Work 1
FREQUENCY ANALYSIS OF SIGNALS USING MATLAB

Group members: _____ and _____

Date: __ / __ 200_ Time _____ - _____ Assistant: _____

A) Getting acquaintent with Matlab

Remember, that the assistants are there to help and give guidance!
- Ask for help, if you get stuck into some point or your program doesn't work correctly.
- There are questions to be solved during the work. Assistant checks your answers and helps if needed.

There are some additional questions in this work that are marked with symbol @ to be solved in the report.

A1. ● Start Matlab, open Matlab's editor by typing 'edit' and write the following program listing:

```
%Setting sample frequency Fs.
Fs = 40;
%Setting time domain from zero to almost one second.
%Step size (time between samples) is 1/Fs.
t = (0:1/Fs:1-1/Fs);
%Signal to be sampled.
x = cos(2*pi*5*t);
%Printing to the screen.
plot(t,x);
%Putting grid on.
grid on;
%Making zoom (with mouse) available. Double clicking returns the original
%picture.
zoom on;
%Make the graph appear as the topmost window.
shg; %Show graphics.
```

Notice semicolons in the end of every command. Thanks to them the content of a vector doesn't print to the command window of Matlab.

● Study the listing above and use course material to answer following questions. After answering, call the assistant to check your answers!

How long is the time between samples (sampling period)? Ts = _____

How many samples are taken from a signal altogether? N = _____
(Hint: You can check the result in the command window by typing `max(size(t))`)

How many samples are taken from one period of signal? N1 = _____

@ What would the step size f_0 be in discrete frequency domain? f_0 = _____

● Save listing by name test1, assistant gives the right directory. Make sure that the saved file ends with .m, in other words check that there is a listing named test1.m in the directory. Don't close the editor, so you can easily make changes to the listing (macro).

● Run the file in Matlab. You'll get a graph reminding a sine wave. According to Nyquist's theorem the sample frequency is sufficcient, but for plotting there are too few samples. With plot-command Matlab connects points to each other with a straight line. If needed, Matlab shows sample points for example with *-marks (included in plot-commands parameters).

● Give more adequate value for sample frequency Fs in editor, save the file with the same name and run the file in Matlab.

With which value of Fs does the graph remind cosine wave? _____

● Change the frequency of sampled signal to 200 (Hz) and value of Fs to 1000 (Hz) .
● Add the following lines under the formula, before plot-command (notice big X!):

```
N = max(size(x);
X = abs(fft(x))*2/N;
```

Command fft makes a fast Fourier-transform to a time vector (the signal) based on N sample values. Abs-command calculates absolute values (amplitudes) for the transform from its complex form. Factor 2 scales the values of frequency vector (spectrum) X appropriate for a single-side spectrum. Division by N scales the spectrum values to be right ones.

● Add this command under the line just written:

```
F = (0:1:Fs-1);
```

With this command the frequency scale becomes right. The scale begins from zero, not from one. That's why Fs-1 in the end.

● Change plot to form:

```
plot(F,X);
```

● Save file by name test1 and run file in Matlab.

A3. ● Answer the following questions now. After answering, call the assistant.

Observations and explanations of the spectrum component at 200 Hz (amplitude and shape)? Remember to zoom!

Why is there a spectrum component also at 800 Hz?

● Change the frequency f to value 600 and run the listing. Explanation to phenomenon? How should listing be changed? Let the assistant check your answer!