

# Introduction to TFA and Wavelet Transforms

## Solutions to Assignments

ARUN K. TANGIRALA

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### Assignment 2

1. (c)
2. (d)
3. (b)
4. (b),(c)
5. (b),(c)
6. (d)
7. (b),(c)
8. (a),(d)
9. (d)
10. (a),(d)
11. (c)
12. For an  $N$  point DFT, there are  $(N/2) + 1$  unique frequencies. Hence the answer is 65.
13. Using Parseval's relation and property of the Gaussian integral, the answer will come to be 3
14. Since the signal is continuous and given range is within fundamental frequency range, there is only 1 peak.
15. Using the time shift and convolution property of Fourier Transforms i.e. Fourier transform of the signal obtained by convolving 2 signals is just the product of their individual Fourier transforms. The answer is 1.

## Assignment 3

1. (c)
2. (b),(c)
3. (a),(b)
4. (c)
5. (b),(d)
6. (a),(c)
7. (b),(c)
8. (c)
9. (b),(d)
10. (b),(d)
11. No Question
12. (a)
13. The instantaneous frequency is given by  $\dot{\phi}(t)$ . It is 2 rad/sec in this case.
14. The average time and duration are to be calculated from the signal. The final result is that the expression sums to 0.
15. The expectation of  $\omega^2$  is calculated from the Fourier transform and comes to be 7.
16. Using the averages previously computed, the product of duration and bandwidth can be found and substituted in the required expression. The answer is 3.

**Note:** Questions 12 to 16 are based on a signal taken from Cohen's book. The chapter is 3 and the signal is based on that in example 3.3

## Assignment 4

1. (b),(d)
2. (c)
3. (b),(d)
4. (a),(c)
5. (a),(b)
6. (b),(d)
7. (c)
8. No Question
9. (d)
10. Outside the chosen window, the spectrogram will have zero value due to finite support. Hence, the value is 0. Alternatively, the spectrogram may also be calculated and the result turns to be the same.
11. Using the concept of ridges,  $\xi_0$  can be calculated.  $\xi_1$  can be obtained using the definition of instantaneous frequency. The final answer is 100, with each of  $\xi_0$  and  $\xi_1$  being 10.

**Note:** For a detailed discussion on the signal in questions 9 and 10, refer to Cohen's book (example 7.5, chapter 7)

## Assignment 5

1. (b)
2. (d)
3. (a),(d)
4. (d)
5. (c)
6. (c)
7. (b),(d)
8. (b),(c),(d)
9. (a),(b),(d)
10. (d) (Refer chapter 10 in Cohen's book for discussion)
11. The answer is obtained by evaluating the WVD and plugging in the given values of time and frequency. The answer is 1. (Refer chapter 8 in Cohen's book for derivation)
12. Each of  $\alpha$ ,  $\beta$  and  $\gamma$  turns out to be 2. They are obtained by calculating the WVD of the signal and matching coefficients from the given expression. The answer is 6.

## Assignment 6

1. (b)
2. (c)
3. (b)
4. (a)
5. (b)
6. (a), (b)
7. (c)
8. (b)
9. (c)
10. (c)