

Introduction to Time-Frequency Analysis and Wavelet Transforms

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Assignment 2: Lectures 3.1 to 3.6

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1. Select the correct statement from the following:
 - a. Fourier transforms work with adaptive bases.
 - b. Wavelet transforms work with adaptive bases.
 - c. Both Fourier and wavelet transforms work with fixed bases.
 - d. None of the above.

2. Which of the following statements is correct regarding Fourier transforms ?
- a. The synthesis equation is used for local feature extraction and de-noising.
 - b. The analysis equation is used for local feature extraction and de-noising.
 - c. The synthesis equation is used for global feature extraction and de-noising.
 - d. The analysis equation is used for global feature extraction and de-noising.

3. Which of the following statements is true regarding continuous time periodic signals ?
- a. They have zero power and finite energy.
 - b. They have finite power and infinite energy.
 - c. They have infinite power and infinite energy.
 - d. None of the above.

4. The continuous time periodic signal $x(t)$ is represented as $\sum c_n e^{j2\pi n F_0 t}$. Select the correct **option(s)** from the following.
- a. c_n represents the power contribution of the n^{th} harmonic.
 - b. c_n is a measure of the amount of correlation between the signal and the n^{th} harmonic.
 - c. $|c_n|^2$ represents the power contribution of the n^{th} harmonic.
 - d. $|c_n|^2$ represents the fraction of energy contained in the n^{th} harmonic.

5. A signal $x(t)$ is a finite duration sine wave with cyclic frequency F_0 . Then,
- Shorter duration implies less smearing in the energy spectral density plot.
 - Shorter duration implies more smearing in the energy spectral density plot.
 - Longer duration implies less smearing in the energy spectral density plot.
 - Longer duration implies more smearing in the energy spectral density plot.

6. Select the correct **option(s)** from the following
- a. The power spectrum constructed from the continuous time Fourier series is a continuous spectrum.
 - b. The energy spectrum obtained from the continuous time Fourier transform is a line spectrum.
 - c. Both (a) and (b).
 - d. Neither (a) nor (b)

7. Select the correct **option(s)** from the following:

- a. Discrete-time signals are unique over the cyclic frequency range $f \in [-0.25, 0.75]$.
- b. Discrete-time signals are unique over the cyclic frequency range $f \in [-0.75, 0.25]$.
- c. Discrete-time signals are unique over the angular frequency range $\omega \in \left[-\frac{\pi}{2}, \frac{3\pi}{2}\right)$.
- d. Discrete-time signals are unique over the angular frequency range $\omega \in [-\pi, \pi]$.

8. The discrete-time signal $x[k]$ has autocovariance of the form $\sigma_{xx}[l] = \cos(\omega_0 l)$. Then, select the correct **option(s)** from the following:
- a. The power spectral density has a peak at frequency $\omega = \omega_0$.
 - b. The power spectral density has a peak at frequency $\omega = \omega_0 + \pi$.
 - c. The power spectral density has a peak at frequency $\omega = \omega_0 + \frac{\pi}{2}$.
 - d. The power spectral density has a peak at frequency $\omega = \omega_0 + 2\pi$.

9. Select the correct **option(s)** from the following
- a. Continuous-time signals have periodic spectra.
 - b. Discrete-time signals have aperiodic spectra.
 - c. Periodic signals have discrete energy spectra.
 - d. Aperiodic signals with finite 2-norm have continuous energy spectra.

10. If $x_1[k] \xrightarrow{\mathcal{F}} X_1(f)$, then select the correct **option(s)**:

a. $x_1\left[\frac{k}{s} - D\right] \xrightarrow{\mathcal{F}} e^{-j2\pi s f D} X_1(sf)$.

b. $x_1\left[\frac{k}{s} - D\right] \xrightarrow{\mathcal{F}} e^{-j2\pi f D} X_1(sf)$.

c. $x_1\left[\frac{k-D}{s}\right] \xrightarrow{\mathcal{F}} e^{-j2\pi s f D} X_1(sf)$.

d. $x_1\left[\frac{k-D}{s}\right] \xrightarrow{\mathcal{F}} e^{-j2\pi f D} X_1(sf)$.

11. Select the correct option(s) from the following
- a. The N -point DFT assumes the value of the signal to be zero outside the given sequence.
 - b. The N -point DFT assumes periodic extension of the signal only for sinusoids.
 - c. The N -point DFT assumes periodic extension of the signal irrespective of its nature.
 - d. None of the above.

For questions **12** to **15**, the answer is of the form of an integer, to be filled in the blank space

12. The number of unique frequencies in a 128 point DFT is _____

13. Consider the continuous-time signal $x(t) = e^{\frac{-t^2}{9}}$. The value of $\frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} |X(F)|^2$ is _____

14. The power spectrum of a continuous time signal $x(t) = \sin(0.35\pi t)$ is calculated. The number of peaks in the cyclic frequency range $[0, 0.5)$ is _____

15. Let $x_1[k] = \delta[k - k_0]$ and $x_2[k] = \delta[k + k_0]$. Then, $\mathcal{F}\{(x_1 \star x_2)[k]\}$ is equal to _____