Signals 1: Assignment 1 (Optional)

Part 1: Analytical approach for getting the mean and RMS of a periodic signal

In this assignment, you first derive mathematical expressions of the mean, the signal energy, and the RMS of two periodic signals that are defined in mathematical terms. The expressions for analytical derivation of the mean, the MS (signal energy), and the RMS of a periodic signal $s(t)$ with period T are given in the lecture notes in Section 6.3. Worked out examples for the rectified sine wave and the triangular wave are given in Section 6.4. This assignment addresses two periodic signals:

• The square wave with duty cycle a:

$$s_1(t) = \begin{cases} A & if \quad 0 \le t < aT \\ 0 & if \quad aT \le t < T \end{cases}$$

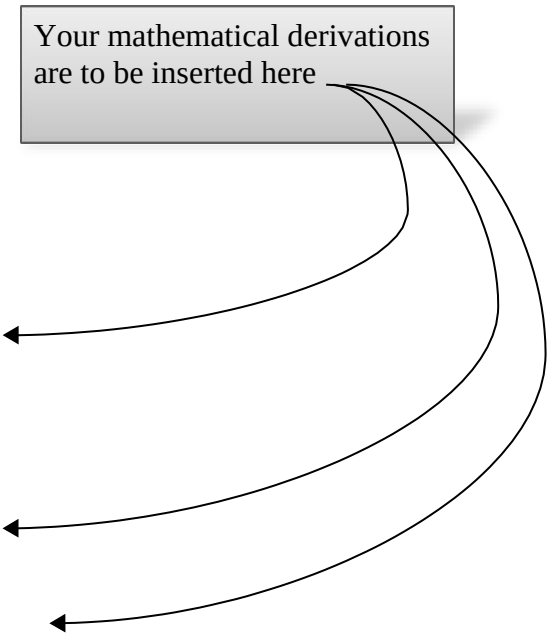
• The saw-tooth wave

$$s_2(t) = 2A\frac{t}{T} \qquad if \qquad -\frac{1}{2}T \le t < +\frac{1}{2}T$$

For each signal, analytically calculate the mean, the signal energy (MS) and the RMS. The answers will be expressions of the parameters, i.e. amplitude A, period T, and possibly the duty cycle a.

- Work out the expressions for these parameters in exactly the same level of detail as is done in the worked out examples in the lecture notes. Simplify the expressions as much as possible.
- Usage of an equation editor is **mandatory**. MATLAB-like expressions are forbidden.
- As an equation editor, you can use:
  - The built-in equation editor of MS-Word.
  - "MathType" (which is more user friendly than the built-in equation editor).
  - The online latex equation editors, like
    - http://www.sciweavers.org/free-online-latex-equation-editor
    - https://www.codecogs.com/latex/eqneditor.php

  Then you have to import images (jpg, png, eps) to your report. If you use this, make sure that the size of these images is correct.
- Be exact with the notation. For instance, the variables: **a,** *a,* **A,** and *A* are four different mathematical symbols. Each one may have its own connotation. So, don't mix them up.



Mean square wave

$$mean = \frac{1}{T}\int_{t=0}^{T} s_1(t)dt$$

$$= ....$$

Signal energy of the square wave:

$$signal\_energy = \frac{1}{T}\int_{t=0}^{T} s_1^2(t)dt$$

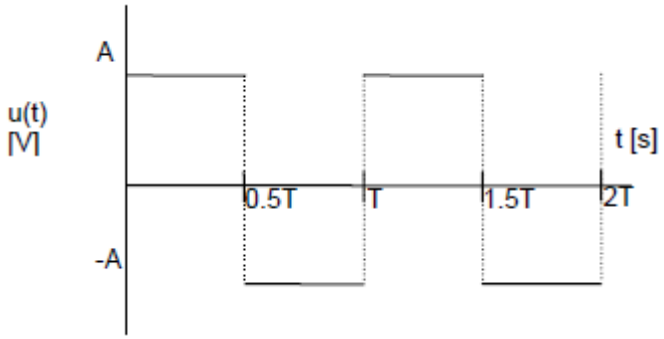
$$= ....$$

RMS of the square wave:

$$RMS = \sqrt{signal\_energy} = ...$$

Mean of the sawtooth wave: …

Part 2
Given is the following (periodic) square wave voltage u(t)



u(t) = A, 0 + nT ≤ t < T/2 + nT
u(t) = -A, T/2 + nT ≤ t < T + nT

Figure 4.1. (Periodic) square wave voltage u(t).

a) What is the instantaneous value of u(t) at t = T/4 and 16T/3?
b) What is the frequency of the signal? What is the angular frequency of the signal?
c) What is the amplitude and what is the peak-to-peak amplitude?
d) Calculate the mean value of the signal.
e) Calculate the RMS value of the signal.