# MA 3457 / CS 4033
# HW #4
# Due: Thursday 11/19 by 11 pm

This assignment is due on **Thursday 11/19 by 11 pm on Canvas**. Your assignment submission should contain a few files. You should submit all of your Matlab code and it should be properly commented to explain what the code is doing. You can submit as separate m-files saved as HW#Q# OR you can submit a single word or text file with all of the code pasted in (specifying or delineating code for each problem). For additional written work and discussion of problems, this should be a single pdf that is well-organized and either typed or neatly written. (If hand-written, use an app to scan and save as a single pdf). This file should be saved as HW#. To receive full credit on a problem, the code must run with no errors and the written work/discussion of the problem must also be complete. Matlab output should be discussed in the write-up.

1. (10 points total) *Circuits*
   In a circuit with impressed voltage $\varepsilon(t)$ and inductance $L$, Kirchhoff's first law gives the relationship

   $$\varepsilon(t) = L\frac{di}{dt} + Ri$$

   where $R$ is the resistance in the circuit and $i$ is the current. Suppose we measure the current $i$ for several values of $t$ and obtain:

   | t | 1.00 | 1.01 | 1.02 | 1.03 | 1.04 |
   |---|---|---|---|---|---|
   | $i$ | 3.01 | 3.12 | 3.14 | 3.18 | 3.24 |

   where $t$ is measured in seconds, $i$ is in amperes, the inductance $L$ is a constant 0.98 henries, and the resistance is 0.142 ohms.

   (a) (6 points) Approximate the voltage $\varepsilon(t)$ when $t = 1.00, 1.01, 1.02, 1.03$, and 1.04 using the derivative approximations derived in class and/or 4.1 in Burden & Faires textbook.

   (b) (4 points) Specify the order of accuracy of each approximation and whether it is a forward, backward, or centered approximation.

   You can complete this by hand or with a Matlab code.

2. (10 points total) *Approximating Derivatives*

   (a) (5 points) Derive a method for approximating $f'''(x_o)$ whose error term is $\mathcal{O}(h^2)$, by expanding the function $f$ in a Taylor polynomial about $x_o$ using $x_o \pm h$, $x_o$, and $x_o \pm 2h$.

   (b) (5 points) The partial derivative $f_x(x, y)$ of $f(x, y)$ with respect to $x$ is obtained by holding $y$ fixed and differentiating with respect to $x$. Similar for $f_y$ when holding $x$ fixed. Using a Taylor series expansion of a function of two variables, determine the $O(h^2)$ numerical approximation formulas and associated truncation error for $f_x$ and $f_y$.