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Faculty of Science and Engineering

Department of Electrical and Electronic Engineering

EEEE2051

Modelling Methods and Tools

Coursework 1: Fourier Transforms (24-25)

Report

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# Fourier Transform of signal

## Fourier Transform derivation

General formula to perform Fourier Transform, FT of :

Whereby is the signal in time domain (refer Figure X),  is the angular frequency of the signal.

A graph with a line

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Figure 1‑1 Time domain signal of signal S2(t)

Based on the signal’s shape, piecewise linear function can be obtained:

By substituting the piecewise linear function into equation(X):

By eliminating the integral involving multiple of zero:

By evaluating the definite integral:

By substituting the limits:

By combining the fraction:

From Euler’s identity, we know that:

Therefore:

By substituting the obtained derived Euler’s identity equation into equation:

By multiplying in both numerator and denominator to eliminate the in denominator:

Separating sine terms and cos terms to express equation in the form of ):

## Fourier Transform derivation – checking your answer

Based on waveform, it can be derived as the addition of two different function with same amplitude but different shift and width, hence we’ll represent as the one with lower amplitude and another one with higher amplitude, called as .

From Figure X, we know the minimum amplitude for addition between each function, , is given by:

Since proposed and function have a much smaller width compared to the original , we’ll apply scaling of 1ms, to the width such that:

To perform phase shift, a on the two different function:

By substituting respective and value, we can obtain and :

To obtain :

By performing Fourier transform on :

From Fourier Transform table, we know that:

By applying time-shift rule to the general function obtained from FT table, whereby is the time shift in seconds, we will obtain:

By applying the concept in equation(X) to equation(X), we can obtain:

To make the denominator to be only , we can rewrite:

Hence:

From Euler’s identity, we know that:

Therefore:

By substituting the obtained derived Euler’s identity equation into equation:

Expanding the bracket:

Separating sine terms and cos terms to express equation in the form of ):

By applying Double angle formula whereby, :

By applying Product to sum formulas whereby, :

By applying double-angle formula, whereby :

By applying Product-to-sum formula whereby, :

By expanding the bracket:

Hence, the result obtained this section is same as in section 1.2, answer is verified.

## How can an FFT differ from theory?