IAM 550 Introduction to Engineering Computing
Computer Lab 10
Differential equations
J. Raeder, November 19/21 2019

Objectives:

- Practice ODE integration.
- Practice using functions.

Deliverables **due no later than 2 days after the end of your lab session:**

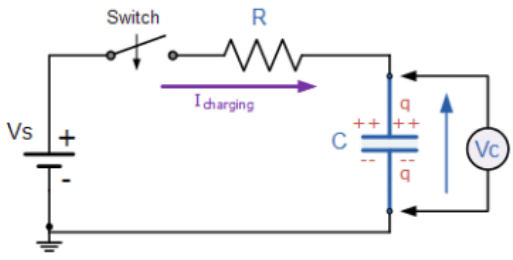
A MATLAB diary for your laboratory session (25% of your laboratory grade). This should be submitted via blackboard as an assignment no later than 2 days after your lab.

Deliverables **due at the beginning of your next lab session (2 weeks out):**

- A lab hard-copy report summarizing your results and including all required files (m-files, plots, tables), but **not any data files**. Make sure your name is on *all* pages of your lab report. Document your script profusely with comments. This will be emphasized when grading.

Task 1 of 2

Consider a simple electrical circuit where you charge a capacitor through a resistor by connecting a battery (closing the switch) at time t=0.



The charge *Q* on the capacitor is related to the current *I* by *dQ/dt=I*. Furthermore, by Kirchhoff's law, *V – RI – Vc* =0, and the charge *Q* on the capacitor is *Q=CVc*, where *C* is the capacitance. That can be combined to give the differential equation

dQ/dt = V/R - Q/RC

The analytic solution is Q(t)=CV(1 – exp(-t/(RC)). Write a MATLAB code that solves the differentia equation with the Euler forward method and the Predictor-Corrector method. Use values of 1F for the capacitor, 10 Ohm for

the resistor, and 10 V for the battery. Run the code from 0 to 10 seconds. Use values for dt of 1.0, 0.1, and 0.01. For each of the runs calculate the percentage error at the end, and make a table of the errors. Discuss and submit the table and only the first plot for Euler/dt=1. Which dt and how many step do you need with each of the methods to achieve an accuracy of better than 0.01%?

Task 2 of 2 (50 extra points)

Add the Runge-Kutta (RK4) method to the mix.

Grading guidance: Total 100 pts

Diary for lab 10: [25 pts] Can be multiple diaries if work was not done all at once.

Overall report writing [75 pts]

- Are the results correct? [10 pts]
- Are the plots present, in proper format, labelled, and referenced? [10 pts]
- Is the table present [10 pts]
- Is the m-files attached, labelled, and referenced? [10 pts]
- Is there a 'sanity test' for the results? [10 pts]
- Is the report written in a reasonably clear way and on? Note that the reports do not have to follow a specific format, They just have to be clear [25 pts]

- If the report
    - is mostly hand-written remove [30 pts]
    - includes a few hand-written elements remove [15 pts]