Calculus II - Spring 2019

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Date	**2019-03-29T05:50:42**
Project	**37bc3906-ade8-480b-a982-5ce07ae4200c**
Location	**Labs/Lab_0/Lab_0.sagews**
Original file	**Lab_0.sagews**

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# Jorge Basilio - PCC
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# Calculus II - Spring 2019
## Instructor: *Dr. Basilio*
# Lab 0

## Introduction to Sage

<span style="font-size:18pt; color:red">
Due: Tuesday, April 9 by 11:59pm via Canvas
</span>

## Objectives

1. Learn what `SageMath` is and why you are asked to learn it
2. Become familiar with performing basic arithmetic calculations with `SageMath`
3. Learn how to calculate: limits, derivatives, integrals with `SageMath`
4. Learn how to make a PDF of your work to save and submit

# 0. Introduction

## Why use SageMath?

- It's free!
- Using it on web is free (hassle-free, no messy downloading needed)
- Dowloading it is free (if you want to use it without internet)
- It's open source!
- No hidden algorithms (you can look at source code if you wish--and look "under the hood" so to speak)
- It will prepare you for the future!
    - You will likely need to learn some basic programming no matter what you study in college
    - In Pyschology, for example, it's common to learn Python (and the R package) when learning statistics

# 1. Some reading assignments:

## - Read: [Why use SageMath?](https://github.com/sagemathinc/cocalc/wiki/SageInCalculus)

> *An excerpt:*
> > #### Why not just use graphing calculators?
> > Back in their day, graphing calculators were rather popular. I used one in high school in the 1990s.
> > - Let's say you're working with a large data set. Using a system like Sage, a professor can upload data into a project, and distril
> > - Students can take the images and outputs of their computations in Sage and easily add them to any document for their classes, or
> > - The appearance of graphs and 3D plots on a computer is vastly more realistic and comprehensible than the display of a graphing c
> > - The "online help" systems available (such as web-pages) such as Sage's wiki can be a tremendous boon to the student who is new t
> > - Many faculty working with Sage have made online videos, to help new students learn Sage.
> > - If a student learns Sage, then the student learns Python "along the way." Python is an extremely popular computer programming la

## - Read: [Getting Started with SageMath](https://mosullivan.sdsu.edu/sagetutorial/about.html#getting-started)

> - Read: **About Sage**
> - Read: **Sage as a Calculator**
> - Read: Section: Arithmetic and Functions
>      1. Basic Arithmetic
>      2. Integer Division and Factoring
>      3. Standard Functions and Constants

## - Reference: [Sage for Undergraduates](http://www.gregorybard.com/Sage.html)

> - Reference: this site has an entire book you can download for more information

# 2. Getting Started

1. Make an account at the [CoCalc website](https://cocalc.com/) page so you can **login** to the free Sage server. No nosy questions,

2. Create a new **Sage Worksheet** and begin experimenting, OR
Upload worksheets using the "Upload" link in the upper-left corner, OR
If you are making a worksheet to submit an assignment, give the worksheet a title like **"Math5B-Lab_0— YourLastName_YourFirstName-S19

3. At the beginning of your worksheet include course info and lab info by using **comments** (see the template you can follow)

    - By looking at this document, you are encouraged to copy and paste lines of code and modify them :-)
```

```
4. Have some fun and make a few calculations


# 3. Handy Short Cuts

- `Command+Enter` (on Mac) or `Shift+Enter` (on PC) runs the code and gives you an output

# 4. Quick Examples

```

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> - Let's say you're working with a large data set. Using a system like Sage, a professor can upload data into a project, and distribute it to all of his students with a click. With a graphing calculator, the data would have to be entered by each student, by hand.
> - Students can take the images and outputs of their computations in Sage and easily add them to any document for their classes, or undergraduate research papers suitable for publication. A picture on a graphing calculator is idle and immovable.
> - The appearance of graphs and 3D plots on a computer is vastly more realistic and comprehensible than the display of a graphing calculator.
> - The "online help" systems available (such as web-pages) such as Sage's wiki can be a tremendous boon to the student who is new to Sage. A graphing calculator just has a manual.
> - Many faculty working with Sage have made online videos, to help new students learn Sage.
> - If a student learns Sage, then the student learns Python "along the way." Python is an extremely popular computer programming language, used in industry. (Ranked #3 in this article published in IEEE Spectrum.)

- Read: Getting Started with SageMath

- Read: **About Sage**
- Read: **Sage as a Calculator**
- Read: Section: Arithmetic and Functions
    1. Basic Arithmetic
    2. Integer Division and Factoring
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3. At the beginning of your worksheet include course info and lab info by using **comments** (see the template you can follow)
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4. Have some fun and make a few calculations

3. Handy Short Cuts

- `Command+Enter` (on Mac) or `Shift+Enter` (on PC) runs the code and gives you an output

4. Quick Examples

```
# this a SageMath worksheet
# comments are designated by a hashtag and are not read by the program

# how to add; hit `Run` when you are ready to tell SageMath to compute
2+2
```

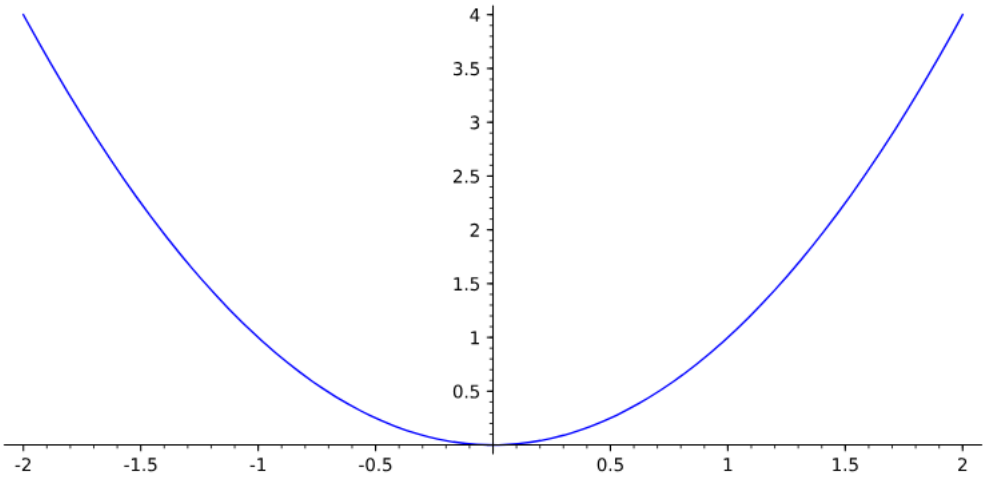
```
4
```

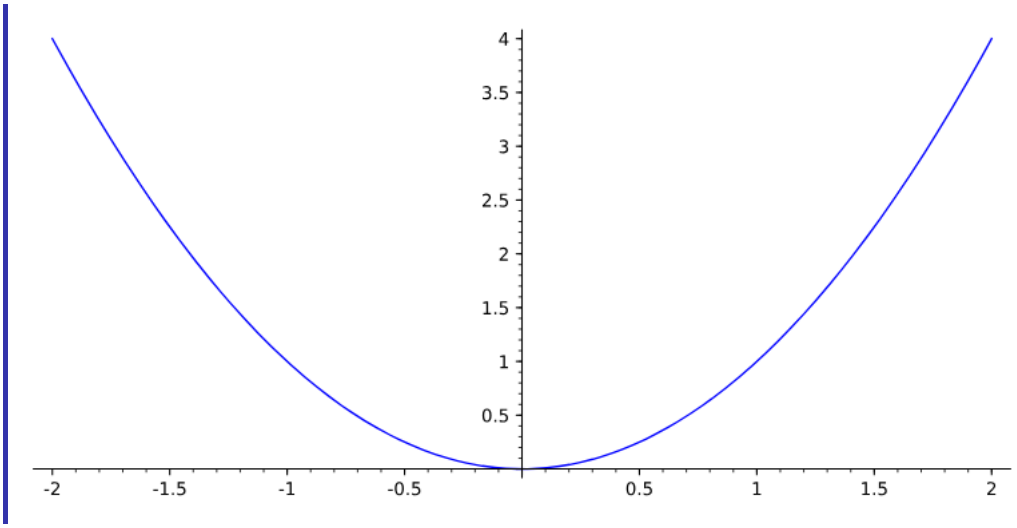
```
# evaluating a function
f(x) = x^2 # defines f; note the notation is similar to math notation!
f(-2)

```

```
4
```

```
# graphing a function
# this will graph f(x)=x^2 with x in (-2,2)
plot(x^2,x,-2,2)
```






```
# limits
f(x)=x*e^(-x) # note: must use * to multiply
limit(f,x=ln(2))
```

```
x |--> 1/2*log(2)
```

```
# another limit
f(x)=1/x
limit(f,x=0)
```

```
x |--> Infinity
```

```
# notice we have to be careful in the above limit!
# the above example doesn't give us the expected 'DNE' (Recall: LHL is -Infinity whereas RHL is +Infinity)
# to do a one sided limit:
f(x)=1/x
limit(f, x=0, dir="left") # this means `approaches from the left`
```

```
x |--> -Infinity
```

```
# and the RHL
f(x)=1/x
limit(f,x=0, dir="right")
```

```
x |--> +Infinity
```

```
# derivative
f(x)=x^3*e^(sqrt(x))
derivative(f,x) # 'd(f,x)' is basically 'df/dx'
```

```
x |--> 1/2*x^(5/2)*e^sqrt(x) + 3*x^2*e^sqrt(x)
```

```
# the above is correct but not easy to look at
# we can use show() function to make the output look prettier
f(x)=x^3*e^(sqrt(x))
show(derivative(f,x))
```

$$x \mapsto \frac{1}{2} x^{\frac{5}{2}} e^{\sqrt{x}} + 3 x^{2} e^{\sqrt{x}}$$

```
# better way to use show()
f(x)=x^3*e^(sqrt(x))
g=derivative(f,x)
show(g)
```

$$x \mapsto \frac{1}{2} x^{\frac{5}{2}} e^{\sqrt{x}} + 3 x^{2} e^{\sqrt{x}}$$

```
# anti-derivatives or indefinite integrals
integral(x^3,x) # integral(f,x) the ",x" is like our "dx"
```

```
1/4*x^4
```

```
# definite integral
integral(x^3*sin(x),x,-1,1)
```

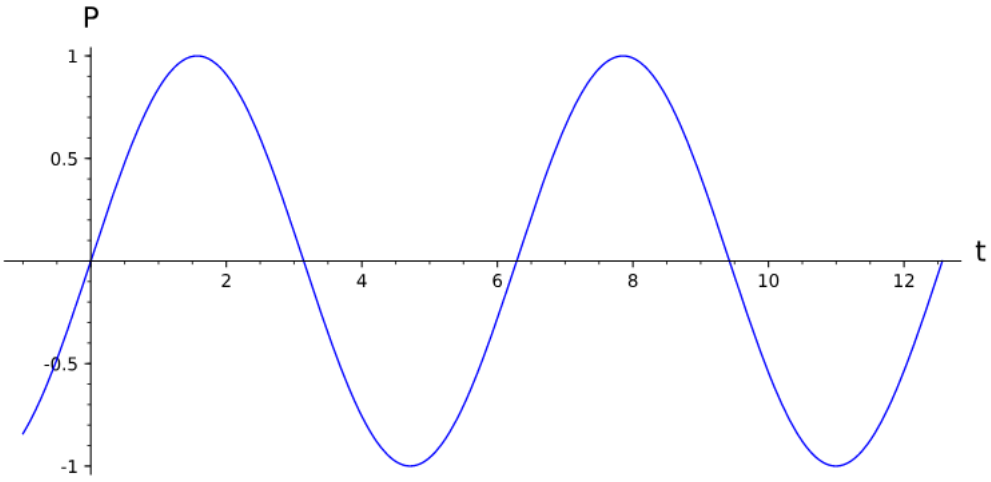
```
10*cos(1) - 6*sin(1)
```

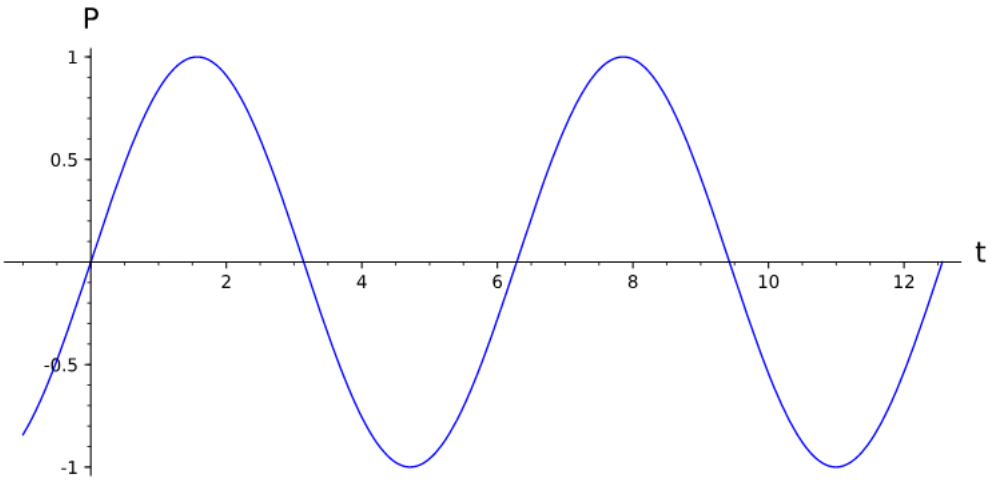
```
# a hard integral
I=integrate(x^4*exp(x),x)
show(I)
```

$$\left(x^4 - 4\,x^3 + 12\,x^2 - 24\,x + 24\right)e^x$$

```
# variables have to be declared (x is predefined for convenience)
var('t')
show(plot(sin(t),(t,-1,4*pi)), axes_labels = ['t','P']) # t for time and P for population
```

t






```
# Assignment for Lab_0
%md
# 5. Assignment

1. Evaluate: $\cos(\pi/8)$, $e^8$, $\sqrt{8}$, $\ln(8)$

2. Now, have Sage compute numerical approximations for the expression in \#1. *(Consult the reading from above "Getting Started with S

3. Compute $e$ to one hundred decimal places.

4. Let $f(x)=x^3+7^x-\ln(e^{x^2}\cdot \sqrt{x})$.

    a. Compute: $\lim_{x \to 1} f(x)$.

    b. Compute: $f'(x)$.

    c. Compute: $\int f(x) dx$.

    d. Verify the Fundamental Theorem of Calculus by defining $F(x)=\int f(x)dx$ and checking that $F'(x)=f(x)$.

    e. Compute: $\int_2^8 f(x) dx$.

    f. Plot $f$ for $x \in (2,8)$.

    g. Make your plot prettier by labeling the $x$ and $f(x)$ axes appropriately.

5. Download your Sage worksheet *(extension .sagews)* and submit it via Canvas.
```

```
6. Submit a pdf of your lab via Canvas.

**Note:** Use comments to indicate which problem you are working on (see template)
```

5. Assignment

1. Evaluate: $\cos(\pi/8)$, e^8, $\sqrt{8}$, $\ln(8)$
2. Now, have Sage compute numerical approximations for the expression in #1. (Consult the reading from above "Getting Started with Sage")
3. Compute e to one hundred decimal places.
4. Let $f(x) = x^3 + 7^x - \ln(e^{x^2} \cdot \sqrt{x})$.
   a. Compute: $\lim_{x \to 1} f(x)$.
   b. Compute: $f'(x)$.
   c. Compute: $\int f(x)dx$.
   d. Verify the Fundamental Theorem of Calculus by defining $F(x) = \int f(x)dx$ and checking that $F'(x) = f(x)$.
   e. Compute: $\int_2^8 f(x)dx$.
   f. Plot f for $x \in (2, 8)$.
   g. Make your plot prettier by labeling the x and $f(x)$ axes appropriately.
5. Download your Sage worksheet (extension .sagews) and submit it via Canvas.
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```
# printing PDF
%md

# 6. How to create a PDF

When you have completed the assignment, download the worksheet and also a PDF version of your file and submit both files via Canvas. T

**Note \#1:** Do **not** use `Convert to PDF` *(try it if your curious but the formatting is not as nice looking as when it is convert

**Note \#2:** Do **not** use `Ctrl+P`. It doesn't seem to print the entire document.
```

6. How to create a PDF

When you have completed the assignment, download the worksheet and also a PDF version of your file and submit both files via Canvas. To accomplish this, select `Print` (*You'll see prompt that says "Conver to HTML") then select `Download`. A pop-up will give you a PDF of your worksheet. You may now downnload and save it to your computer. As before, give yo file the name **"Math5B-Lab_0– YourLastName_YourFirstName-S19.pdf"**.

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```
# Bonus
%md

# 7. Bonus Section (Optional): Python

`SageMath` is built using the `Python` programming language.
In fact, you can type `Python` code directly on Sage Worksheets without any special instructions.

Below, I'll give a few simple examples for those of you who are  curious ;-)
```

7. Bonus Section (Optional): Python

`SageMath` is built using the `Python` programming language. In fact, you can type `Python` code directly on Sage Worksheets without any special instructions.

Below, I'll give a few simple examples for those of you who are curious ;-)

```
# example of python code
print("Hello World!")
```

```
Hello World!
```

```
# example of python code
# defining a more complicated function
def f(x):
    if -1 <= x <=0:
        return -x
    elif 0 < x < 0.5:
        return x
    else:
        return 0.5
f(-0.1)
```

```
0.100000000000000
```

```
f(0)
```

```
0
```

```
f(0.1)
```

```
0.100000000000000
```

```
#mix and match; use sage to plot the function f defined with python
plot(f)
```