Fourier Synthesizer for Time-Periodic Signals

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1.0 Introduction

This report has been written in order to give you a result of our project till this time , which are many time periodic signals by using Matlab Program.

1.1 What is the Fourier Synthesizer

1.1.1 Definition

Fourier synthesis can be known as the inverse of Fourier analysis, in other words we can generate a signal by adding the fundamental frequency to the harmonic components.

1.1.2 Why it's important

It's important because we want to achieve many type of signals such as square ,triangular ,saw tooth ,…… But in fact we can build any type of signal we want by combine the two main signals (cos & sin) and play with the number of harmonic components

2.0 Aim & Objective

▪The Aim of the project is to Design and implement a Matlab-based program for synthesizing different periodic signals. This involves:

1- Finding the Sinusoidal Fourier Series of commonly-used periodic signals.

2- Convert derived expressions into Matlab code.

3- Analysis of Matlab program to study effect of increasing harmonics.

4- Build a Graphical-User Interface to facilitate the use of the program.

3.0 System functionality

Input & User Interface

The program will calculate the Fourier series constants an & bn of the periodic signals
After that it will calculate the Fourier series summation of the periodic signals.
The user should Select the type of signal than he can Insert the number of harmonics & Input frequency and the number of cycles

Output

The Matlab plot the approximate shape of the entered signal ,The project includes also many methods to select the good harmonics and reject the others .

4.0 Project specification

❖ **Stage 1 :-**

Implement our initial program in the Matlab ,that is designed to get a periodic signal.
- the user should insert his function & open the program each time to enter frequency and harmonics then save it.

❖Stage 2 :-

Instead of writing the expression of the function,
The program use Fourier series to find the summation of the coefficients to draw the shape.

❖Stage 3 :-

We develop the program to ask the user automatically to insert
1.Frequency
2.Number of harmonics
3.Number of cycles

Rather than opening the program to change the coefficients and save it which is wasting the time .

❖Stage 4 :-

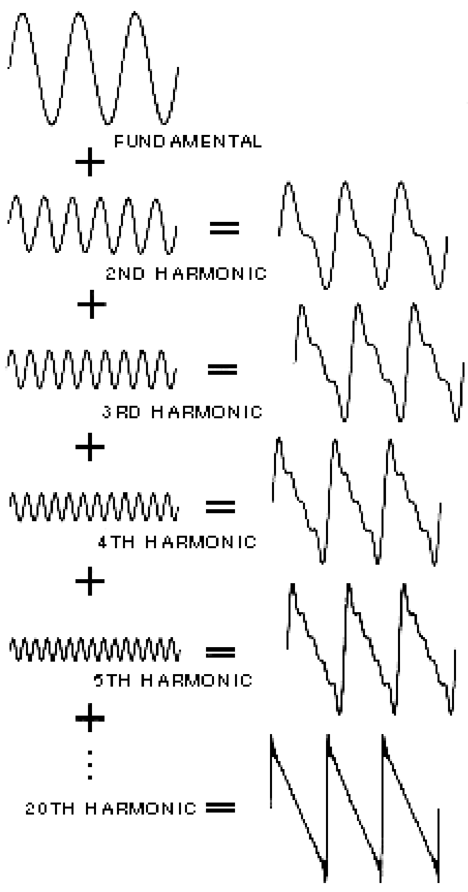
Build different type of signals

In this stage we search for the Fourier series constants an & bn have been obtained from a number of references. Emphasis has been on commonly-used periodic signals in communications applications.

Effect of harmonics

Here we see the fundamental frequency and We add more harmonic component to get the Required shape

As the number of terms or harmonics is Increased the graph of the Output (the shape of the signal become More accurate .



5.0 Results

This is Matlab program is to generate many type of periodic signal , Just by choosing the values of the coeffiecnt of the fourier series then put it in this program to get the required signal :-

```
% This sample program calculate the Fourier series approximation of a Bipolar
%Function

clc;
clf;
clear all;
close all;

freq=input('Enter the frequency of the periodic signal to be generated freq=');
N=input('Enter the number of harmonics N=');
cycles=input('Enter the number of cycles to be plotted cycles=');

T=1/freq;                    w0=2*pi/T;
t_initial=-T*cycles/2;
t_final=T*cycles/2;
step=(t_final-t_initial)/1000;
t=[t_initial:step:t_final];

a0=0;

for n=1:N
    a(n)=0;
    b(n)=2/(n*pi)*(1-cos(n*pi));
end;

for ii=1:length(t)
   func(ii)=a0/2;
   for n=1:N
      func(ii)=func(ii)+a(n)*cos(n*w0*t(ii))+b(n)*sin(n*w0*t(ii));
   end;
end;

maxvalue=max(func);
func=func/maxvalue;

x_time=[t_initial t_final];
y_time=[0 0];

x_amp=[0 0];
y_amp=[-1.25 1.25];
```

```
plot(t,func,x_time,y_time,'k',x_amp,y_amp,'k');

axis ([t_initial t_final -1.25 1.25]);
Title('bipolar Function');

xlabel('Time t');
ylabel('Function Value');

end;
```

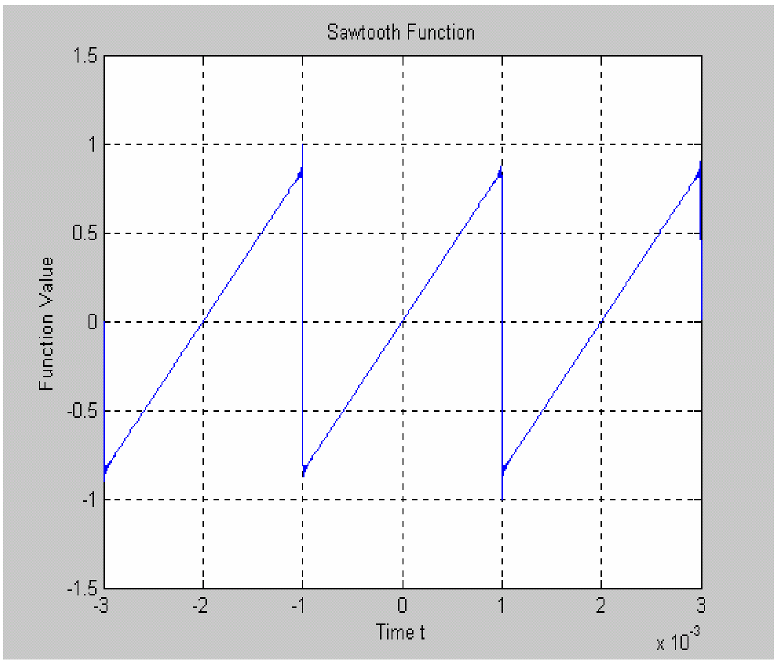
Example of sawtooth signal :-

The coefficients to be used and inserted by the user

$$a_0 = 0$$

$$a_n = 0$$

$$b_n = 2*\cos(n*\pi) / (n*\pi)$$



Example of triangular signal :-

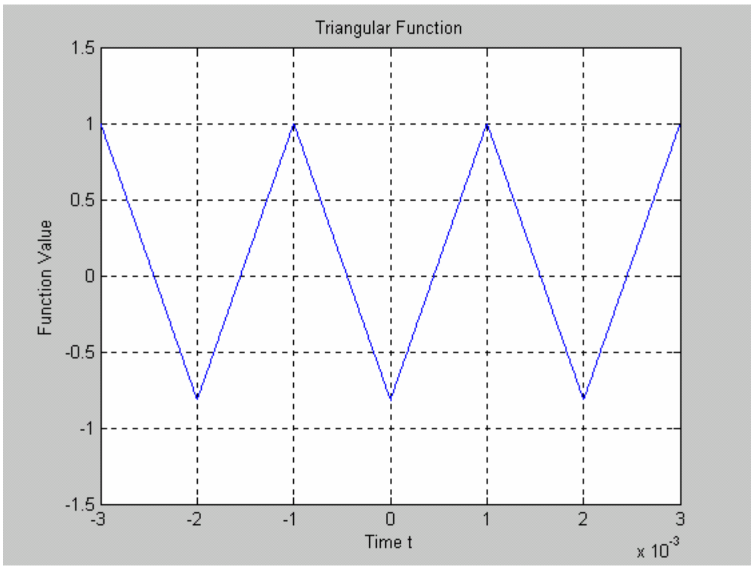
The shape of the signal

The coefficients to be used and inserted by the user

$a_0 = 3*\pi$

$a_n = \dfrac{6}{n^2*\pi*(\cos(n*\pi)-1)}$

$b_n = 0$



Example of Square signal :-

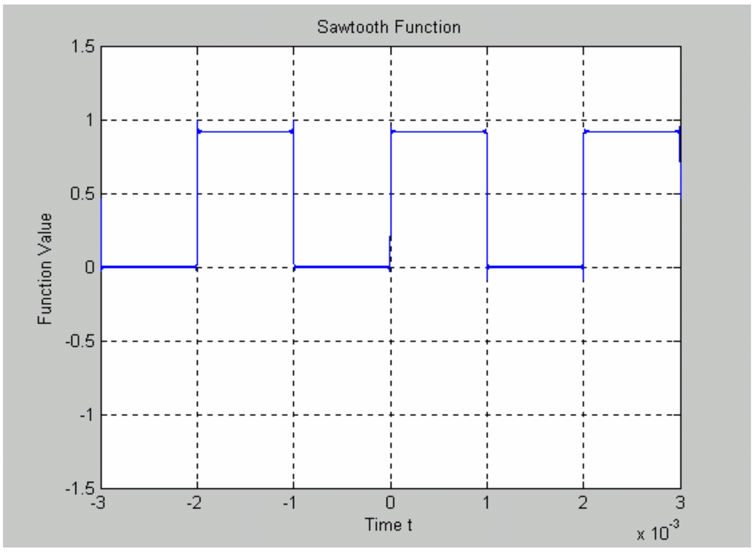
The shape of the signal

The coefficients to be used and inserted by the user

$a_0 = 0$

$a_n = 0$

$b_n = \dfrac{1}{(n*\pi)*(1-\cos(n*\pi))}$



Example of Bipolar signal :-

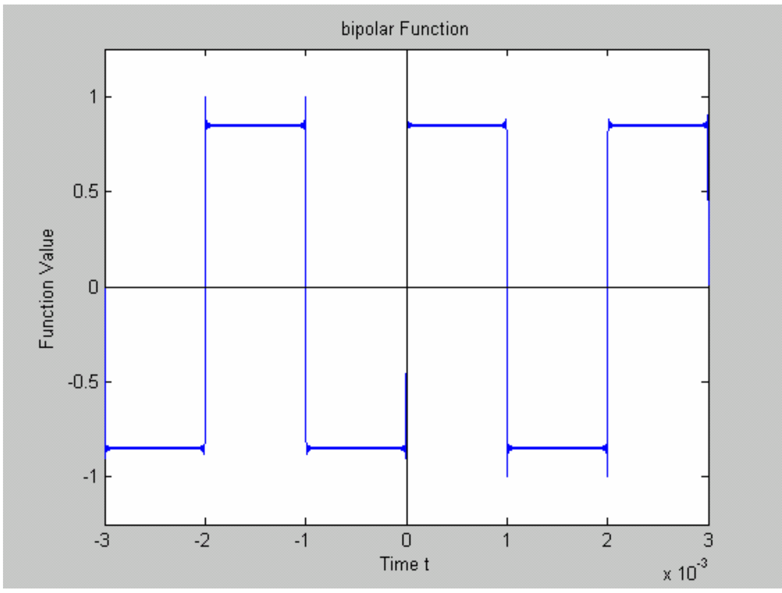
The shape of the signal

The coefficients to be used and inserted by the user

$$a_0 = 0$$

$$a_n = 0$$

$$b_n = \frac{2}{(n*\pi)*(1-\cos(n*\pi))}$$



Example of Rectified sin signal :-

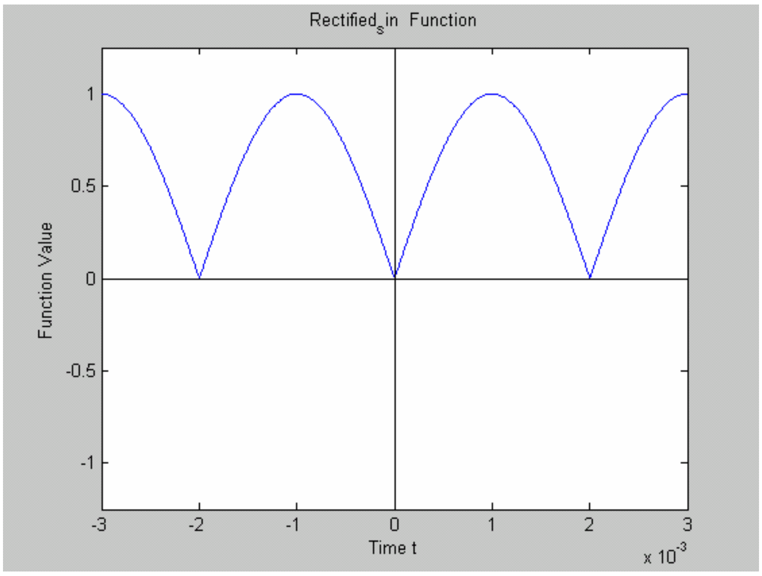
The shape of the signal

The coefficients to be used and inserted by the user

$$a_0 = -4/\pi$$

$$a_n = \frac{-4}{(\pi*(n^2-1))}$$

$$b_n = 0$$



Example of comb signal :-

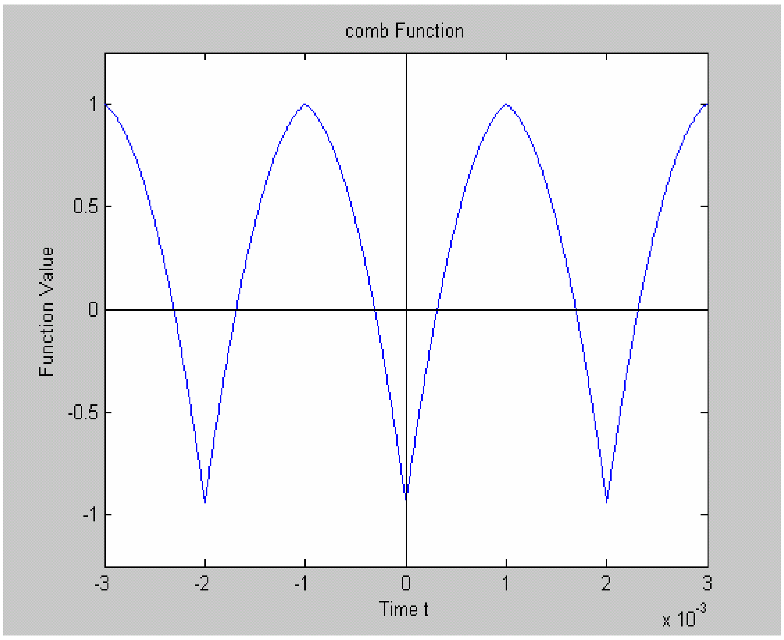
The shape of the signal

The coefficients to be used and inserted by the user

$$a_0 = 1 + (\pi/2)$$

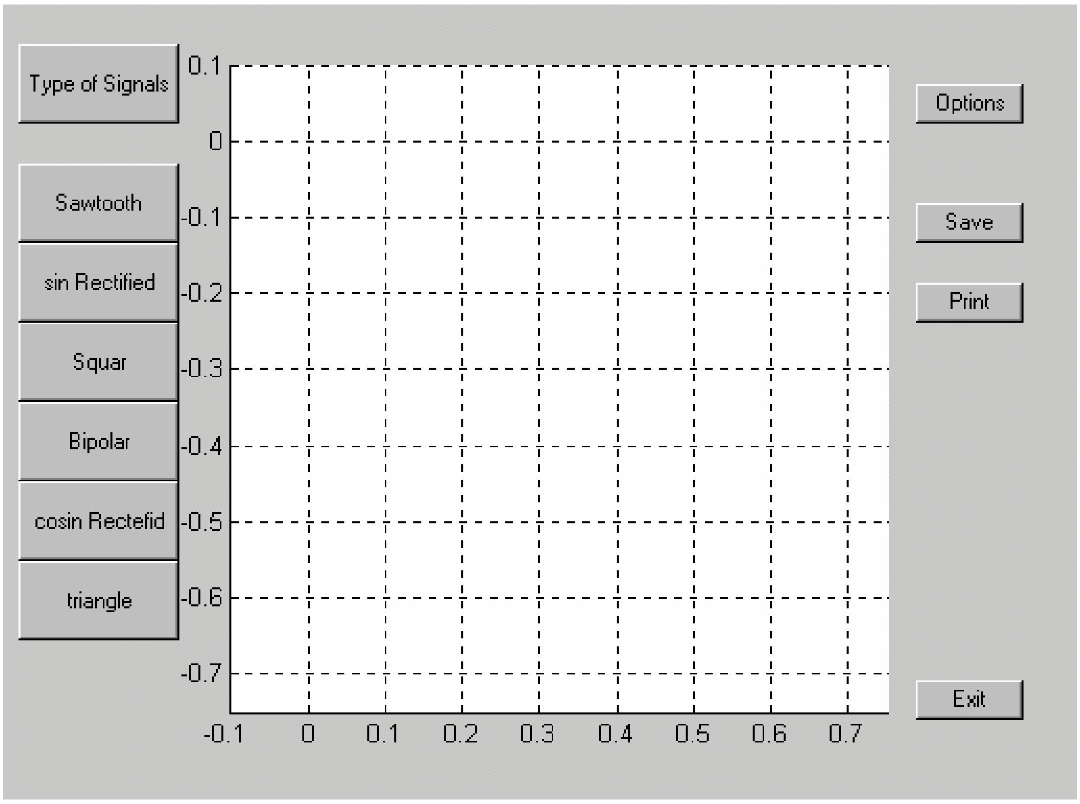
$$a_n = \frac{\cos(n * \pi)}{((n^2 * \pi) - 1/(n^2 * \pi)}$$

$$b_n = 0$$



6.0 Final System

Graphical User Interface



Graphical user interface is one of the most important part in the project because it use to collect all the type of signal and other options (such as starting simulation, plot , save or exit from the program) to make the program easy to use rather than putting each signal individually and wastes the user time ,

7.0 Immediate tasks

6	Complete Program for one type of signals
7	Generalize the program for more periodic signals
8	Test the program for different cases
9	Continue testing of program & Progress Presentation

Conclusion

❖Project schedule has been followed without delays

❖Different periodic signals have been synthesized individually

❖Project tasks will be completed when the graphical user interface design is finished.

❖This will be followed up with the writing of the final project report.

Reverences

- Norman Morrison ,introduction to fourier analyses ,john wiley &SONS, INC , USE

- Further Engineering mathematics ,3rd edition , by K.A.Stroud

- Engineering mathematics , 3rd edition , By ANJ-TUMA