Phys234, 2018, Problem set #7: In-lab questions

Question 1:

The following integral has an exact analytical solution:

$$I = \int_{-1}^{5} e^{-x}\,\cos(e^{-x})\,dx = \left[-\sin(e^{-x})\right]_{-1}^{5} = \sin(e^{1}) - \sin(e^{-5})$$

Write a function `ps7q1` that computes this integral numerically with both:

– the trapezoidal rule (using the function `trapezoid`)

– Simpson's rule (using the function `simpson`)

Do each case for $n_f = 9, 17, 33, 65, 129, 257, 513$ where n_f is the number of points on which you evaluate the function. Recall that for a given number of panels N, the number of function evaluations for the trapezoid and Simpson rule are, respectively, $n_f = N + 1$ and $n_f = 2N + 1$. For each n_f compute the error (i.e. the difference between the *exact* value of the integral and your numerical approximation). Execution of your function `ps7q1` should create two tables (one each for Trapezoidal and Simpson method) that shows the evaluation of I and the error for each n_f. You can use and modify the functions `demoTrap` and `demoSimp` that I showed in class as templates for producing your tables. (You will also need to create a function m-file `f=fint(x)` that evaluates $e^{-x}\cos(e^{-x})$)

Question 2:

Repeat the calculation of question 1, but using Gauss-Legendre (GL) quadrature with the function `gaussQuad.m` using different number (n) of GL points per panel:

a) $n = 2$ (i.e. 2-pt GL rule), b) $n = 3$ (3-pt GL rule), c) $n = 4$ (4-pt GL rule).

For each case, calculate the integral by subdividing the interval $[-1, 5]$ into $N = 4, 8, 16, 32, 64, 128$ panels. Present your answer in a function file `ps7q2` that produces 3 tables (one for each choice of n) of the evaluation of I and the error as a function of n_f (the number of function evaluation) where $n_f = N \cdot n$. You can use and modify the function `demoGauss` that I showed in class as a template for producing your tables.