Q9. Fast Fourier Transform (Dr. Meyer-Baese)

For a prime factor FFT the following 2D DFT is used:

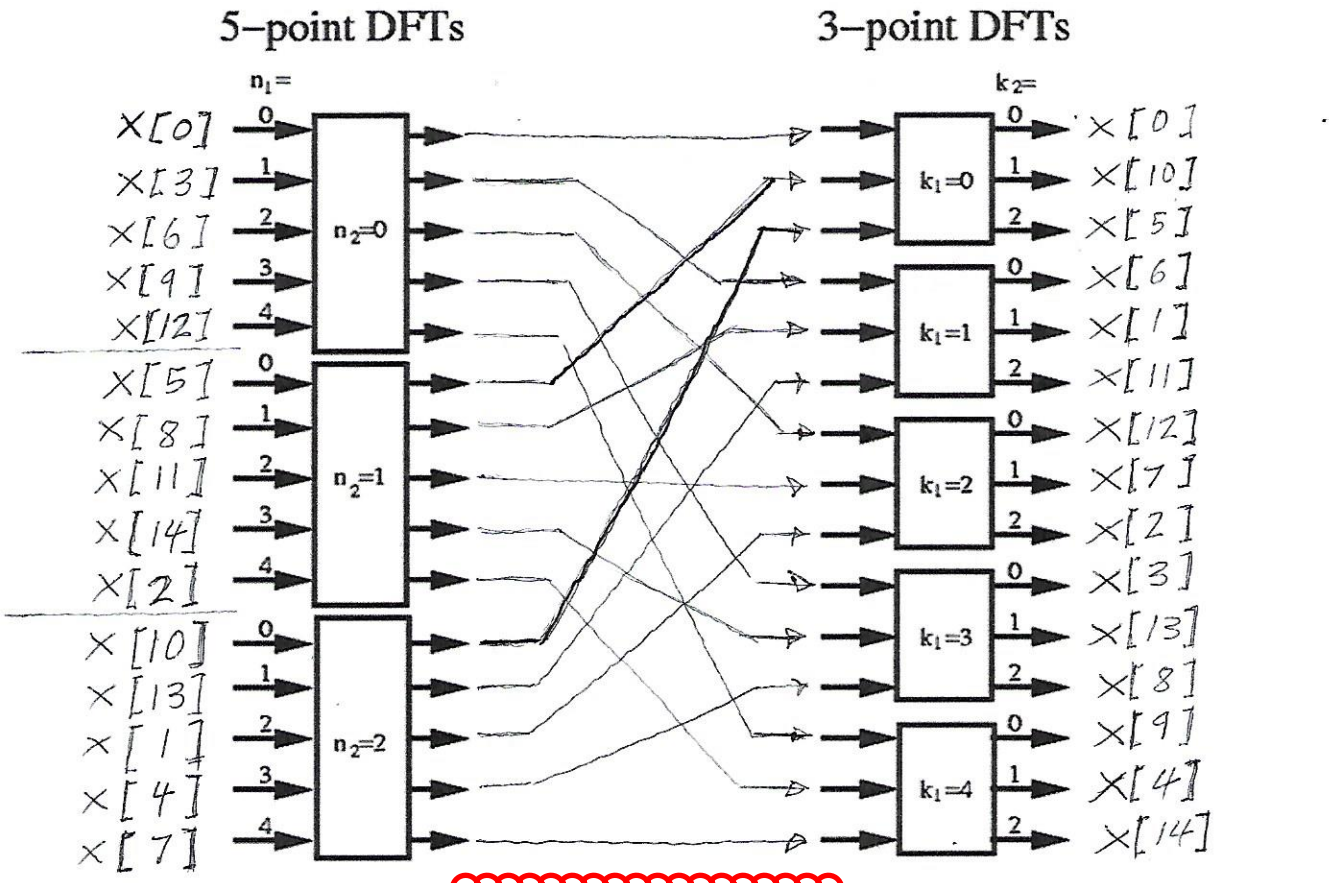
$$X[k_1, k_2] = \sum_{n_2=0}^{N_2-1} W_{N_2}^{n_2 k_2} \sum_{n_1=0}^{N_1-1} x[n_1, n_2] W_{N_1}^{n_1 k_1} \quad !$$

1. Complete the following table for the index map for a $N = 15$ with $N_1 = 5$ and $N_2 = 3$ FFT with: $n = 3n_1 + 5n_2$ mod 15 and $k = 6k_1 + 10k_2$ mod 15. (40 points)

| $n_2$ | $n_1$ | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | 0 | 3 | 6 | 9 | 12 |
| 1 | 5 | 8 | 11 | 14 | 2 |
| 2 | 10 | 13 | 1 | 4 | 7 |

| $k_2$ | $k_1$ | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 |
| 0 | 0 | 6 | 12 | 3 | 9 |
| 1 | 10 | 1 | 7 | 13 | 4 |
| 2 | 5 | 11 | 2 | 8 | 14 |

2. Complete the SFG (for x[n], X[k] and connection between first and second stage) for the FFT: (60 points)




No Twiddle Factors !!!