

Module 1 - Quiz 2024 Solutions

Question 1

Not yet answered

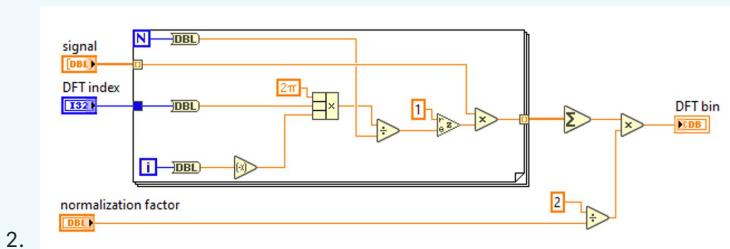
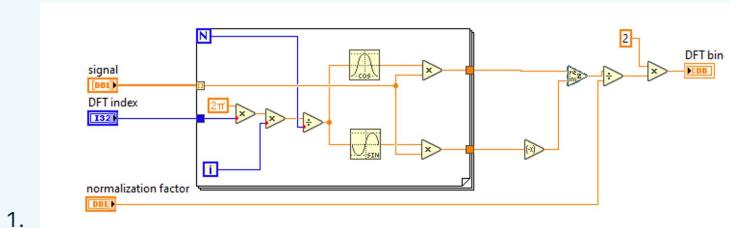
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The DFT for a frequency bin k can be expressed as follows:

$$X(k) = \frac{2}{B} \sum_{n=0}^{N-1} w(n) \cdot x(n) \cdot e^{-j2\pi kn/N}, \quad k \in [0, N-1]$$

where $x(n)$ is the sampled signal under analysis, $w(n)$ is the discrete windowing function, k and n are the indexes of the frequency bins and time-domain samples, respectively, B is the normalization factor.

Which of the following two code examples is correctly computing this DFT bin (the input "signal" refers to the windowed signal, i.e., $w(n) \cdot x(n)$)?



Choose the correct statement:

- a. Only 1. is correct.
- b. None is correct.
- c. Both are correct.
- d. Only 2. is correct.

Question 2

Not yet answered

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Assume a PMU is equipped with a synchrophasor estimation algorithm characterized by a window length of 60 ms and a reporting rate of 50 frames per second (fps). A fault occurs in the substation that is continuously monitored by the PMU. The fault lasts for 30 ms. How many synchrophasor estimates are affected by the transient?

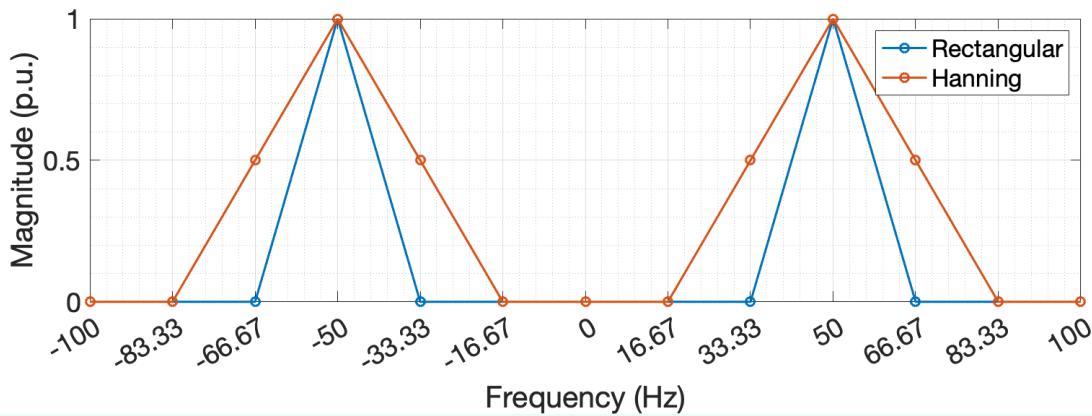
Select one:

- a. 1
- b. 2
- c. 3
- d. 4 or more

Question 3

Not yet answered

Marked out of 10



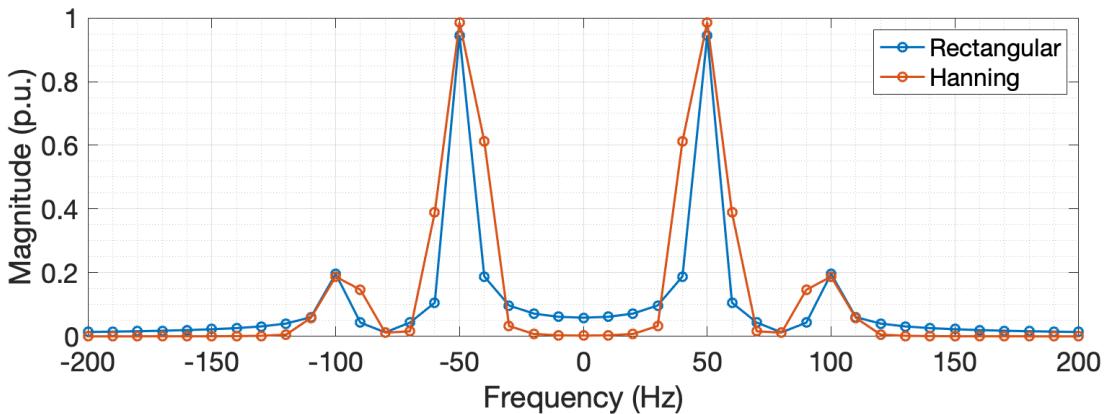
We can deduce the following parameters from the above spectrum:

- a. Signal frequency $f_0 = 50$ Hz with a phase $\varphi = \pi/4$ rad.
- b. Signal frequency $f_0 = 50$ Hz, window length $T_w = 100$ ms, sampling frequency $T_s = 5$ kHz.
- c. Signal frequency $f_0 = 50$ Hz, window length $T_w = 60$ ms.
- d. Signal frequency $f_0 = 50$ Hz, window length $T_w = 60$ ms, sampling frequency $T_s = 500$ Hz.

Question 4

Not yet answered

Marked out of 10



Select the correct statement concerning the above spectrum.

- a. The tails of the negative image leak into the positive DFT bins. This phenomenon is less evident with the Hanning window.
- b. The signal is incoherently sampled and no spectral leakage can be observed for the Hanning window.
- c. The main tone is only affected by spectral leakage from the interfering tone.
- d. The Rectangular window is better in suppressing the spectral leakage that occurs due to incoherent sampling.

Question 5

Not yet answered

Marked out of 10

Suppose you need to compute the 1pDFT of a single-tone sinusoidal signal at 52 Hz, sampled at 5kHz, windowed with a Hanning function characterized by a window length of 60 ms. Select the **incorrect** statement:

Select one:

- a. The correction term delta is negative.
- b. The spectrum peak lies between bins $k=3$ and $k=4$.
- c. All the bins exhibit non-zero projections on the entire DFT basis set but the majority of the energy is concentrated around the third bin.
- d. The continuous spectrum peak does not correspond to the DFT bin characterized by the highest magnitude.

Question 6

Not yet answered

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A PMU is programmed to have a reporting rate of 50 fps, a window length of 60 ms and a sampling frequency of 5 kHz. The PMU is estimating a frequency of 50.5 Hz and a constant phase.

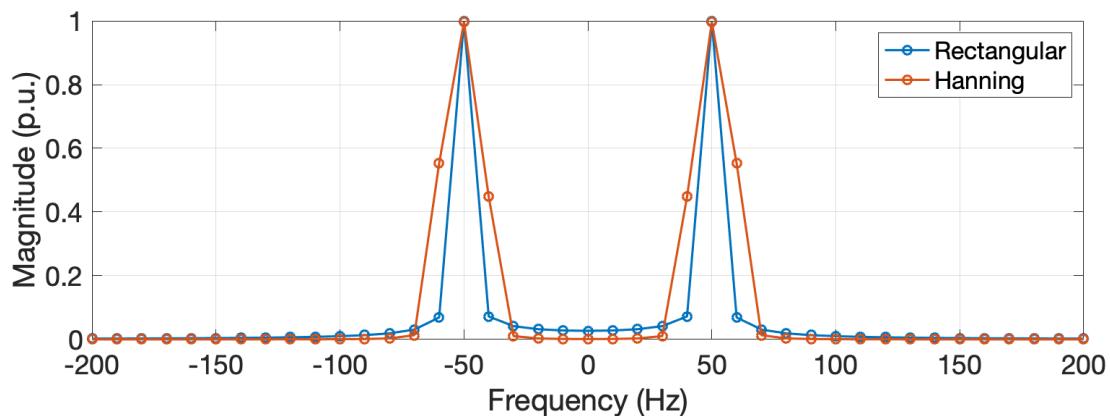
Select the **incorrect** statement.

- a. The actual sampling frequency of the PMU is less than the one that is used in the IpDFT.
- b. The reported window includes more than 3 periods of the measured signal.
- c. The PMU has a constant time synchronization error which results in a constant phase shift.
- d. The phase is constant since the actual frequency of the measured signal is synchronized to the reporting rate.

Question 7

Not yet answered

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Assume an interpolated DFT (IpDFT) is performed on the spectrum above. Select the **correct** statement.

- a. The DFT bins used to perform the interpolation are only generated by the positive image of the tone under analysis.
- b. The TVE of the Rectangular window should be smaller than the one of the Hanning, because the two tones are very close.
- c. The Hanning window should be chosen over the Rectangular window because it better meets the Nyquist theorem.
- d. The correction factor ϵ used in the IpDFT algorithm is positive.

Question 8

Not yet answered

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A PMU uses GPS to synchronize to UTC time. However, there is a time delay on the GPS chip, which is not compensated for in the PMU synchronization. Which metric would be **unaffected** by this mistake?

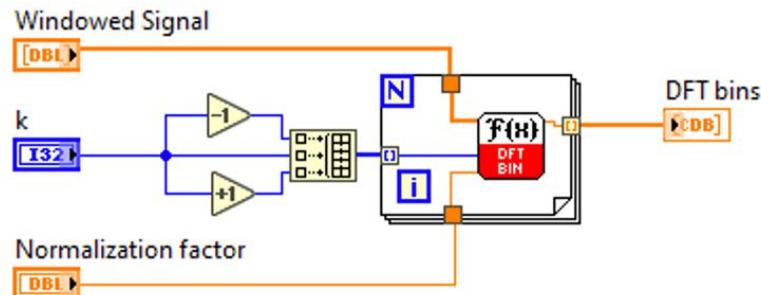
Select one:

- a. Phase error.
- b. Frequency error.
- c. TVE.
- d. All error metrics would be affected.

Question 9

Not yet answered

Marked out of 10



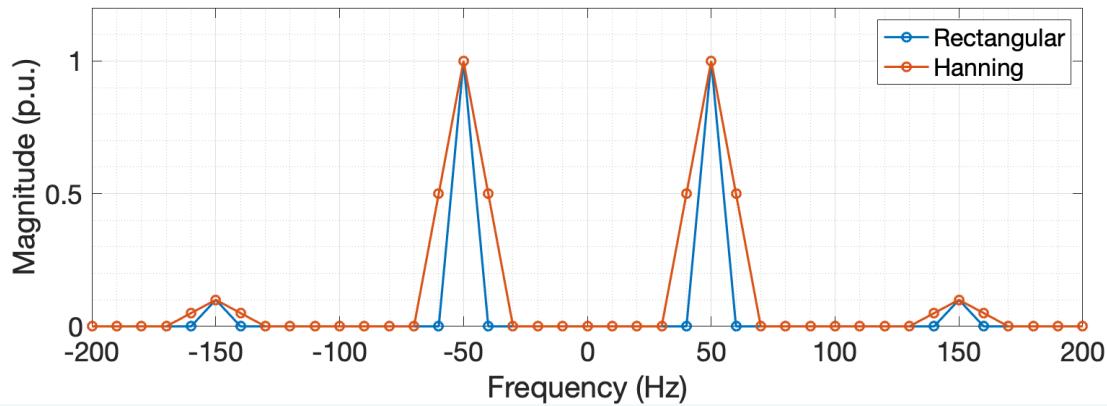
Assuming a nominal frequency of 50 Hz, select the **correct** statement concerning the code above.

- a. Given a window length of 600 samples at a sampling frequency of 10 kHz, $k = 3$.
- b. Given a window length of 60 ms and a sampling frequency of 10 kHz, $k = 0 \dots 999$.
- c. Given a window length of 1000 samples at a sampling frequency of 10 kHz, $k = 3$.
- d. When analyzing a signal with a frequency of 51 Hz, using a window length of 100 ms, $k = 6$.

Question 10

Not yet answered

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

- a. The actual signal is composed of a 50 Hz and a 350 Hz component, and the sampling frequency of the DFT is 500 Hz.
- b. The actual signal is composed of a 50 Hz and a 150 Hz component, and aliasing occurs.
- c. The actual signal is composed of a 50 Hz and a 400 Hz component, and the sampling frequency of the DFT is 500 Hz.
- d. The actual signal is composed of a 50 Hz and a 100 Hz component, and the sampling frequency of the DFT is bigger than 800 Hz.