Return as an email attachment to taneli.kalvas@jyu.fi no later than 21 February at 12:15 (before lecture). The email title should include FYSY115/Harjoitus 4. If the exercises are made with a partner include the names of the team.

Make each exercise to its own script/function file.

1. Write a function file, which goes through integer numbers $i = 1, 2, \ldots, 10$ in a loop. Within the loop one passes i to a subfunction as an argument. The subfunction contains a loop in which the index k starts from the value given in the argument and goes down in steps of 2 until zero. The subfunction sums the values of the index k and returns this sum. The main function prints out i and the value returned by the subfunction on a single line within the loop.

2. Often programs become more clear when logically separate parts are put to separate subfunctions. In this exercise we practise this by calculating a so called envelope to a signal. Write a function file in which you produce a time vector with times going from 0 to 10 seconds in $\Delta t = 1/100$ s steps. Produce a signal x in a subfunction. The signal is a 12 Hz sine when $t \in [3, 6]$ and zero elsewhere. Write another subfunction, which processes the signal. It rectifies the signal (takes the absolute value) and runs it through a low pass filter with cutoff frequency of 1.2 Hz. Show the original and the processed signal in the same graph.

3. Often one needs many different models in a computer simulation. Let us produce a model for a sledgeride downhill. The downhill needs to be monotonic, it starts at height 46 m and ends at 0 m. The derivative needs to be continuous. Produce the hill as a stepwise function using two constant value functions ($y = 0$ and $y = 46$) and half a period of a trigonometric function sine or cosine. The hill starts at $x = 5$ m and ends at $x = 280$ m. The function for the hill shape needs to be vector callable. Plot the result.

4. Prove to yourself that

$$\lim_{x \to 0} \frac{e^x - 1}{x} = 1$$

by calculating values using $x = 1, \frac{1}{10}, \frac{1}{100}, \ldots$. Set `format long` to see the decuimals and use a loop.

5. Produce a 1 second signal with 52.2 Hz square wave on 1000 Hz sampling frequency. The

square wave has $+1$ for half of the period and -1 the other half. You can calculate the phase of the wave at time t from the parity of the index $k = \text{floor}(2t/T)$, where T is the period of the wave. Calculate the fft-transformation of the signal. Show graphically the signal versus time and its power versus frequency in decibels.