FALL 2021 EC516 Problem Set 08

Due: Sunday November 14 (Before Midnight) on Blackboard Learn

Problem 9.1 (Algorithmic)

Let $Y_v[n,k] = Y_v[n, 2\pi k/10)$ represent the discrete TDFT of a signal $y[n]$ with respect to an analysis window $v[n] = (0.5)^{|n|}\left(1 - \frac{1}{10}\sum_{k=0}^{9} e^{j\frac{2\pi k}{10}n}\right) + \delta[n]$. Is it true that $\alpha\sum_{k=0}^{9} Y_v[n,k] = y[n]$ for some real number α whose value is independent of *n*? *Justify your answer*

Problem 9.2 (Algorithmic)

Throughout this problem, let $x[n]$ be an arbitrary 200-point signal whose TDFT is given as $X_w[n,\omega)$. The analysis window is given by $w[n] = u[n] - u[n-100]$ and the discrete TDFT of $x[n]$ is specified as $X_w[n,k] = X_w[100n, 2\pi k/200)$ for $0 \le k \le 199$ and zero otherwise. Is it true that $x[n] = \frac{1}{200}\sum_{k=0}^{199} X_w[n,k]$? *Justify your answer.*

Problem 9.3 (Algorithmic; Software)

You may use MATLAB or any other software package/language to answer the questions in this problem. Throughout this problem, use $x[n] = \sin(0.125\pi n + 0.1\pi)\{u[n] - u\{n - 64)\}$.

(a) Generate and display a plot of the signal $x[n]$.
(b) Generate and display a plot of the magnitude of the 64-point DFT of $x[n]$.
(c) Generate and display a plot of the magnitude of the 128-pont DFT of $x[n]$.
(d) Generate and display a plot of the magnitude of the 512-pont DFT of $x[n]$.
(e) Please comment on the differences between the plots in the previous three parts of this problem.

Problem 9.4 (Algorithmic; Software)

You may use MATLAB or any other software package/language to answer the questions in this problem. Throughout this problem, use

$$x[n] = \sin(0.25\pi n)\{u[n] - u\{n - 64)\} + \sin(0.5\pi n)\{u[n - 128] - u[n - 192]$$

Let $X_w[n,k]$ denote the discrete TDFT $(L = 1, M = 512)$ of $x[n]$ with respect to the analysis window $w[n]$ that is specified as

$$w[n] = u[n] - u[n - 16]$$

(a) Generate and display a plot of the signal $x[n]$.
(b) Generate and display a plot of the magnitude of the 512-point DFT of $x[n]$.

(c) Generate and display a plot of $|X_w[n, 64]|$ as a function of n. At what time n does this plot reach its maximum magnitude? Explain why this result makes sense.
(d) Generate and display a plot of $|X_w[n, 128]|$ as a function of n. At what time n does this plot reach its maximum magnitude? Explain why this result makes sense.
(e) Generate and display a plot of $|X_w[n, 256]|$ as a function of n. What is the maximum value this plot reaches? How does the maximum value reached here compare to the maximum values reached in the plots of the previous two parts? Explain why this result makes sense.
(f) Use the FBS algorithm to synthesize the signal $x[n]$ from $X_w[n, k]$.

Problem 9.5 (Analytical)

Assume that $X_w[n,\omega)$ is the TDFT of a signal $x[n]$ with respect to analysis window $w[n] = (0.5)^n\{u[n] - u[n-8]\}$. If $x[n] = 1$ for all n, is it true that $X_w[n,\omega) \neq 0$ for all finite values of n and ω? *Justify your answer*.