## **Objectives:**

- Review indeterminate forms of limits.
- Introduce and practice using l'Hospital's Rule, a derivative based tool for evaluating limits.

## Recap of Indeterminate Forms

Earlier in the semester, we encountered indeterminate forms while taking limits.

For example,  $\lim_{x\to\infty} \frac{x^4 - 3x^2 + 4}{x^2 + 1}$  is an indeterminate form, because:

Note: We don't write	
Instead write	

## Types of Indeterminate Forms:

Forms that are not indeterminate:

In the past we have dealt with indeterminate forms by attempting to rewrite the existing function in a way that doesn't lead to an indeterminate form.

## Examples of various methods:

Find 
$$\lim_{x\to\infty} \frac{x^4 - 3x^2 + 4}{x^2 + 1}$$
 if it exists.

Find 
$$\lim_{x\to\infty} \sqrt{x^2 + 3x} - x$$
 if it exists.

However, there are some limits where this doesn't work. For example,  $\lim_{x\to\infty}\frac{x^2}{e^x}$  has the indeterminate form  $\frac{\infty}{\infty}$  but we can't simplify it with any of our existing strategies.

Now that we know how to take derivatives, we can add another tool to our indeterminate form toolbox:

l'Hospital's Rule: (also written l'Hôpital's Rule)

If f(x) and g(x) are \_\_\_\_\_ and  $\lim_{x\to a} \frac{f(x)}{g(x)}$  is of the form

or  $\underline{\hspace{1cm}}$ , then

l'Hospital's rule applies for:

Why?

**Examples:** 

$$1. \lim_{x \to \infty} \frac{x+3}{x^2 + 2x}$$

2. 
$$\lim_{x\to 2} \frac{x-2}{x^2-4}$$

$$3. \lim_{x \to \infty} \frac{x^2}{e^x}$$

$$4. \lim_{x \to 0} \frac{x}{\cos(x)}$$

$$5. \lim_{x \to 0} \frac{x}{\sin(x)}$$