COMS21202 – Symbols, Patterns and Signals

Problem Sheet A: Representations and Features

1 – Using *sin(2πnx)*, demonstrate the concept of superposition as follows:

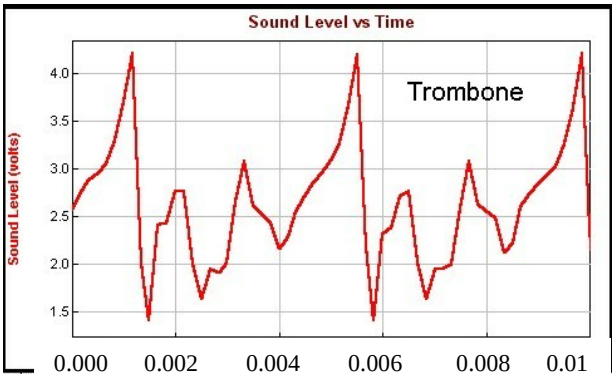
(a) first plot three sine functions over the range ±3 in steps of 0.1 using *n={1/4,1,2}*. Note, plots should appear in the same graph to give a better sense of what is happening.

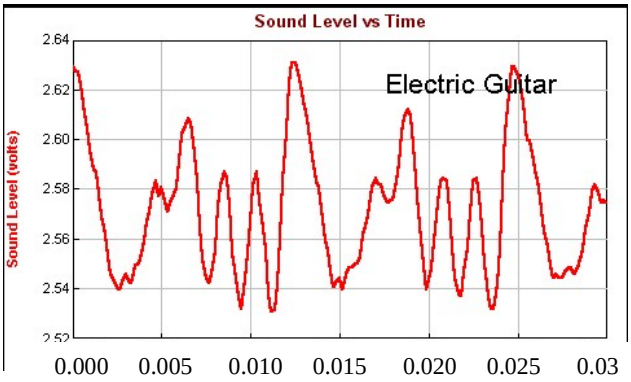
(b) Now plot in a different colour the sum of all the sines above.

(c) Add more sine functions over the same range and repeat step (b).

2 – What is White Light? Illustrate your answer with an approximate graph.

3 – The graphs below display the amplitude of the sound wave for a Trombone and an Electric Guitar as a function of time. The y-axis is the amplitude axis and the x-axis is the time axis. Notice that each one is plotted over a different length of time.





(a) Mark the period of the signal for each instrument.

(b) Approximately, how many periods are shown in these graphs for each instrument?

(c) Approximately, what is the peak amplitude in each case?

(d) Approximately, what is the frequency given the signal period in each case?

(e) Which signal contains higher frequency information? Why?

4- Determine which is an even and which is an odd function:

(i) $f(x) = 7x^3 - x$

(ii) $f(x) = 3x^2 + 1$

(iii) $f(x) = 3x^2 \sin(x)$

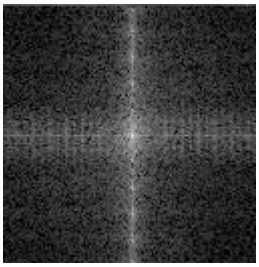
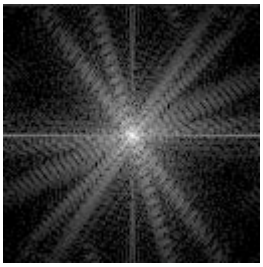
(iv) $f(x) = \dfrac{3}{(-x)^4 - 4}$

(v) $f(x) = \cos(x) + 5x \quad -3$

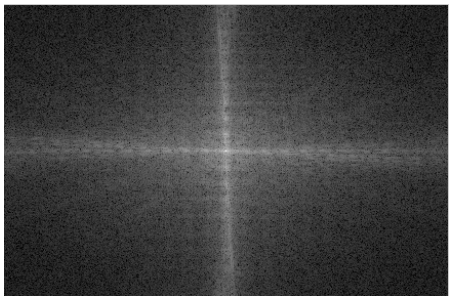
5 – Consider the two images (Sugar and Bricks) on the left. Identify which of the Fourier spaces (FS1 and FS2) on the right belongs to which image and explain clearly why.

Sugar **Bricks** **FS1** **FS2**



6 – The figure below on the left shows an image of a building wall, with its Fourier Space magnitudes shown in the middle. A reconstructed image (inverse FFT image), after some manipulation of the Fourier magnitudes, is shown on the right. How should the Fourier space be manipulated (e.g., what kind of a mask could have been applied to it) to achieve this reconstructed result? Include a sketch to illustrate your answer.


7 – The following gene sequence contains significant frequencies. Design two different symbolic encodings and in each case apply your encoding to extract some of these frequencies.

ACAGAGATACAGAGATACAG . . . . .