Handout 6

MATH 140 Lab: Section 1

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Note: *This handout contains a review for some important things in limits and derivatives.*

- If you cannot find the limit for a particular question using any method you studied before, then there is still one possible way to solve that. This method is called *L'Hôpital's Rule.*

  For example: Find $\lim\limits_{x\to 1}\left(\frac{\ln(x)}{x-1}\right)$.

  Solution: *L'Hôpital's Rule:*

  1- Find the derivative for

  Numerator$\left(The\ derivative\ of\ natural\ logarithm\ of\ x\ is\ \frac{1}{x}\right)$.

  2- Find the derivative for Denominator$(The\ derivative\ of\ (x-1)\ is\ 1)$.

  3- $\lim\limits_{x\to 1}\left(\frac{ln(x)}{x-1}\right)=\lim\limits_{x\to 1}\left(\frac{\frac{1}{x}}{1}\right)=\frac{\frac{1}{1}}{1}=1.$

- The derivative of f, denoted by $f'(x)$, can be written as follows:
  $f'(x)=\lim\limits_{h\to 0}\left(\frac{f(x+h)-f(x)}{h}\right)$ provided that the limit exists.

- ***Pascal Triangle Method for Simplification:***

```
                1
              1   1
            1   2   1
          1   3   3   1
        1   4   6   4   1
      1   5   10  10  5   1
```

Examples:

$$(x+y)^2=x^2+2xy+y^2$$

$$(x+y)^4=x^4+4x^3y+6x^2y^2+4xy^3+y^4$$

$$(x-y)^4=(x+(-y))^4$$

- The derivative of f, denoted by $f'(x)$, can be written in the following three different ways:

$$f'(x) = \lim_{h\to 0}\left(\frac{f(x+h)-f(x)}{h}\right)$$

OR

$$f'(a) = \lim_{h\to 0}\left(\frac{f(a+h)-f(a)}{h}\right)$$

OR

$$f'(a) = \lim_{x\to a}\left(\frac{f(x)-f(a)}{x-a}\right)$$

- **Important Theorems:**

Derivatives:

1- The derivative of $\sin(x)$ is: $\cos(x)$
2- The derivative of $\cos(x)$ is: $-\sin(x)$
3- The derivative of $\tan(x)$ is: $\sec^2 x$
4- The derivative of $\cot(x)$ is: $-\csc^2 x$
5- The derivative of $\sec(x)$ is: $\sec(x)\tan(x)$
6- The derivative of $\csc(x)$ is: $-\csc(x)\cot(x)$
7- The derivative of $\ln(x)$ is: $\frac{1}{x}$
8- The derivative of e^{2x} is $2e^{2x}$

Simplifications:

1- $\cos(A+B) = \cos(A)\cos(B) - \sin(A)\sin(B)$
2- $\sin(A+B) = \sin(A)\cos(B) + \sin(B)\cos(A)$

Trigonometric Functions:

1- $\sin(0) = 0$
2- $\cos(0) = 1$
3- $\sin(90) = 1$
4- $\cos(90) = 0$
5- $\sin(180) = 0$
6- $\cos(180) = -1$
7- $\sin(360) = 0$
8- $\cos(360) = 1$
9- $\sin(30) = \frac{1}{2}$

10- $\cos(60) = \frac{1}{2}$

11- $\tan(45) = 1$

12- $\tan(90) = Undefined$

13- $\sin(45) = \cos(45) = \frac{\sqrt{2}}{2}$

Good Luck in MATH 140 Exam 1

Math is Fun

Do not get scared from Math