Εργασία 2η

Consider the real discrete process given by

$$X[k] = \sum_{i=1}^{6} \cos(\omega_i k + \varphi_i)\,, k = 0,1, \dots, N-1,$$

where $\omega_i = 2\pi\lambda_i$, $\lambda_3 = \lambda_1 + \lambda_2$ and $\lambda_6 = \lambda_4 + \lambda_5$, $\varphi_3 = \varphi_1 + \varphi_2$, $\varphi_6 = \varphi_4 + \varphi_5$ and $\varphi_1, \varphi_2, \varphi_4, \varphi_5$ are independent and uniformly distributed random variables on $[0,2\pi]$. Consider that $\lambda_1 = 0.12Hz$, $\lambda_2 = 0.30Hz$, $\lambda_4 = 0.19Hz$ and $\lambda_5 = 0.17Hz$ (hence, $\lambda_3 = 0.42Hz$ and $\lambda_6 = 0.36Hz$). Moreover, let $N = 8192$ as the data length.

1. Construct the $X[k]$.
2. Estimate the power spectrum $C_2^x(f)$. Use $L_2 = 128$ max shiftings for autocorrelation.
3. Estimate the bispectrum (only in the primary area) $C_3^x(f_1, f_2)$ using
   a) the indirect method with $K = 32$ and $M = 256$. Use $L_3 = 64$ max shiftings for the third-order cumulants. Use: a_1) rectangular window and a_2) Parzen window.
   b) the direct method with $K = 32$ and $M = 256$. Use $J = 0$.
4. Plot $X[k]$, $C_2^x(f)$, $C_3^x(f_1, f_2)$ (all estimations).

5. Compare the estimations of $C_3^x(f_1, f_2)$ amongst $\{a_1, a_2, b\}$ settings. Comment on the comparisons.
6. What can you deduce regarding the frequency content from the comparison of $C_2^x(f)$ and $C_3^x(f_1, f_2)$ (all estimations)?
7. How the results will change if you repeat the process from 1 to 5 taking into account:
   a) different segment length: i) $K = 16$ and $M = 512$ ii) $K = 64$ and $M = 128$?
   b) 50 realizations of the $X[k]$ and comparing the mean values of the estimated $C_2^x(f)$, $C_3^x(f_1, f_2)$?