

STUDENT FEEDBACK FORM-CHRIS STONELAKE

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Your work show little evidence of reading and reliance on inappropriate sources. Views and findings mostly unsupported and non-authoritative. Referencing conventions used incoherently or largely absent.	15	5
2. Knowledge and Understanding Skills		
Task 2 calculations shows good effort and good understanding of the topics covered. Good structure, detail and data presented in clear and appropriate format (in task 2).	20	17
3. Cognitive and Intellectual Skills		
Your work showed that you can summarise scientific facts into your own words. There is a coherent flow in the writing and the reader can easily follow the calculation process and the analysis of the results. You have made attempts at drawing conclusions for the area you studied.	20	15
4. Practical Application Skills		
A good and appropriate application of established methods and techniques. The report clearly demonstrates the student has a clear understanding of studies to date and also shows the student's ability to work as an individual. Good detail provided throughout the report with all aspects being suitably and sufficiently carried out. Not all tables and figures presented are thoroughly discussed in the assignment.	20	15
5. Transferable Skills for Life and Professional Practice		
Mostly ordered presentation and structure in which relevant concepts are reasonably expressed. Demonstrates the basic skills for employment requiring the exercise of personal responsibility and decision-making, with some areas of minor weakness.	25	14

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

66%

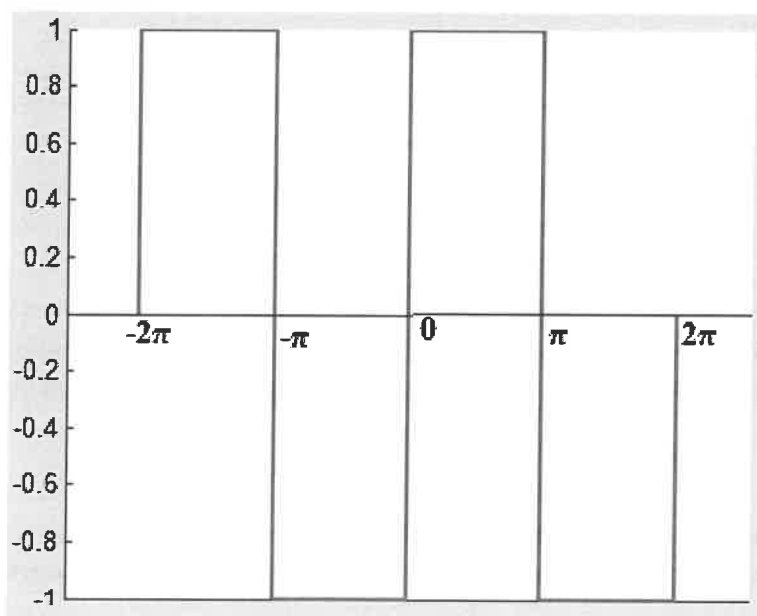
1. Briefly define Fourier series and Fourier Transform. Explain the importance of Fourier Transform in the field of engineering.

A – Fourier series is a representation of a wave form or other periodic function as a sum of sines and cosines. It is named after the French mathematician and physicist Jean-Baptiste Joseph Fourier, since sound waves are made up of sine waves, Fourier transforms are widely used in signal processing.

A Fourier series is a way to represent complex waves, such as sound, as a series of simple sine waves. The series breaks down a wave into a sum of sines and cosines. This means that elements of a wave can be isolated from each other. The field of Fourier analysis is the study of various Fourier series. The practice of isolating a signal into individual frequency's is known as a Fourier Transform.

Virtually everything in the world can be described via a waveform – a function of time, space or some other variable. For instance, sound waves, electromagnetic fields, the elevation of a hill versus location, a plot of VSWR verses frequency, the price of your favourite stock versus time, etc. the Fourier Transform gives us a unique and powerful way of viewing these waveforms.

2. Explain then show using a suitable graph method how the Fourier series expansion for a square wave is made up of a sum of odd numbers.



3. Given $f(x)$ is a function representing a complex wave with a period of 2π .

Continuation of question 3 hand writing formula.

$$f(x) = \begin{cases} 1, & -\pi < x < 0 \\ 0, & 0 < x < \pi \end{cases}$$

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} [a_n \cos nx + b_n \sin nx]$$

$$a_0 = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) dx$$

$$a_0 = \frac{1}{\pi} \int_{-\pi}^0 f(x) dx + \frac{1}{\pi} \int_0^{\pi} f(x) dx$$

$$= \frac{1}{\pi} \int_{-\pi}^0 1 dx + \frac{1}{\pi} \int_0^{\pi} 0 dx$$

$$= \frac{1}{\pi} [x]_{-\pi}^0$$

$$= \frac{1}{\pi} (\pi)$$

$$= 1$$

$$a_0 = 1 \quad \checkmark$$

$$a_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \cos nx dx$$

$$a_n = \frac{1}{\pi} \int_{-\pi}^0 f(x) \cos nx dx + \frac{1}{\pi} \int_0^{\pi} f(x) \cos nx dx$$

$$a_n = 0 + \frac{1}{\pi} \left(\left[\frac{\sin nx}{n} \right]_0^{\pi} \right)$$

$$a_n = \frac{1}{n\pi} [\sin(n\pi) - \sin 0]$$

$$a_n = \frac{1}{n\pi} [0]$$

$$a_n = 0 \quad \checkmark$$

$$bn = \frac{1}{\pi} \int_{-\pi}^{\pi} f(x) \sin nx \, dx$$

$$bn = \frac{1}{\pi} \int_{-\pi}^0 \sin nx \, dx + \frac{1}{\pi} \int_0^{\pi} f(x) \sin nx \, dx \quad \checkmark$$

$$bn = \frac{1}{\pi} \int_{-\pi}^0 \sin nx \, dx + \frac{1}{\pi} \int_0^{\pi} 1 \sin nx \, dx$$

$$bn = \frac{1}{\pi} \left[-\frac{\cos nx}{n} \right]_0^{\pi}$$

$$bn = \frac{-1}{n\pi} [(\cos nx)]_0^{\pi}$$

$$bn = \frac{-1}{n\pi} (\cos n\pi - \cos -0)$$

$$bn = \begin{cases} 0 & \text{if } n \text{ is even} \\ \frac{2}{n\pi} & \text{if } n \text{ is odd} \end{cases} \quad \checkmark$$

$$s(x) = \frac{1}{2} + \frac{2}{\pi} \sin x + \frac{2}{3\pi} \sin 3x + \frac{2}{5\pi} \sin 5x + \frac{2}{7\pi} \sin 7x + \frac{2}{9\pi} \sin 9x + \frac{2}{11\pi} \sin 11x \\ + \frac{2}{13\pi} \sin 13x$$

$$\frac{2}{\pi} \sin x = 0.636$$

$$\frac{2}{3\pi} \sin 3x = 0.212$$

$$\frac{2}{5\pi} \sin 5x = 0.1275$$

$$\frac{2}{7\pi} \sin 7x = 0.090$$

$$\frac{2}{9\pi} \sin 9x = 0.0707$$

$$\frac{2}{11\pi} \sin 11x = 0.057$$

$$\frac{2}{13\pi} \sin 13x = 0.0489 \quad \checkmark$$

The above seven values is the data input used for the 1-7 the harmonics in my square wave experiment, as stated in the review section of this assignment I further continued to expand the input data harmonic up to the 15th, as follows;

$$\frac{2}{15\pi} \sin 15 x = 0.042$$

$$\frac{2}{17\pi} \sin 17 x = 0.037$$

$$\frac{2}{19\pi} \sin 19 x = 0.035$$

$$\frac{2}{21\pi} \sin 21 x = 0.030$$

$$\frac{2}{23\pi} \sin 23 x = 0.027$$

$$\frac{2}{25\pi} \sin 25 x = 0.025$$

$$\frac{2}{27\pi} \sin 27 x = 0.0235$$

$$\frac{2}{29\pi} \sin 29 x = 0.021$$

The input of the additional harmonic harmonics above into daisy lab can be seen in the following images 7 – 10, which in the assignment summery will deliver the finding of the increase number of harmonics has on the wave.

4. Verify the spectral analysis in task 3 by re-creating the waveform by using suitable.

From question 3 and producing our first 7 harmonics, below are the results from the data input into daisy lab.

Image 1

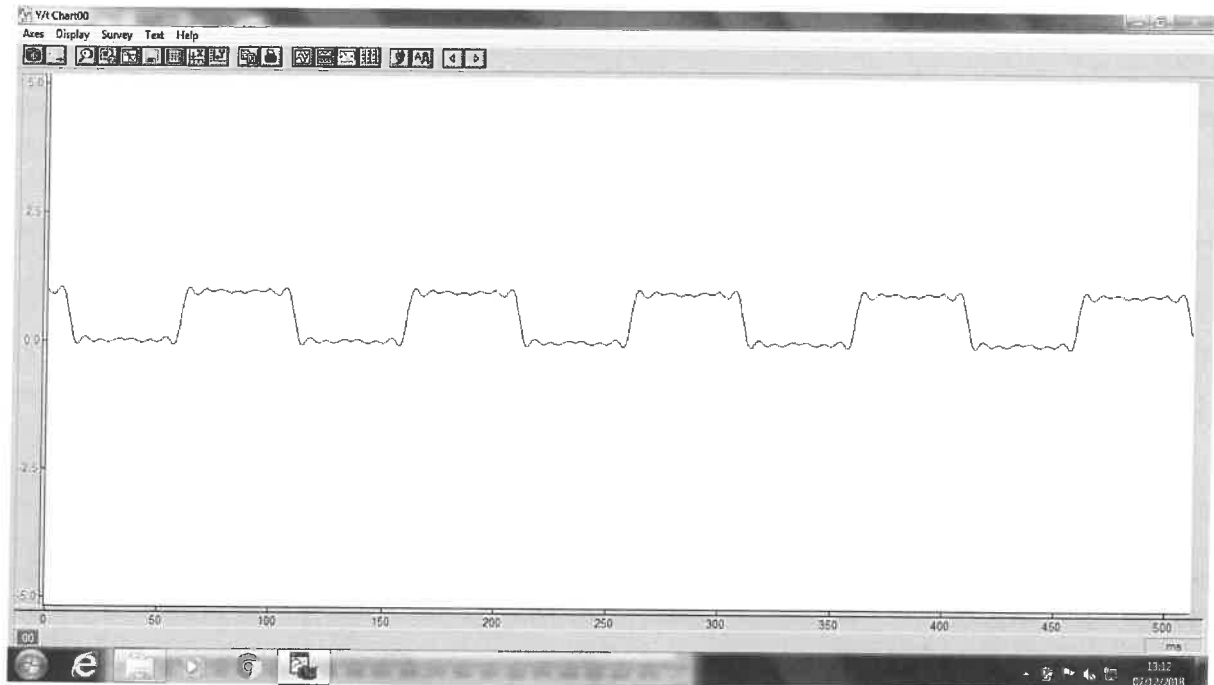


Image 2

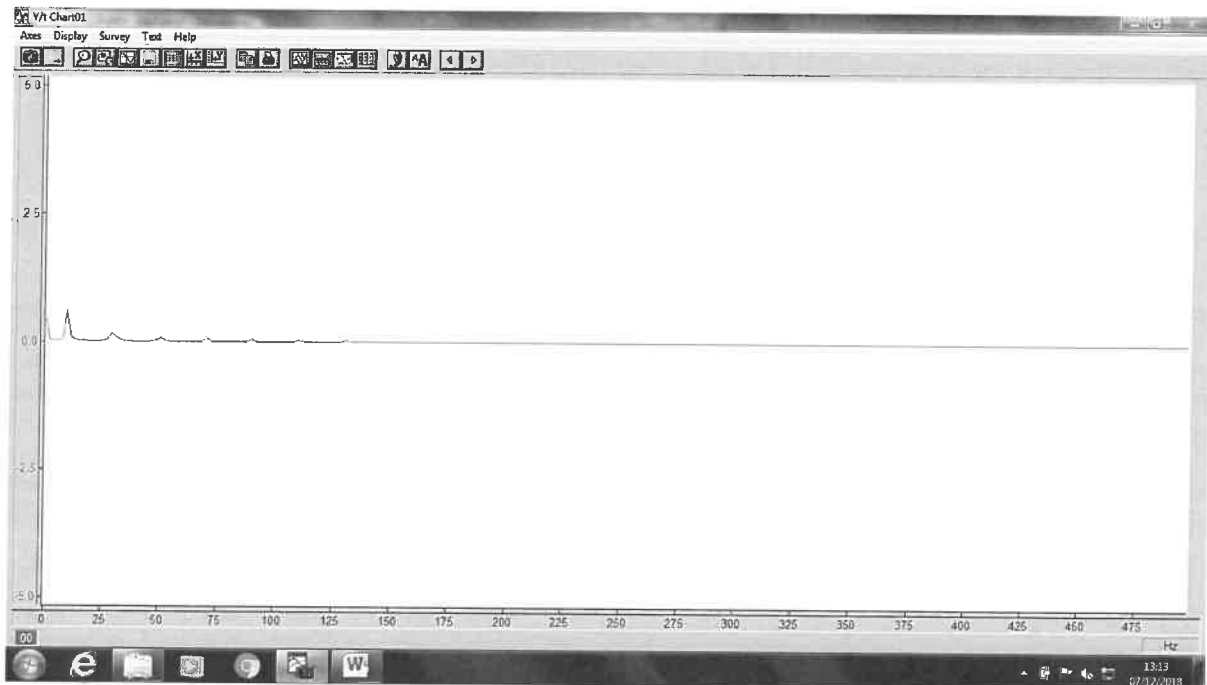


Image 3

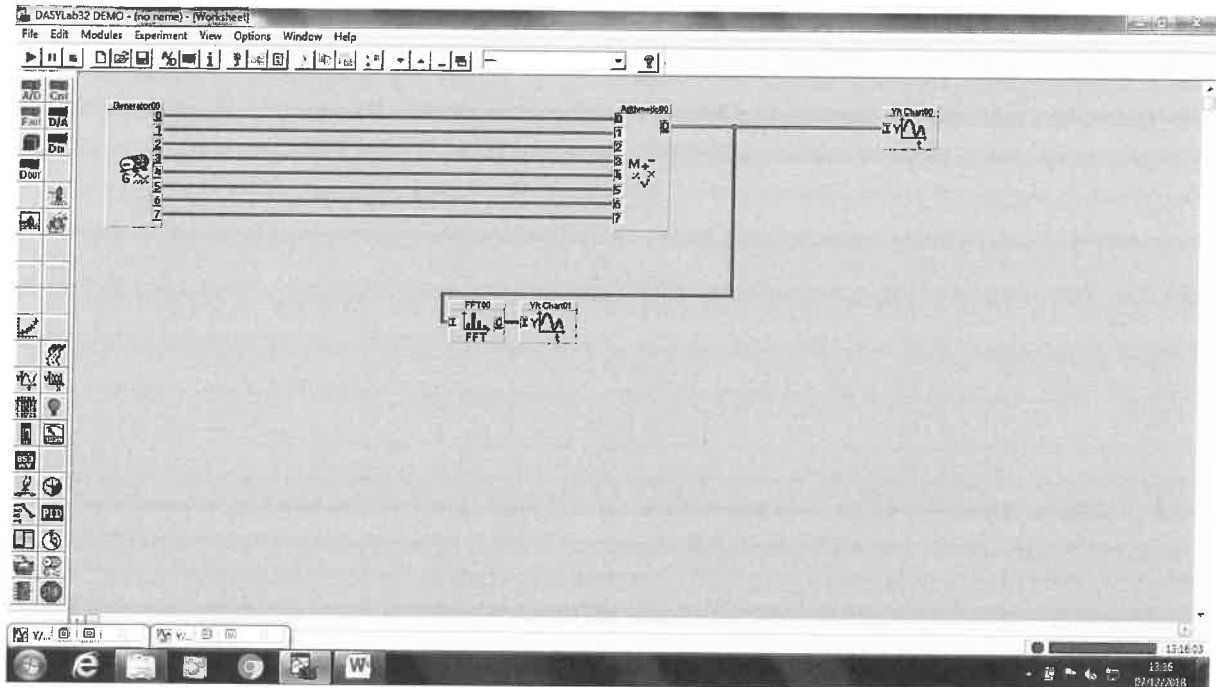


Image 4

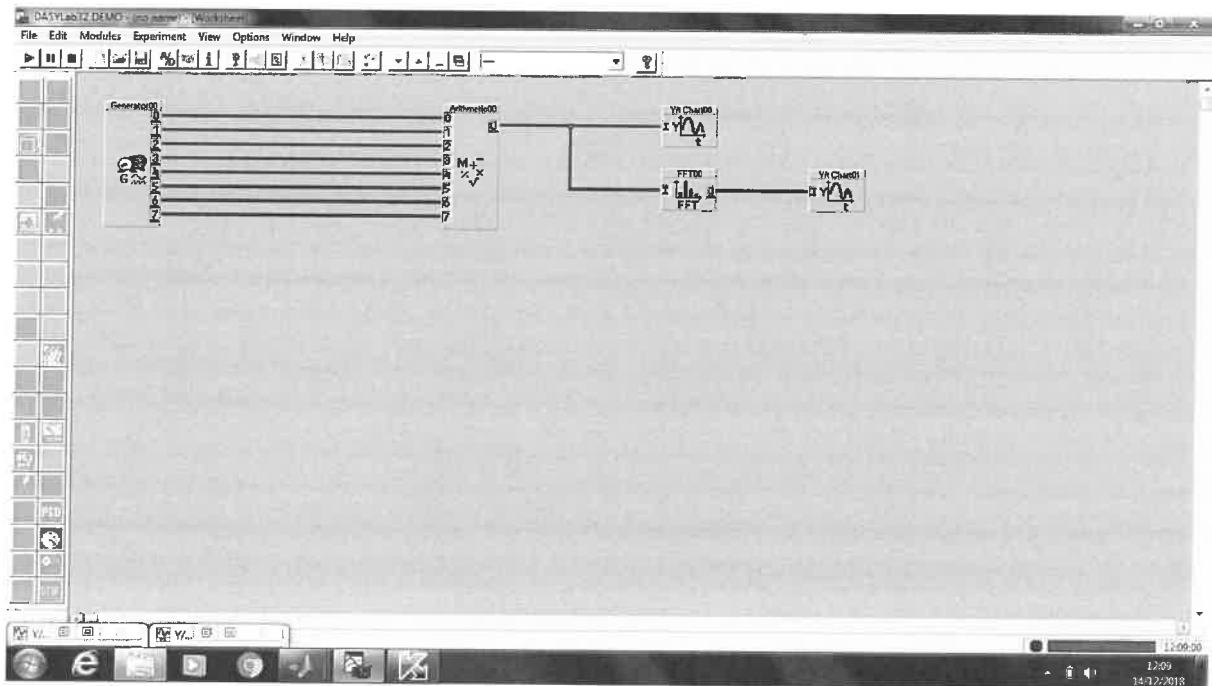


Image 5

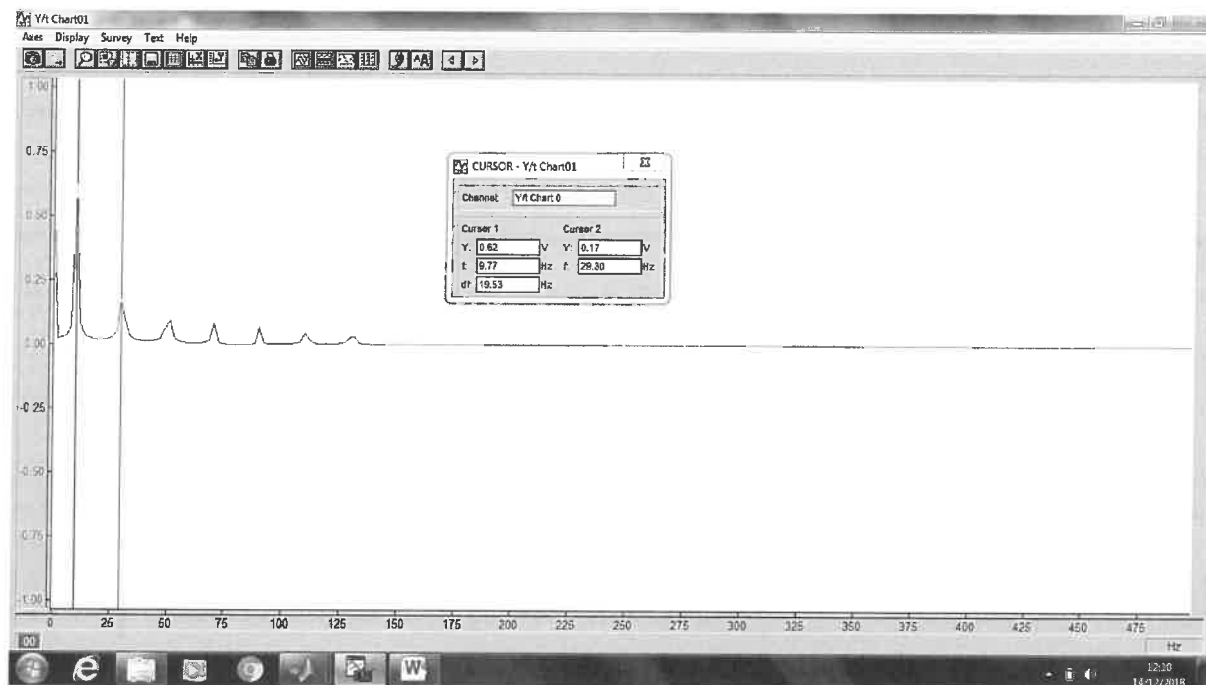
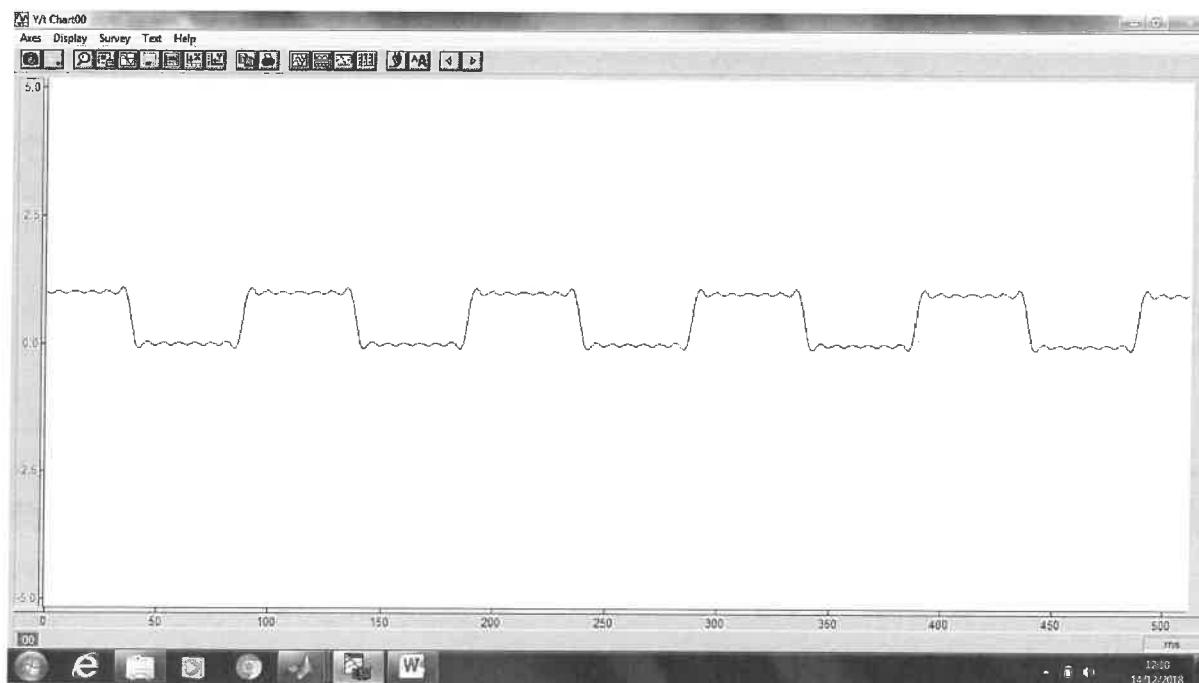


Image 6



Below adding more frequency's the better the quality of the square wave below we have up to 12 frequency's

Image 7

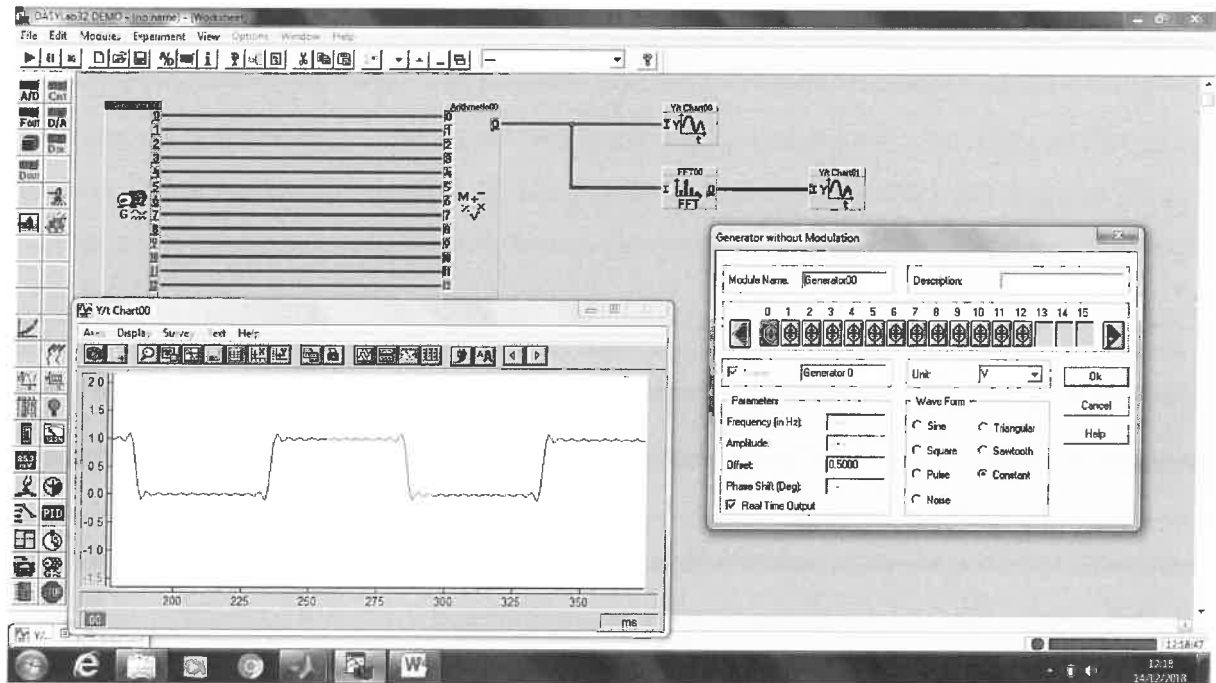
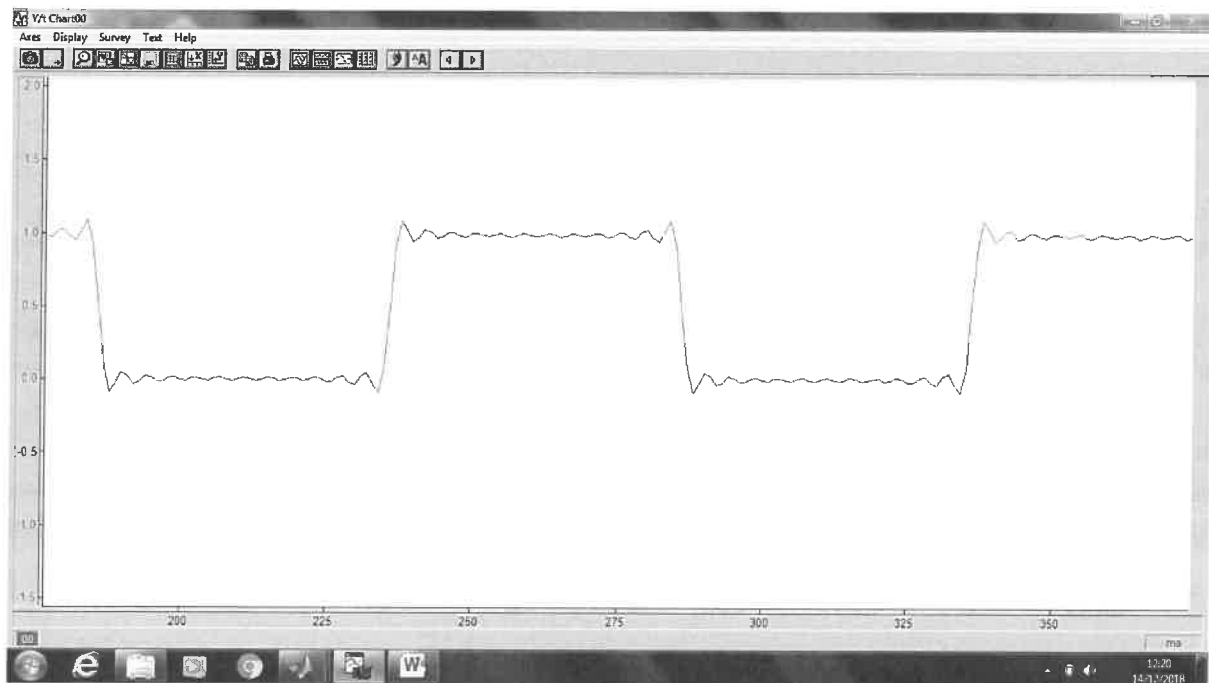


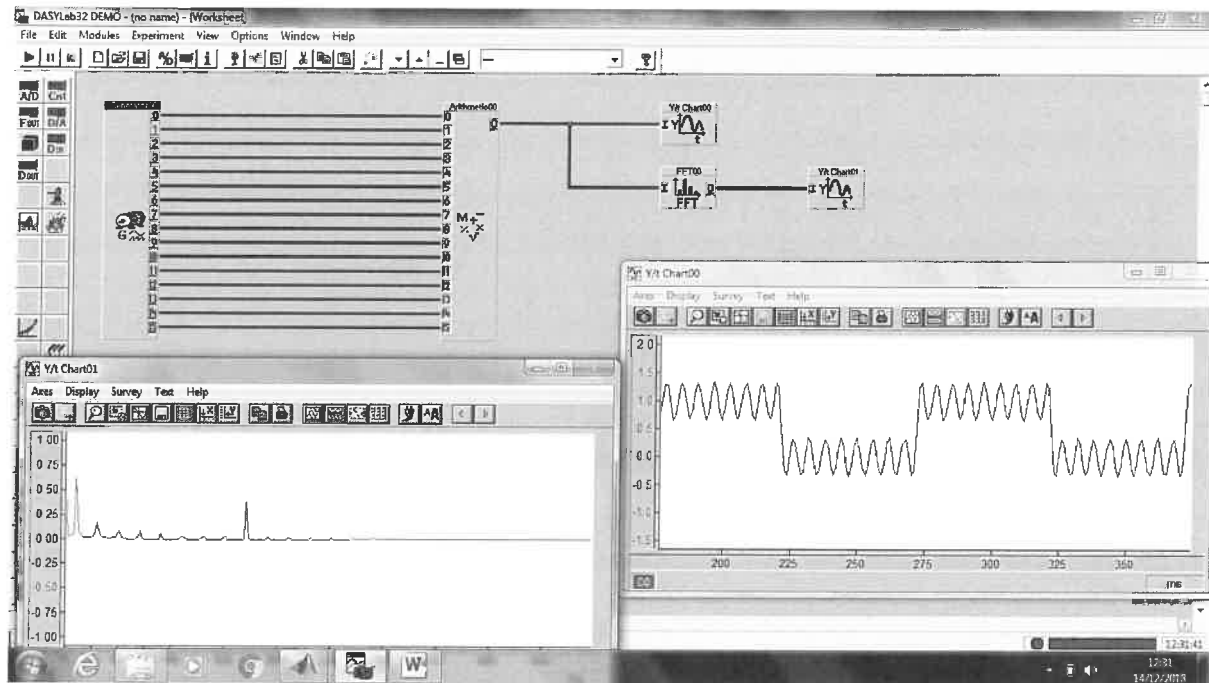
Image 8



The below shows the wave developing from 12 frequency's to 15 frequency's, I also reduced the numbers from the decimal space on the amplitude vale to try and produce better square

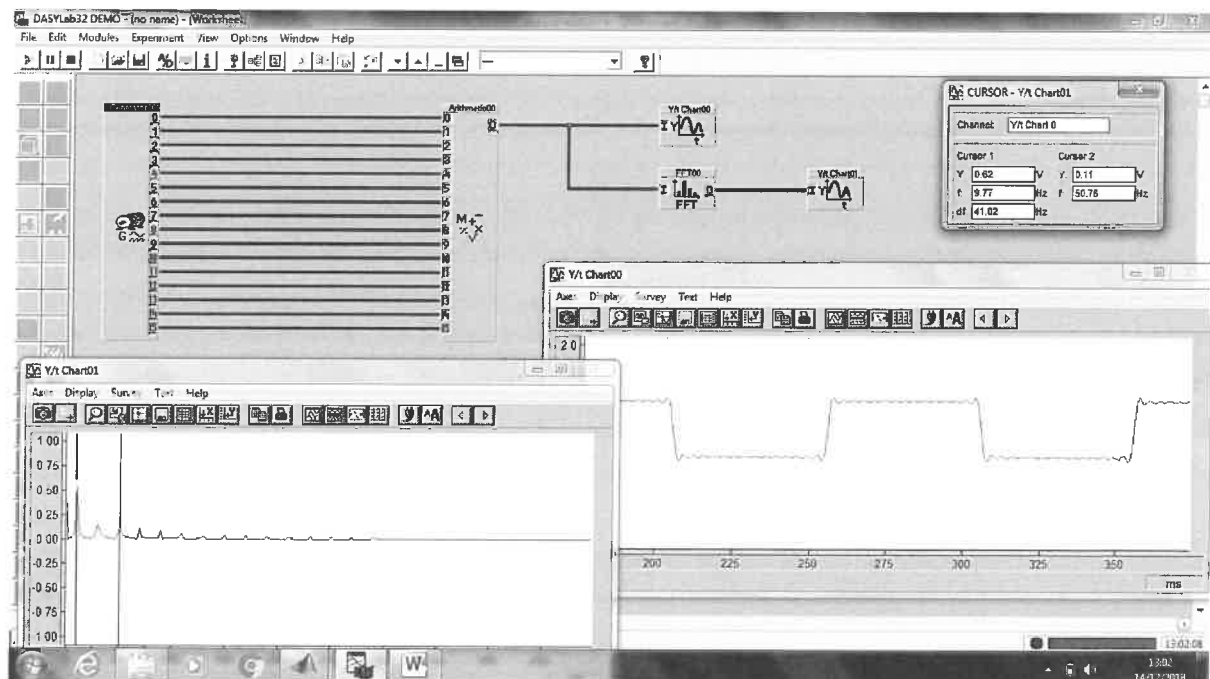
waves, from the below unfortunately the wave still remained in some unity to a square pattern but the horizontal wave lines loss a lot of form as seem below;

Image 9



For my next experiment I will introduce digits up to 5 spaces after the decimal point;

Image 10



Experiment Review

From the experiment conducted spectral analysis as required in task 4, we were to set up using the daisy labs software to create waveform's by inputting the data generated by the equation in task 3.

Information was input into the software daisy lab's up to the first 7 harmonics, from image 1 we can see the square wave form is quite uniform which is almost impossible to achieve, to continue the experiment going forward I continued to add additional inputs to create more wave forms on Daisy labs software you can see this input increase from images 5-8.

The increase was taken up to 12 harmonics our additional values were taken from expanding on my Fourier trigonometric series representation of the function (12 harmonics).

As we can see in image's 7&8 the square wave has a less distorted vertical section than that compared to the images 1 & 2, so adding the additional 5 harmonic's we have slightly improved the overall square frequency to have less distortion.

Given the improvement on the additional frequency's been added to the software, it was taken on theory that if I was to continue to add additional frequency's we could potentially improve the square wave shape even further, to input the additional vales for each harmonic's I continued the Fourier trigonometric series representation of the function (15th harmonic).

Once my calculated vales where produced I continued to add these values and input in to daisy labs software for the remaining 13, 14 & 15th harmonics, this is represented in images 9 & 10, upon the input of the additional information it was seen quite clearly that the wave band unfortunately went the opposite desired effect and thrown the wave form into complete distortion as seen in image 9.

The initial results were very disappointing by going up to the 15th harmonic as this produced a very un-uniform wave, further adjustments were then made to the data inputs across the 15 data points for each harmonic input value to try and arrange the numbers and rounded to the closest decimal place.

From rounding the inputs down to the closest decimal place the results were surprisingly improved as seen in the image 10, is as we can agreed is a lot better than compared to image 9.

To sum up my findings I believe it is very hard if not impossible to achieve a true square wave where the horizontal lines are perfectly flat, you will have always imperfections, as most engineer's know square waves are formed by the summation of all odd harmonics of fundamental frequency's. Unfortunately, function generators do not have infinite bandwidths and cannot include all harmonics of a fundamental frequency in shaping the rise and fall times of a square wave. So, a real-world square wave will have less than perfect rise / fall times. This then begs the question, "When is a square wave, square?"

References

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