MATH 122
Numerical Integration Assignment
Due: Friday, September 17, 2021

(The assignment needs to be **typed**.)

The basic assignment is to numerically integrate $f(x) = \sin(x^2)$ from $x = 0$ to $x = 4$ using the Midpoint, Trapezoidal, and Simpson Rules. And write a report. Here is the structure of your report.

A. Tell what software you use. Some suggestions: Matlab/Octave, Python, Mathematica, C++, Java, Excel. You need to print your code. I have posted possible code for Matlab/Octave, Python, and Mathematica for you to use if you wish. It would even be better if you wrote your own code, but it is OK to use known code. (It is **not** permitted to use some "black box" code from a web site that gives numerical approximations, but does not show any code.)

   While you are deciding what software to use for computation, you should also select something that will graph functions (and derivatives) for use in error analysis. This can be any graphing program from which you can print the graph.

B. Run the software for each of the three methods using $n = 10, 20, 40, 80, 160$. Record your results in a table that looks like:

n	Midpoint	Trapezoid	Simpson
10	1.234567	1.234567	1.234567
20	1.234567	1.234567	1.234567
40	1.234567	1.234567	1.234567
80	1.234567	1.234567	1.234567
160	1.234567	1.234567	1.234567

   Record your results using 6 decimal places with rounding.

C. Errors. Use the "actual" value of the integral as 0.747134.

   Build another table, similar to the form of the first, with the values of the errors in each case.

D. Error bounds

   Use $n = 40$ for this part of the exercise. For each of the numerical methods, use the error bound formulas from the book as discussed in class, and give an upper bound for the error of your approximation of the integral (with $n = 40$). For this you will need to approximate the maximum values of the second and fourth derivatives. Include a plot or plots of these derivatives so that the maximum (absolute) values can be seen on your plot.

Show that your approximate value of the integral is in agreement with this error bound.

E. EXTRA CREDIT
Use the error bound information/inequality in the text to find the (nearly) smallest n that will give an error of at most 0.0001 for the Trapezoidal Rule. Repeat for Simpson's Rule.