Exercise: Nonparametric distortion analysis.

The goal of this exercise is to make a nonparametric distortion analysis of a nonlinear system

A. Setup of the excercise: generate the data in matlab

1) Generate the system G_0:

```
[b0,a0] = cheby1(2,10,2*0.1);b0(2) = b0(2)*1.3; Make a Bode plot
of this system.
```

and

$$f(x) = x + \frac{x^2}{100} + \frac{x^3}{10}$$

2) Define the noise generating filter:

```
[bNoise,aNoise] = butter(1,2*0.1);
bNoise = bNoise+0.1*aNoise;bNoise=bNoise/100;
```

3) Generate a random odd multisine (see slides lesson) with a period length N points, up to 1/6th of the sample frequency (the sample frequency can be normalized to be equal to 1).
Scale the rms value of the signal to be equal to 1, and generate $M = 3 + 1$ periods.

The first $N_{\text{Trans}} = N$ points of the simulation period are used to eliminate all transient effects in the simulation. Check for the presence of transient effects by subtraction the last period from the first period of the data.

4) Generate $y_0, v(t)$: $p(t) = G_0(q)u_0(t))$ $y(t) = f(p(t)) + v(t)$ with $v(t) = G_{\text{noise}}(q)e(t)$ filtered white noise $e(t) \sim N(0, 1)$. Eliminate the first N_{Trans} data points so that 3 periods remain. Verify that no visible transients are present.

B. Task

1) Make a nonparametric distortion analysis, using the graphical representation as explained in the lesson. Choose the period length N such that the results have a good frequency resolution.
2) Plot the amplitude spectrum of the input signal on a linear scale, and verify if the even and odd detection lines have zero amplitude.
3) Discuss what happens if the amplitude of the excitation varies. Analyze the distortions and noise levels for different excitation levels.
4) What excitation level can be used, if a linear model will be used and an error of 10% rms on the output can be tolerated?
5) Provide a pdf-file of your rapport.