

# Numerical Analysis

## Homework 11. Numerical Integrations

**Due: May 19, 2015**

Numerical integration is also important in the area of Electrical Engineering. For example, the current waveform of an electrical circuit with power supply of 1V is shown below. The energy consumed during this period of operation is then

$$E = \int_{t=475}^{775} I \cdot V \, dt = V \int_{t=475}^{775} I \, dt = \int_{t=475}^{775} I \, dt \quad (11.1)$$

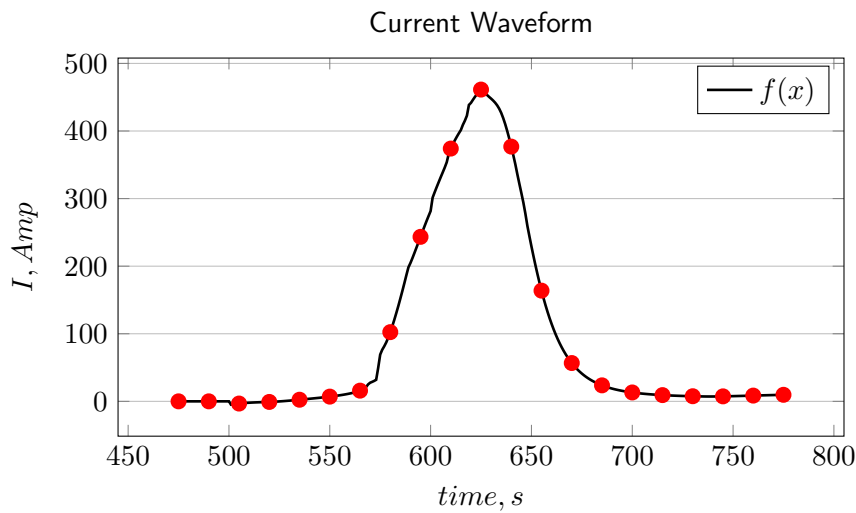


Figure 1. Simulated current waveform.

For this homework assignment, please implement the following function for numerical integration using the [composite  \$n\$ 'th order Newton-Cotes formula](#).

```
double integ(VEC &X,VEC &Y,int n); // composite nth order Newton-Cotes integral
```

where **X** is the vector of the independent variable, **Y** is the dependent variable, and **n** is the order of integration. Note that since the composite integration method is used, the number of points in both **X** and **Y** is usually larger than **n**.

1. Suppose all current values for  $t \in [475, 775]$  are measured with  $\Delta t = 1$  second, and the data is given in the file **f301.dat**. Please use the [first](#) order Newton-Cotes integration method to find the integral  $\int_{t=475}^{775} I \, dt$ . Assume that this is the most accurate integration we can get for this homework assignment.
2. Suppose now the measurement are done with a larger  $\Delta t$  and the data is given by the file **f21.dat**. Please still use the [first](#) order Newton-Cotes integration method to find the integral  $\int_{t=475}^{775} I \, dt$ . What is the error as compared to the value obtained in question 1?

3. Still using the measurements given by the file `f21.dat`, Please use the `second` order Newton-Cotes integration method to find the integral  $\int_{t=475}^{775} I \, dt$ . What is the error as compared to the value obtained in question 1?
4. Still using the measurements given by the file `f21.dat`, Please use the `fourth` order Newton-Cotes integration method to find the integral  $\int_{t=475}^{775} I \, dt$ . What is the error as compared to the value obtained in question 1?
5. Still using the measurements given by the file `f21.dat`, Please use the `Fifth` order Newton-Cotes integration method to find the integral  $\int_{t=475}^{775} I \, dt$ . What is the error as compared to the value obtained in question 1?
6. Please state your observations.

### Notes.

1. For this homework you need to turn in a set of `C++` source codes. That includes `hw11.cpp`, which solves question 5 above, `MAT.h`, the new header file, `MAT.cpp`, which includes the new function above, `VEC.h` and `VEC.cpp` files.
2. A `pdf` file is also needed. Please name this file `hw11a.pdf`.
3. Submit your files on EE workstations. Please use the following command to submit your homework 11.

```
$ ~ee407002/bin/submit hw11 hw11a.pdf hw11.cpp MAT.h MAT.cpp VEC.h VEC.cpp
```

where `hw11` indicates homework 11.

4. Your report should be clearly written such that I can understand it. The writing, including English grammar, is part of the grading criteria.