EEE 419/591
Fall 2025
Homework 2

Solve the following three problems. Put them all into a single code named hw2.py and submit it to the designated link on Canvas. If you upload a second attempt to Canvas and it renames your file, ignore the renaming.

If you are a beginner in programming, you are encouraged to write the code yourself without the help of AI (except for limited help such as understanding how to do numerical integration).

Problem 1: Estimating the accuracy of quad Package for Finite Integrals

Compute the value of the integral:

$$I_1(r) = \int_0^5 (ax^2 + bx + c)dx$$

where a, b, and c are some numbers fed by the user and ranging between -10 and 10. Use the following two methods to compute the above integral

Method 1: Use scipy.integrate.quad package.

Method 2: Numerical integration with a suitable step size. Recall: Numerical integration calculates the area under the curve manually.

Your code should expect a set of 3 numbers separated by a space as an input and print the value of the integration for each method as well as the percentage error between the two methods as the following example

Input a set of 3 numbers between −10 and 10: −2 6 0

Method 1: I1 = −8.3333

Method 2: I1 = −8.3333

Percentage error: 0.0005%

Hint: Choose a small step size in Method 2 to be considered more accurate. It is up to you to decide how small is "small". You need to balance the accuracy with running time. This is an important skill you learn. Choosing a very small step size for ultra-high accuracy might not be right/wise. Note: it is acceptable to get 0 error in this problem since quad is already accurate.

$$Percentage\ error\ = \left|\frac{Accurate\ Method - Inaccurate\ Method}{Accurate\ Method}\right| \times 100\%$$

Problem 2: Estimating the Accuracy of the Substitution Method and Numerical Method for Infinite Integrals

Compute the value of the integral:

$$I_2(r) = \int_0^\infty \frac{dx}{(1+x)\sqrt{x}} = \pi$$

using the following two methods:

Method 1: Substitution method taught in video lecture 2.6 at min ~3:45. You can do this by coding or on a piece of paper. You might be able to find a package that will integrate this integral without substitution, do not use it.

Method 2: Numerical Integration: use a suitable step size and value to replace ∞. Recall: Numerical integration calculates the area under the curve manually. Instead of Numerical Integration, you are allowed to use a package that calculates infinite integrals without substitution.

Be sure to use np.sqrt() to compute any square roots required. Note that this is a known integral whose answer is, in fact, π. For each method,

- Print out the integration value to a precision of 8 digits past the decimal point.
- Print out the absolute difference from π. Recall, you already have an accurate value of π in the numpy package. Subtract π from the integration value from each method. Print as many decimal digits as what illustrates the difference (not more than 16 decimal digits).

Your code should not expect anything as an input and prints something like the following example (print the number before the name of the method for easy comparisons):

```
3.14159265          # I2 Method 1

3.14159245          # I2 Method 2

0.000000000000099    # Difference Method 1

0.000000000000043    # Difference Method 2
```

Note that these numbers might be inaccurate. Your numbers will be different.