac{f(n)}{g(n)}$ taken to infinity can't be 0 or $\infty$, it doesn't mean the limit is a constant. It is possible the limit doesn't exist, and therefore we cannot conclude $\Theta$.

## Problem 4 [4+4+4=12 marks]

- For c), many students arrived at a final running time of $\Theta(n^4)$, likely from incorrectly interpreting the harmonic series.

## Problem 5 [4 or 4(+2), graded out of 4 marks]

- Many students only called one fix-down. While $\mathcal{O}(logn) \in \mathcal{O}((logn)^2)$ is true, one fix-down is not enough. For example, take the sample tree we provided and replace 40 (at index i) with 50. Calling one fix-down on the sub-heap still leaves an almost-heap.