PIC 16, Winter 2018 – Preparation 6M

Assigned 2/9/2018. To be completed by class 2/12/2018.

Intended Learning Outcomes

By the end of this preparatory assignment, students should be able to:

- use SymPy to perform mathematically exact algebraic manipulations, solve equations, differentiate functions, and perform indefinite and definite integrals.

Tasks

- ☐ Follow the SymPy tutorial introduction.
- ☐ Jupyter and IPython console are great for working with SymPy because you can output all the symbols graphically. After `from sympy import *`, execute: `init_printing(use_latex='mathjax')`. Now any statement that would automatically produce printed output in the console will show graphical output instead. You can then force results to be displayed graphically by first executing `from IPython.display import display` and then use `display` instead of `print`. For instance, `display(pi)` shows π.
- ☐ Find the general solution to the quadratic equation:

  $$ax^2 + bx + c = 0$$

  Note that the first argument to the solve function is the expression you want the *root* of (the expression you want to equal zero) and the second is the variable you want to solve for (what value(s) of it make the expression zero?).
- ☐ (Less trivial) Use the definition of the golden rectangle to solve for the golden ratio φ exactly.
- ☐ Find $\frac{dx^x}{dx}$ (the derivative of x^x with respect to x).
- ☐ Find $\int xe^x \mathrm{dx}$. Keep in mind that programming languages typically have a special function for calculating e^x, and Python/SymPy are no exception. The name of the function is the same as it was in PIC 10A (C++) and PIC 20A (Java). If you're surprised, you might want to review the math functions in Python. The names are typically the same in SymPy.
- ☐ Find $\int_0^\infty \frac{\sin x}{x} dx$. Yes, the result is finite. Note that ∞ is typed as two "o"s back to back (`oo`).
- ☐ Express $\sinh x$ in terms of e^x. There is an example of this sort of thing in the document; you might have skipped it assuming it was about Bessel functions…. Pay attention to the syntax in the example.
- ☐ Read the SymPy Gotchas.
- ☐ Determine whether $2 \sin\frac{x+y}{2}\cos\frac{x-y}{2} = \sin x + \sin y$ using SymPy. (Yes, they are).
- ☐ Read SymPy Basic Operations.
- ☐ Use `subs` to evaluate $e^{n\pi i}$, where $i = \sqrt{-1}$, for $n = \frac{1}{2}$, $n = 1$, $n = \frac{3}{2}$, and $n = 2$. If you do it correctly, no two will be the same. Do the same using `lambdify`. (Call the function it returns.)
- ☐ If you are uncomfortable with the concepts behind any of the following topics, please begin to review them:
  - Systems of equations
  - Matrices (especially as used in the representation of systems of linear equations)
  - Ordinary differential equations / systems of ordinary differential equations

  These are reviewed briefly in the first ~30 minutes of this video. If you have never studied these topics before or the video is not helping you refresh your memory, please ask for more help!