Last name _____

First name _____

LARSON—MATH 511—CLASSROOM WORKSHEET 02
Getting Started with Sage/CoCalc.

1. Create a Sage/CoCalc account.

   (a) Start the Chrome browser.

   (b) Go to `http://cocalc.com`

   (c) "Create new account" using **your VCU email address** .

   (d) You should see an existing Project for our class. Click on that.

   (e) Click "New", then "Sage Worksheet", then call it **c02**.

2. Evaluate "e". Then use `n(e,digits=7)` to find a 7-digit approximation for e.

3. Find a 6-digit approximation for e^3.

4. Evaluate `plot(cos,0,2*pi)` to sketch the graph of $\cos x$ on the interval $(0, 2\pi)$.

5. For any variable other than "x" you must tell Sage that you will use it as a variable. Evaluate `var("y")` to define "y" as a variable. Now evaluate `plot3d(x**2+y**2-2, (-1,1),(-1,1))` to sketch $g(x) = x^2 + y^2 - 2$ for $-1 \leq x \leq 1$ and $-1 \leq y \leq 1$.

6. Sage is written in Python. Type in the following program and evaluate.

   ```
   def write_string(string_name):
       print string_name
   ```

   Now type `write_string("hello world!")` and evaluate.

   In order to do sophisticated calculations, or to allow for multiple inputs, you will need to define *procedures* (also called *functions*). Our "hello world!" program was the first example. It included a `print` statement. Other program features, in almost any language, include *conditional statements* (if..then..) and *loops*.

7. Type in the following procedure definition and evaluate.

   ```
   # This function returns the absolute value of a number x
   def absolute(x):
       if x>=0:
           return x
       else:
           return -x
   ```

8. Now test it. Evaluate `absolute(4)`, `absolute(-4)`. "#" is the *comment* symbol. Everything after "#" is ignored—and not evaluated.

```
def abs_plus_five(x):
    return absolute(x)+5
```

9. You don't have to add five, you can add *any* number by adding a *parameter*.

```
def abs_plus(x,y):
    return absolute(x)+y
```

10. Now test it. Evaluate `abs_plus(4,5)`, `abs_plus(-4,5)`, `abs_plus(-4,23)`, etc.

11. We can represent the system of linear equations $\begin{cases} 2x + y = 5 \\ x + 3y = 7 \end{cases}$ with the matrix $A = \begin{bmatrix} 2 & 1 & 5 \\ 1 & 3 & 7 \end{bmatrix}$

    Enter this in Sage by evaluating: `A=matrix(2,3,[2, 1, 5, 1, 3, 7])`

12. Evaluate `A` to see your matrix.

13. Evaluate `A.rref()` to find a matrix that represents an equivalent system in *row-reduced echelon form*. What do you get?

14. Consider the system: $\begin{cases} x + 3y = 5 \\ x + 3y = 7 \end{cases}$

    Find a matrix that represents this system, and enter it in Sage. Then use Sage to find the row-reduced echelon form of this matrix. Then rewrite (on your own, without Sage) this as an equivalent system of linear equations and interpret.

15. Consider the system: $\begin{cases} x + y = 5 \\ 2x + 2y = 10 \end{cases}$

    Find a matrix that represents this system, and enter it in Sage. Then use Sage to find the row-reduced echelon form of this matrix. Then rewrite (on your own, without Sage) this as an equivalent system of linear equations and interpret.

16. Consider the system: $\begin{cases} 9a + 3b + 1c = 32 \\ 4a + 2b + 1c = 15 \\ 1a + 1b + 1c = 6 \end{cases}$

    Find a matrix that represents this system, and enter it in Sage. Then use Sage to find the row-reduced echelon form of this matrix. Then rewrite (on your own, without Sage) this as an equivalent system of linear equations and interpret.

17. Evaluate: `A=matrix(2,2,[1,2,3,4])`, and `b=vector([5,6])`. Solve the matrix equation $A\hat{x} = \hat{b}$ by evaluating `A.solve_right(b)`. What do you get?

18. If there is any time left we will try some of the commands on the **Sage Linear Algebra Quick Reference** handout.

Getting your classwork recorded

When you are done, before you leave class...

1. Click the "Make pdf" (Adobe symbol) icon and make a pdf of this worksheet. (If CoCalc hangs, click the printer icon, then "Open", then print or make a pdf using your browser).

2. Send me an email with an informative header like "Math 511—c02 worksheet attached" (so that it will be properly recorded).

3. Remember to attach today's classroom worksheet!