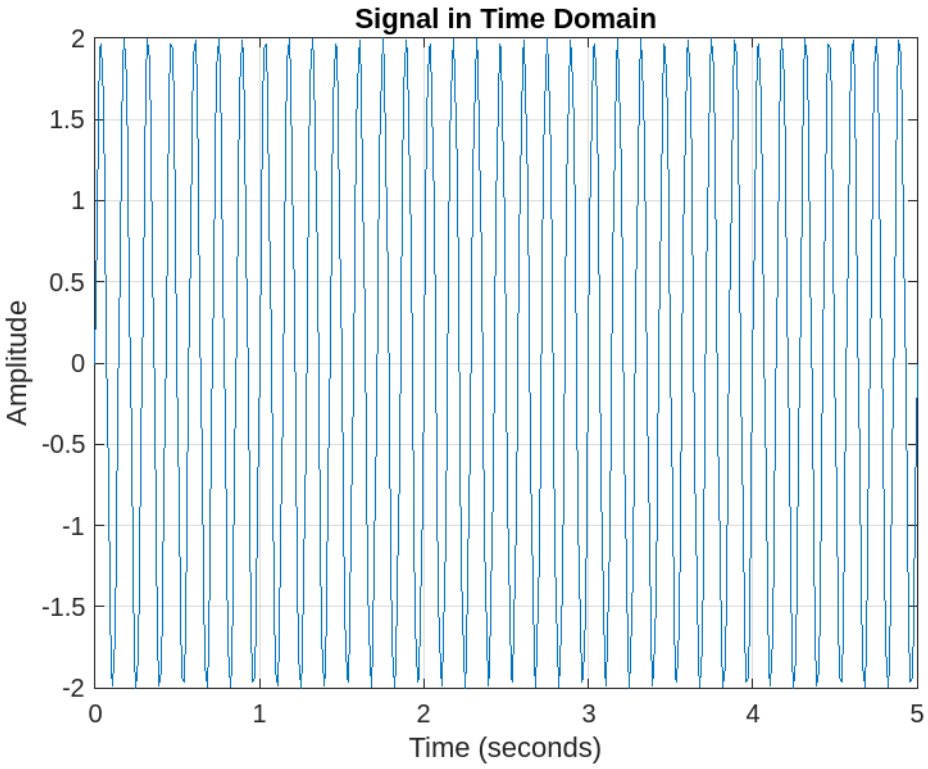
30p

Ex. 1

The file ex1.mat contains signal with sampling frequency f_s = 100Hz. Please, plot the signal in time domain. (You have to generate time vector with specific length).

➔

Fs = 100 Hz



10p

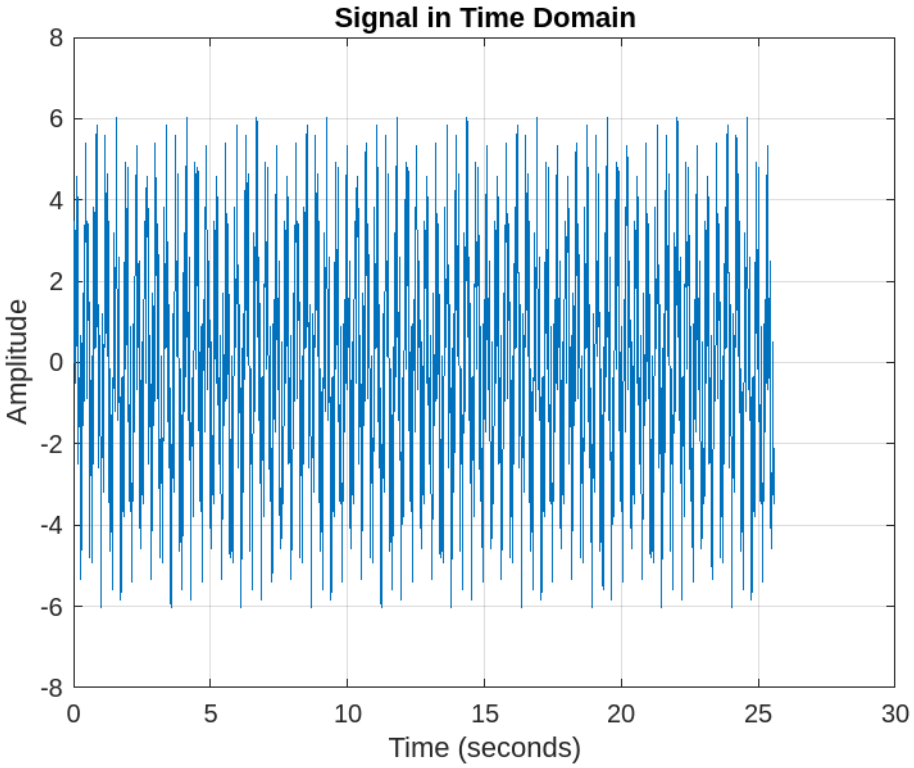
Ex. 2

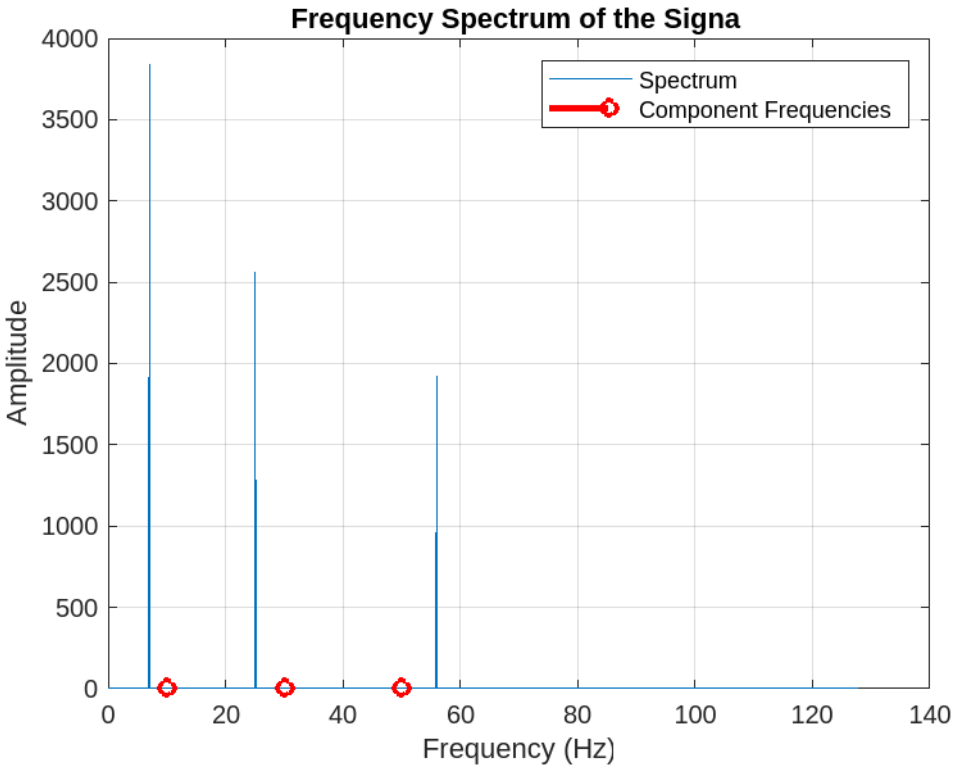
The file ex2.mat contains signal with three frequency component. Sampling frequency of the signal is f_s = 256Hz. Please, plot the spectrum of the signal (base on files from our course). Mark the frequency components. (You have to generate frequency vector). How is frequency resolution?

➔

Fs = 256 Hz

Frequency resolution is 0.10 Hz





10p

Ex. 3

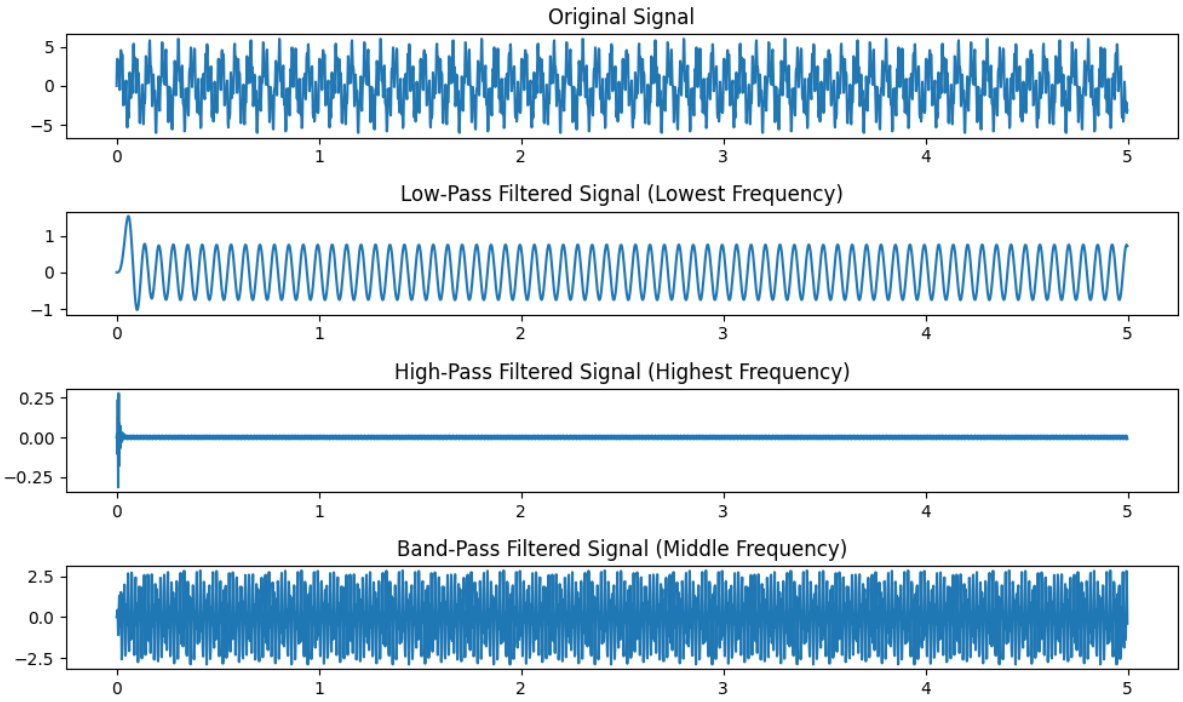
For signal ex2.mat perform filtration process to remove:

1. Component with the lowest frequency
2. Component with the highest frequency

3. Component with the middle frequency

For all cases, the spectra after filtration have to be presented. You can use any filter type (IIR or FIR). Explain in few words why you chose given filter type.

```
You have to use filters to remove:
1. component with the lowest frequency (the other 2 components should remain unchanged)
2.component with the highest  frequency (the other 2 components should remain unchanged)
```
➔
```
3.... etc...
```



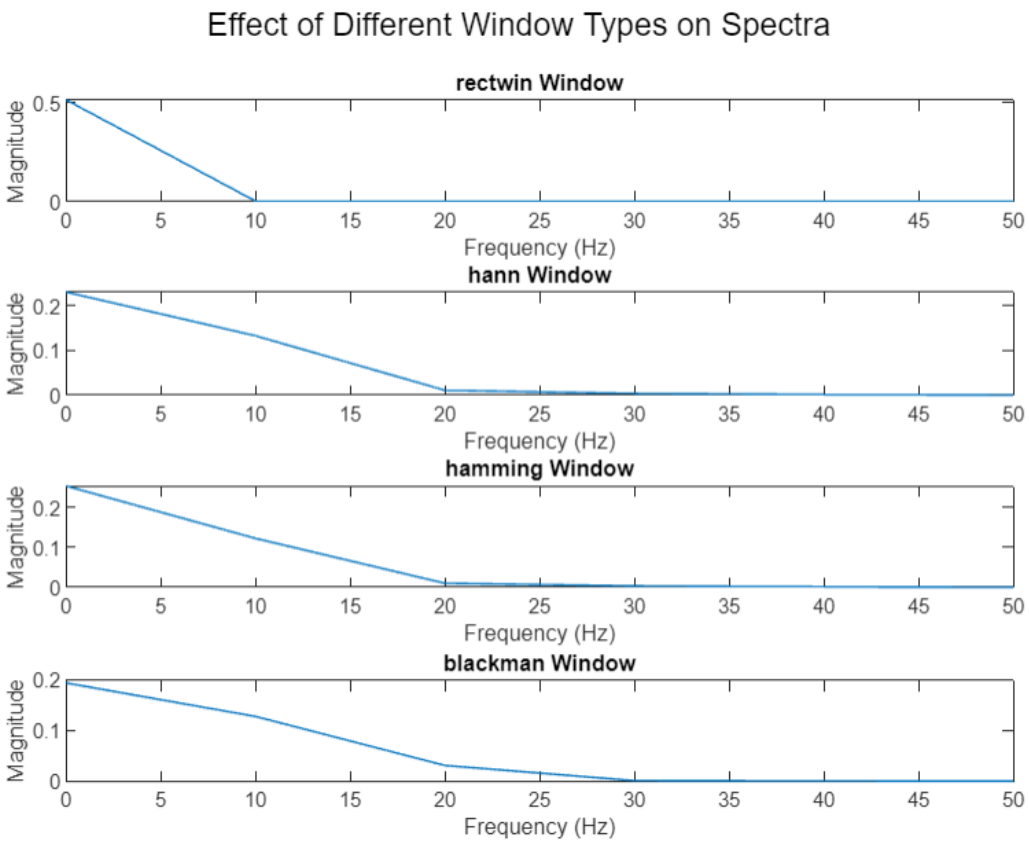
0p

IIR filters are more efficient than the FIR filter, and requires less multiplications for the calculation of a single sample of the output signal (providing the required frequency characteristics).

Ex. 4

For signal ex4.mat prepare sets of spectra with use different windows type. Describe in few words how the windows changes the spectra.

➔



Op

These are not signal spectra after applying windows

Rectangular Window:

- The rectangular window is a simple, box-like window.
- It provides maximum frequency resolution but has poor sidelobe suppression.
- It can introduce spectral leakage, causing smearing of spectral peaks.

Hanning Window:

- The Hanning window is smoother than the rectangular window.
- It reduces spectral leakage and provides moderate frequency resolution.
- It has better sidelobe suppression compared to the rectangular window.

Hamming Window:

- The Hamming window is similar to the Hanning window.
- It provides improved sidelobe suppression compared to the Hanning window.
- It has a trade-off between frequency resolution and sidelobe suppression.

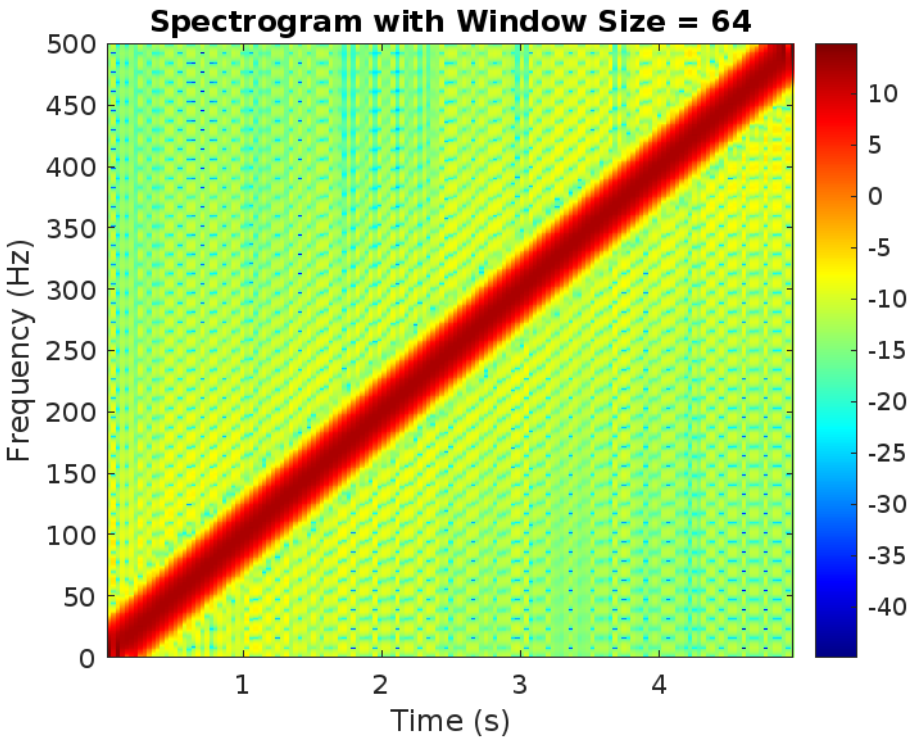
Blackman Window:

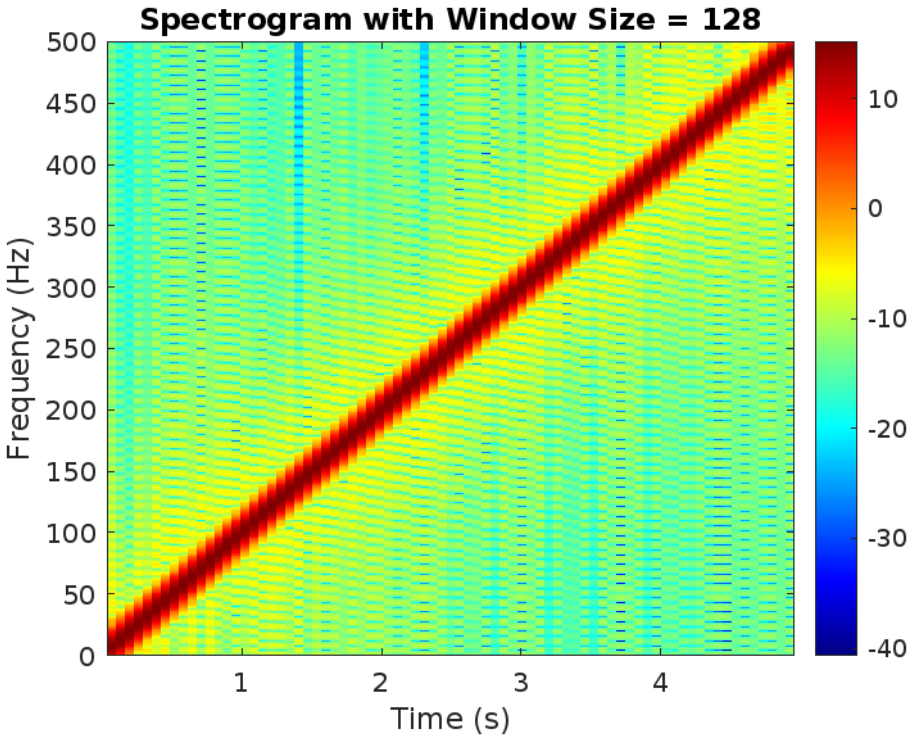
- The Blackman window has even better sidelobe suppression.
- It provides good frequency resolution and minimal spectral leakage.
- It is wider than the Hanning and Hamming windows, which can affect peak sharpness.

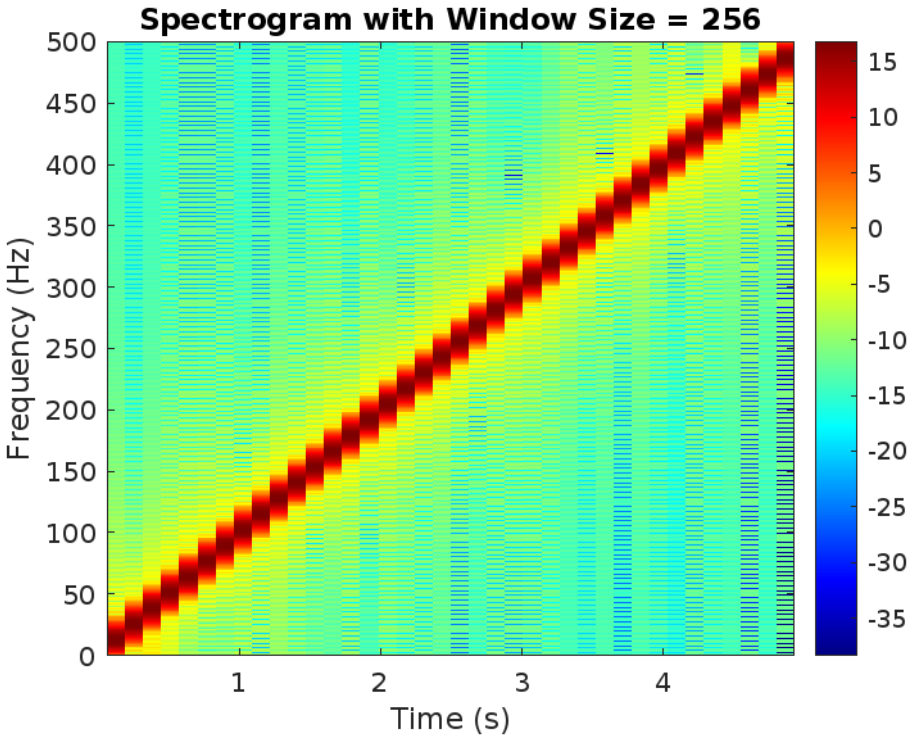
Ex. 5

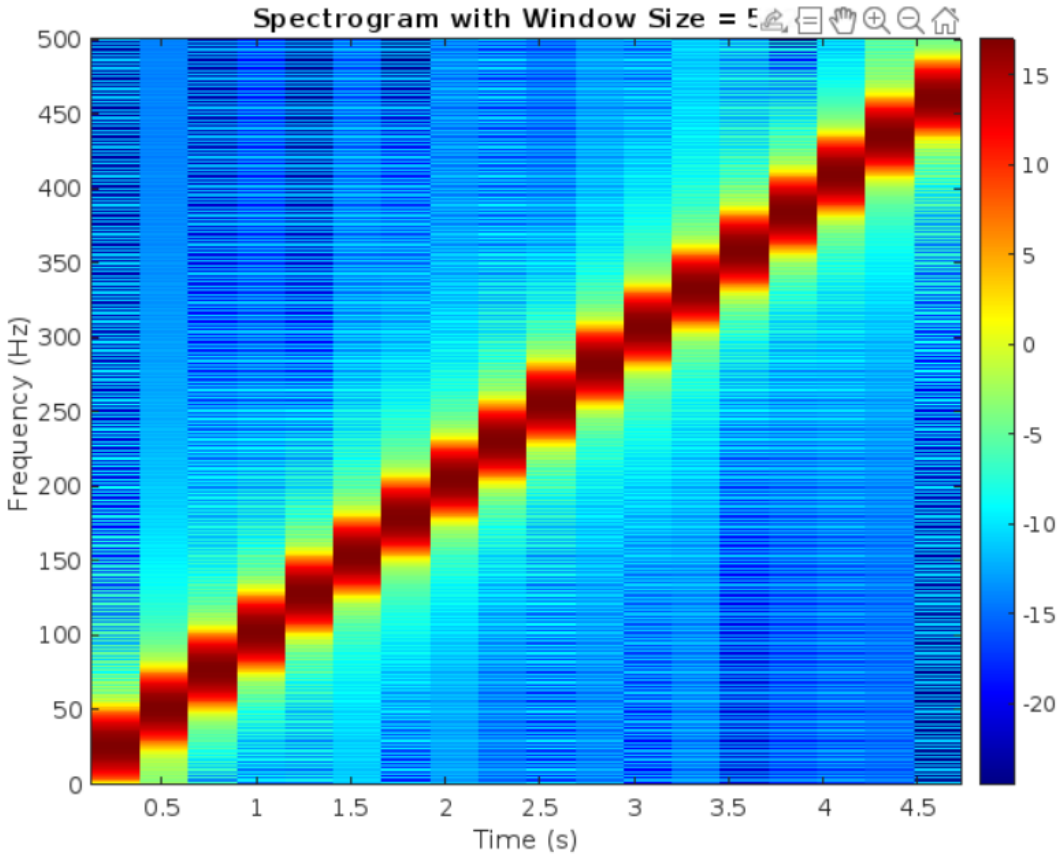
File ex5.mat contains nonstationary data. Please analyse it using STFT with different window size. Make some conclusions related to resolution and window size.

➔ 10p




Spectrogram with Window Size = 128
Frequency (Hz)
Time (s)
500
450
400
350
300
250
200
150
100
50
0
1
2
3
4
10
0
-10
-20
-30
-40


Spectrogram with Window Size = 256
Frequency (Hz)
Time (s)
500
450
400
350
300
250
200
150
100
50
0
1
2
3
4
15
10
5
0
-5
-10
-15
-20
-25
-30
-35



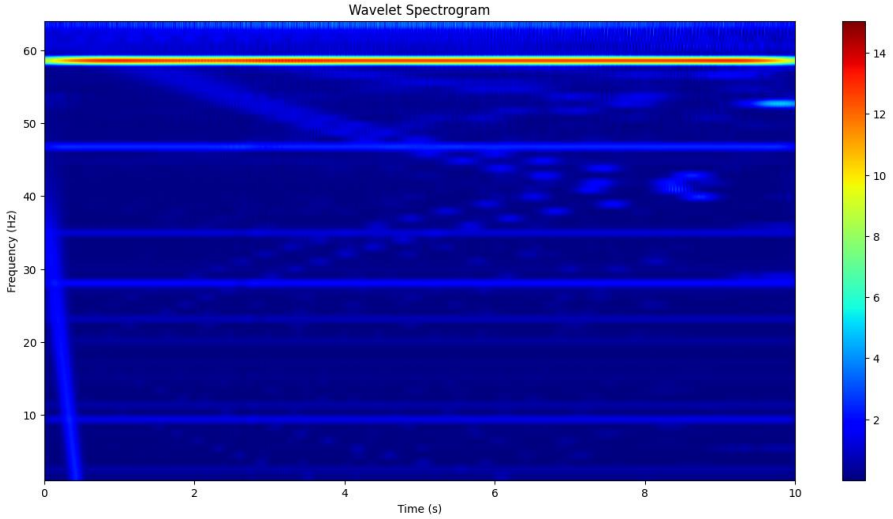
- A wide window gives better frequency resolution but poor time resolution. A narrower window gives good time resolution but poor frequency resolution.

Ex. 6

For file ex6.mat prepare wavelet spectrogram in time-frequency domain. Discuss the results.

Please remember. All axes should be marked in accordance with the requirements of the given task! Results discussion should be short but must include specific information!

➔



0p

The spectrogram is a 2D representation that shows how the frequency content of a signal changes over time. Time is typically on the x-axis, and frequency is on the y-axis. Bright regions in the spectrogram indicate higher energy at specific frequencies and times.

The color intensity in the spectrogram represents the energy of the signal at each time-frequency point. Dark regions have lower energy, and bright regions have higher energy. We can interpret these intensities by color scale.

It should be something like that. All components should be clearly visible