FURTHER QUESTIONS (DFT, FFT and Spectral Leakage)

1. By using the *Radix-2 Butterfly*, draw an 8-point Fast Fourier Transform (FFT) realisation. Discuss how this differs from the Discrete Fourier Transform (DFT).

2. Given the following continuous time signal:

$$x(t) = A_1 \sin(2\pi f_1 t) + A_2 \sin(2\pi f_2 t)$$

where $A_1 = 1$, $A_2 = 0.1$, $f_1 = 1.42 \times 10^3$ Hz and $f_2 = 1.28 \times 10^3$ Hz.

(i) Determine the Fourier Transform of $x(t)$ and plot the magnitude response.

(ii) If the signal is sampled at 5.12×10^3 Hz and 128 samples are observed, plot and explain the FFT magnitude response of this sampled signal.

(iii) Define spectral leakage and identify its main factor.

(iv) Determine the possible amount of distortion on the spectral component at f_2 as a result of leakage due to component at f_1.

(v) How to minimise the effects of spectral leakage?

3. If $A_2 = 0$, f_1 is changed to 4×10^3 Hz and the signal is sampled as in Q2 Part (ii), determine how the spectrum will appear and comment on the reconstructed continuous time signal.

4. In the derivation of Discrete Fourier Transform (DFT), assumptions were made that the time domain signal has been sampled and is periodic. Describe what will happen if the signal is not periodic.