EE-472 Smart Grids Technologies
Module 1 Quiz (Graded)
17. 03. 2025
With Solutions

Student Name: _____

Sciper Number: ☐☐☐☐☐☐

Question 1

Not yet answered

Marked out of 10

Scalloping losses:

- ○ a. Are independent of the selected sampling frequency and window length
- ○ b. Do not depend on the signal's frequency and just depend on the window length
- ○ c. Do not depend on the selected windowing function
- ☒ d. Can be addressed by interpolation of the DFT bins

Question 2

Not yet answered

Marked out of 10

In the IpDFT algorithm for the Hanning window, the fractional correction term δ can be computed by interpolating the the two highest amplitude DFT bins:

$$\delta = \varepsilon \frac{2\,|X(k_m + \varepsilon)| - |X(k_m)|}{|X(k_m)| + |X(k_m + \varepsilon)|}$$

Where:

$$\varepsilon = \pm 1 = \operatorname{sgn}\left(|X(k_m + 1)| - |X(k_m - 1)|\right)$$

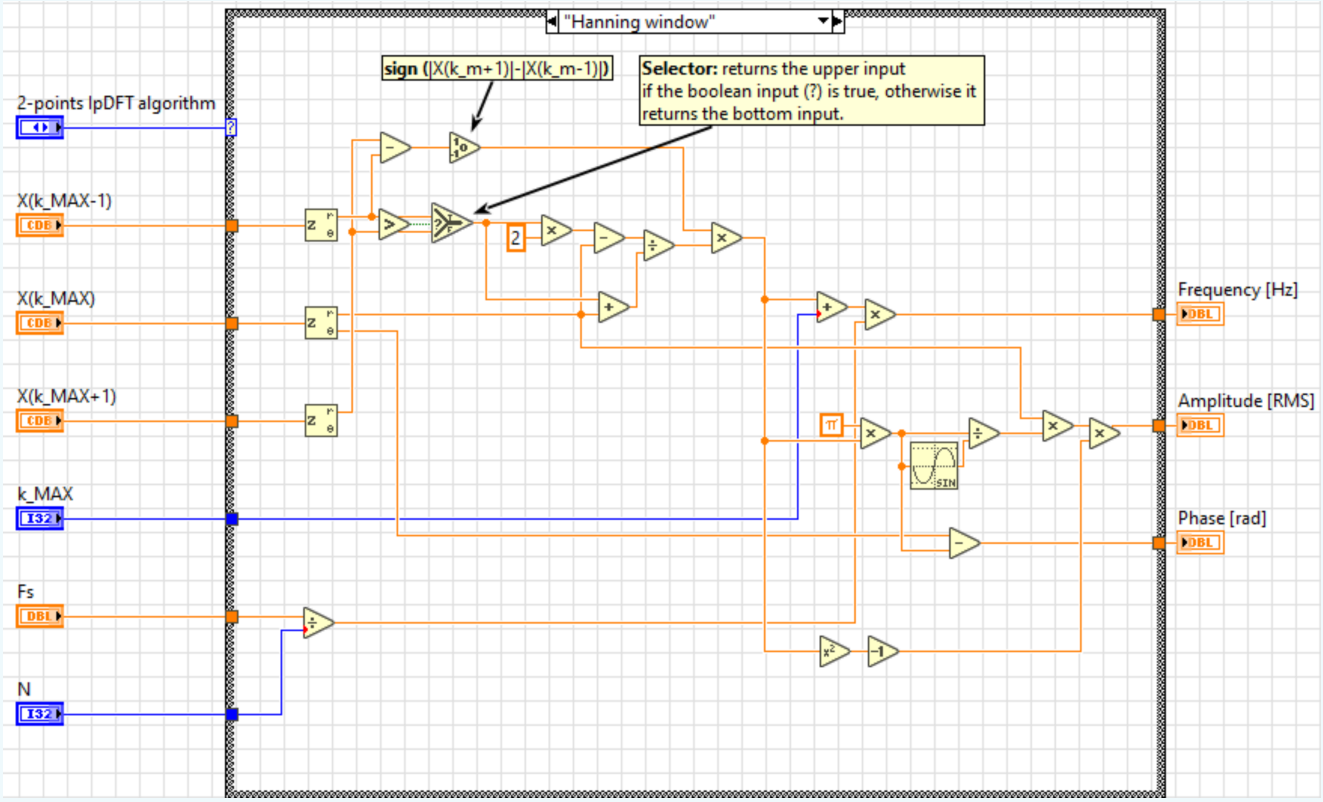
and k_m is used to denote the highest amplitude DFT bin. Consequently, the signal parameters can be computed as follows:

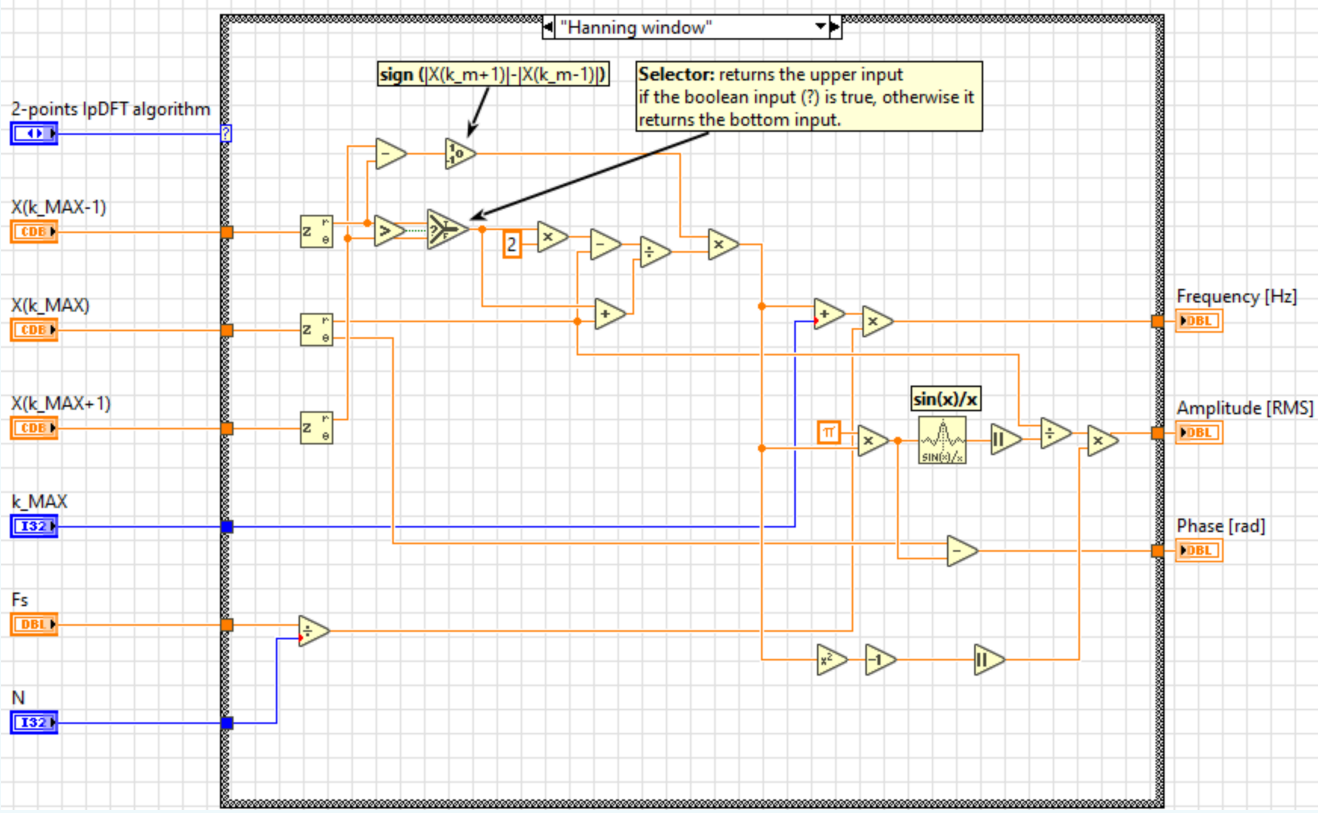
$$f_{est} = (k_m + \delta)\,\Delta f$$

$$A_{est} = |X(k_m)| \left| \frac{\pi\delta}{\sin(\pi\delta)} \right| |\delta^2 - 1|$$

$$\varphi_{est} = \angle X(k_m) - \pi\delta$$

Which of the following two LabVIEW block diagrams correctly implements the IpDFT algorithm for the **Hanning** window:





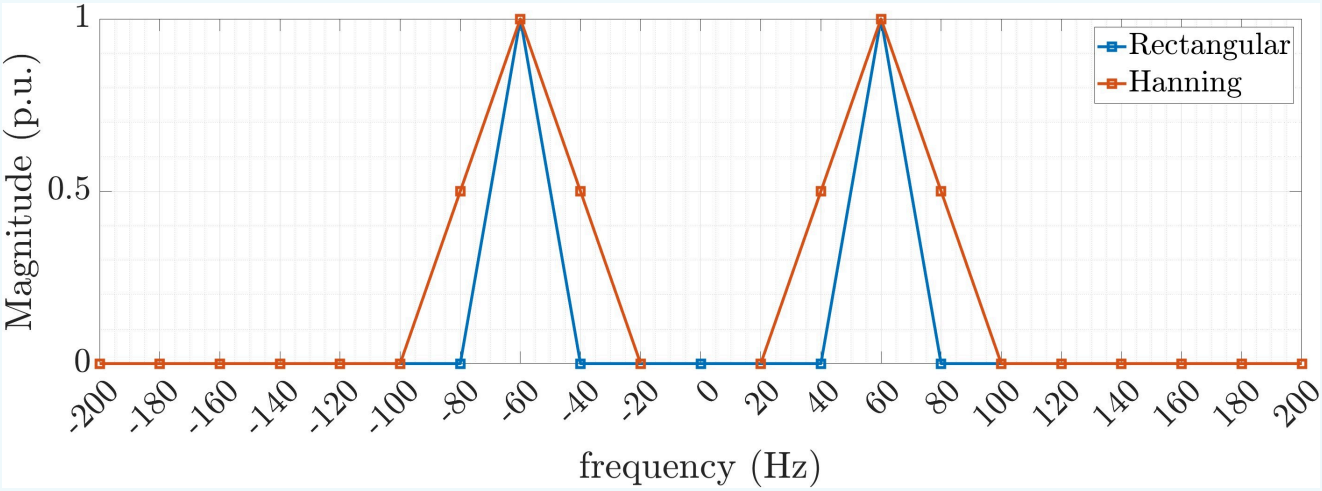
- [x] a. Only the bottom one
- [ ] b. Only the top one
- [ ] c. Both
- [ ] d. None

Question 3

Not yet answered

Marked out of 10

From the following DFT spectrum, we can state that:



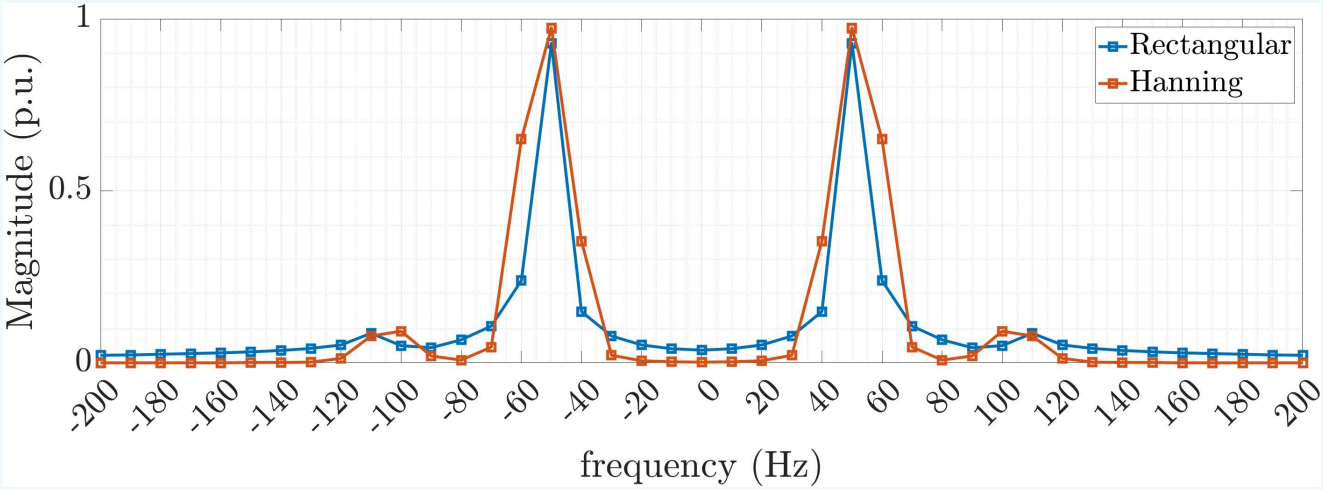
- [ ] a. The signal frequency equals 50 Hz and the window length 50 ms
- [x] b. The signal frequency equals 60 Hz and the window length 50 ms
- [ ] c. The signal frequency equals 60 Hz and its DFT has been calculated using a window of 1000 samples acquired at sampling frequency of 10 kHz
- [ ] d. The signal frequency equals 50 Hz and the window length 100 ms

Question 4

Not yet answered

Marked out of 10

Select the **correct** statement concerning the spectrum shown:



- ○ a. No spectral leakage can be observed for the Hanning window
- ○ b. The interfering tone does not generate spectral leakage
- ○ c. The window length is 120 ms
- ☒ d. The frequency of the main tone is higher than 50 Hz

Question 5

Not yet answered

Marked out of 10

In the case of a coherently sampled signal characterized by two close tones, which windowing function would you favor to detect the presence of those tones?:

(1). Rectangular

(2). Hanning

- ○ a. Neither (1) nor (2)
- ○ b. Either (1) or (2)
- ☒ c. (1)
- ○ d. (2)

Question 6

Not yet answered

Marked out of 10

What is the number of non-zero DFT bins a signal composed of two distant tones and coherently sampled with a 50 kHz sampling frequency over 60 ms Hanning window would result in? **Assume no DC is present and consider both positive and negative spectrums:**

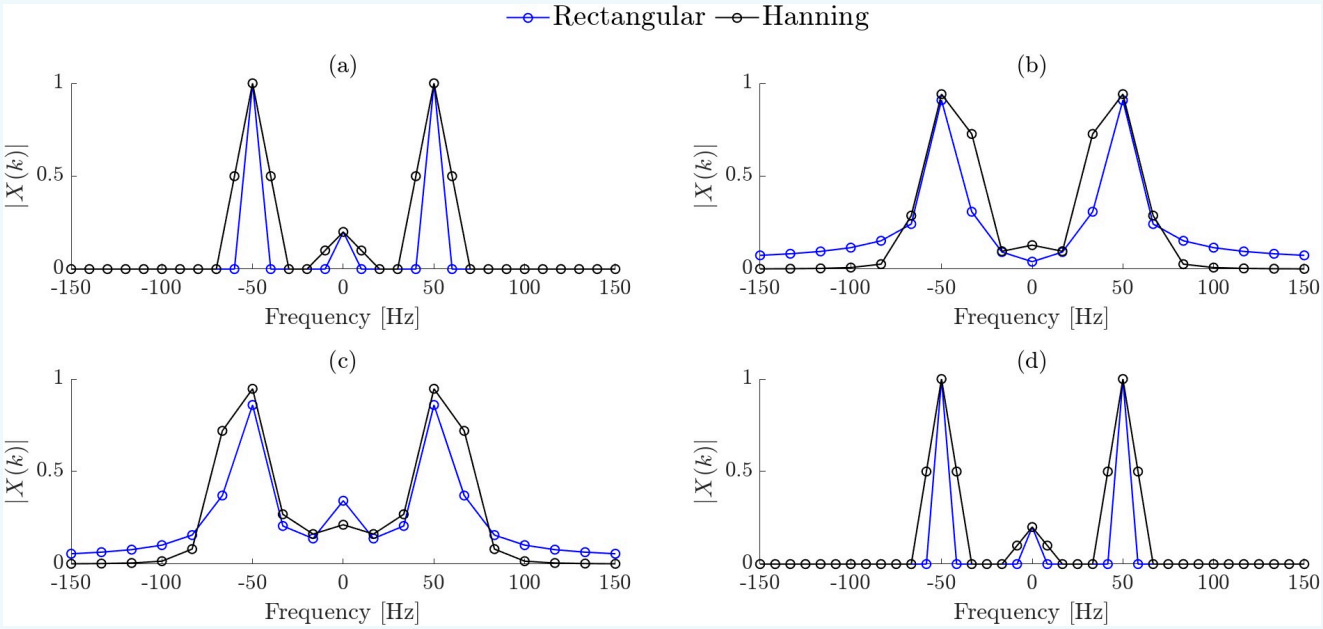
- ○ a. 4 bins
- ☒ b. 12 bins
- ○ c. 6 bins
- ○ d. 9 bins

Question 7

Not yet answered

Marked out of 10

Which one of the following spectral plots (a)(b)(c) or (d) corresponds to a signal with a 50 Hz frequency affected by a DC offset acquired with a sampling frequency of 500 Hz over a 100 ms observation window?



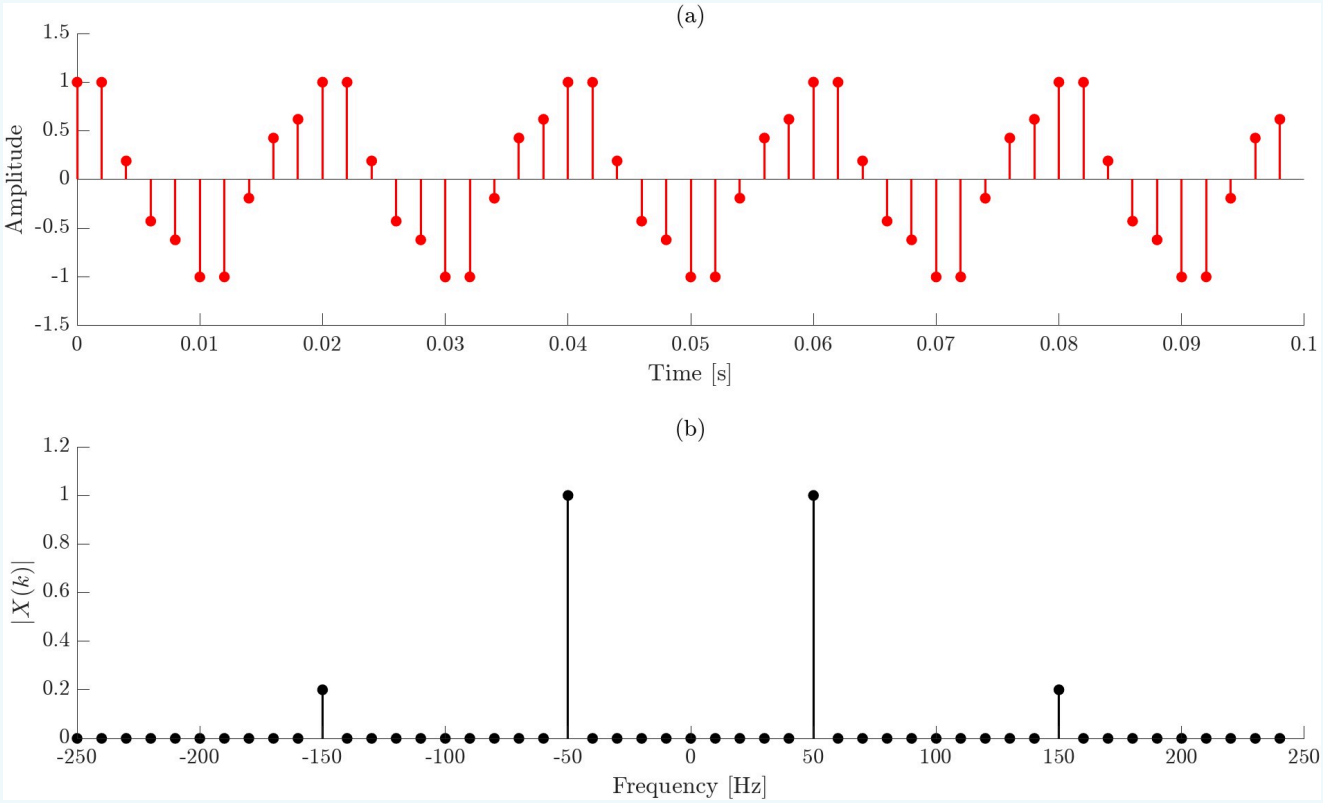
- ☒ i. (a)
- ○ ii. (d)
- ○ iii. (b)
- ○ iv. (c)

Question 8

Not yet answered

Marked out of 10

An analog waveform is filtered with an 1 kHz anti-aliasing filter and sampled at a 500 Hz rate. The resulting samples within one analysis window are shown in the top figure (a) and the obtained spectrum using a rectangular window in the bottom one (b). Please identify the frequency of the interfering tone if it is known that no low order harmonics are present i.e. $\forall h \leq 15 \rightarrow A_h \approx 0$, where h denotes the harmonic order:



- a. 150 Hz
- b. It cannot be determined with the information provided
- c. 350 Hz
- ☒ d. 850 Hz

Question 9

Not yet answered

Marked out of 10

An ideal window function $w(n)$ would provide:

- ☒ a. Minimum main lobe width and maximum side lobe decay
- b. Maximum main lobe width and side lobe decay
- c. Minimum main lobe width and side lobe decay
- d. Maximum main lobe width and minimum side lobe decay

Question 10

Not yet answered

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A PMU installed in continental Europe's High Voltage transmission network has been found to experience a timing error associated with a drift of the frequency of its internal clock. This drift results in an uncompensated timing error $t_\epsilon(t) = D_f \frac{t^2}{2}$, where $D_f = 10^{-18}\ s^{-1}$. Assuming no other source of error is affecting the PMU (i.e. no Amplitude or Frequency estimation errors are present) and that the maximum acceptable TVE is 1% , determine approximately how often the PMU's internal clock should be readjusted by considering a nominal power system frequency of 50 Hz.

Remember:

$$\mathrm{TVE}(\%) = \frac{|X - X_{est}|}{|X|} 100$$

$$\mathrm{PE} = |\varphi - \varphi_{est}| \approx 2\pi f_n t_\epsilon$$

You may consider a reference $X = 1e^{j0}$

- a. It is not possible to determine with the information provided.
- b. Every week
- c. Every 6 months
- d. Every 3 months