UFAZ M1S1 – Signal Processing – Mid-term exam

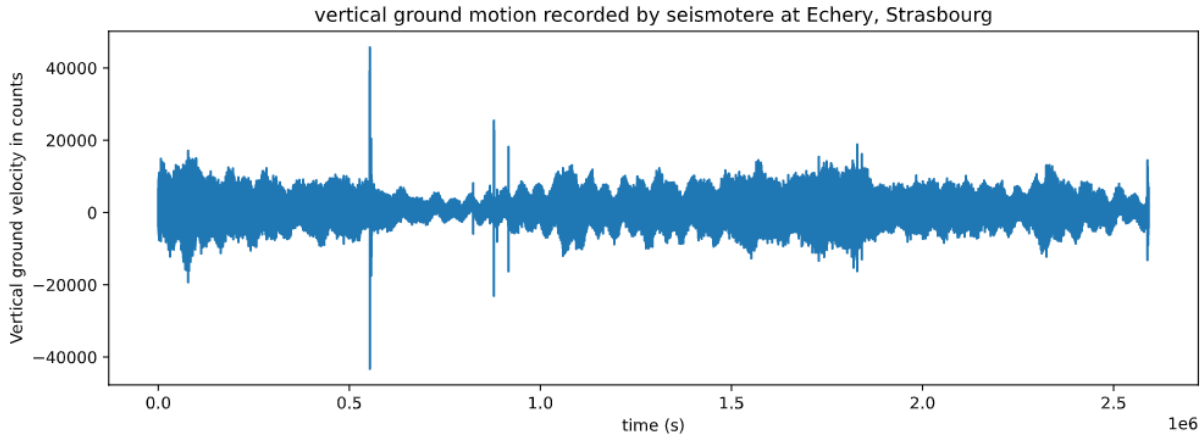
You have been given a dataset and a Jupyter notebook with a few lines of code already written. This code reads the dataset and creates a time array and an array of values for your data.

Use the Jupyter notebook to answer the following questions about your dataset.

Question 1. Plot the data in the time domain

Ensure you add a title and labels for both the x and y axes.

[Add your plot here. Drag-and-drop the image from the Jupyter notebook or take a screenshot and upload the picture here.]



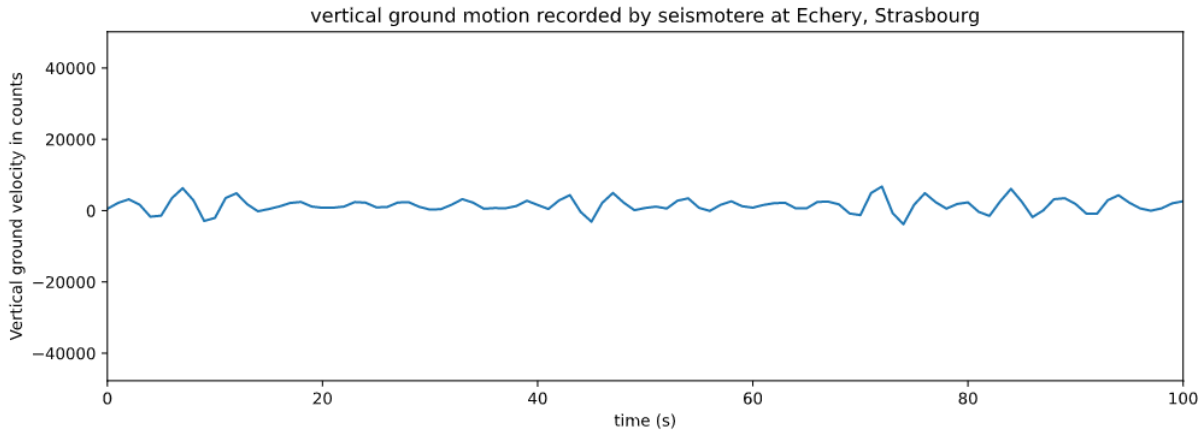
Question 2. Answer the following questions about the time-domain data:¶

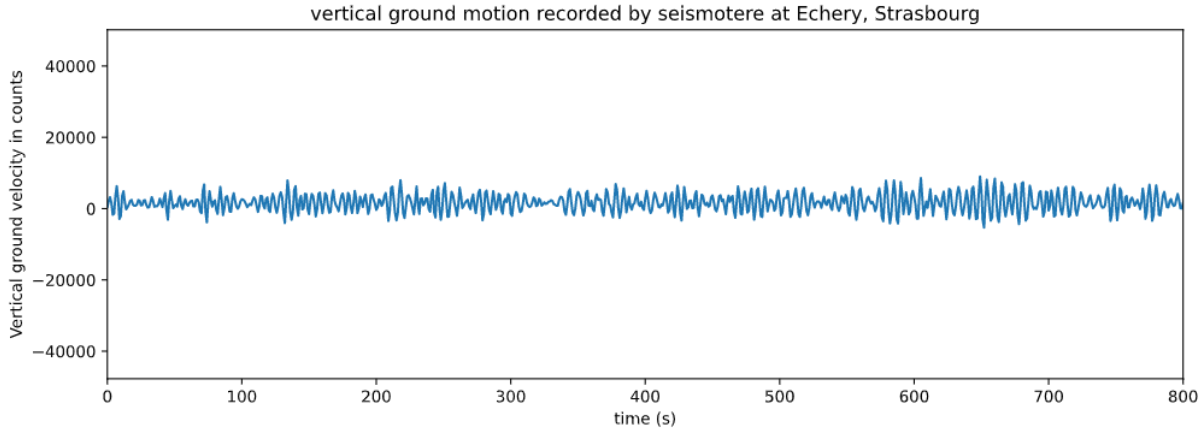
1. **What is the timestep of the signal?**

   1 second.

2. **Is there a periodic element to this signal? If so, what is the approximate period of this periodic element?**

   Yes, there is periodicity. T = 10 hours (from general view of the timeseries), T = 5 seconds, and T = 33 seconds (shown as 2 xlim code cells in jupyter). I add below my zooms for better visual understanding.





3. **Are there transient elements to this signal? If so, describe them.**

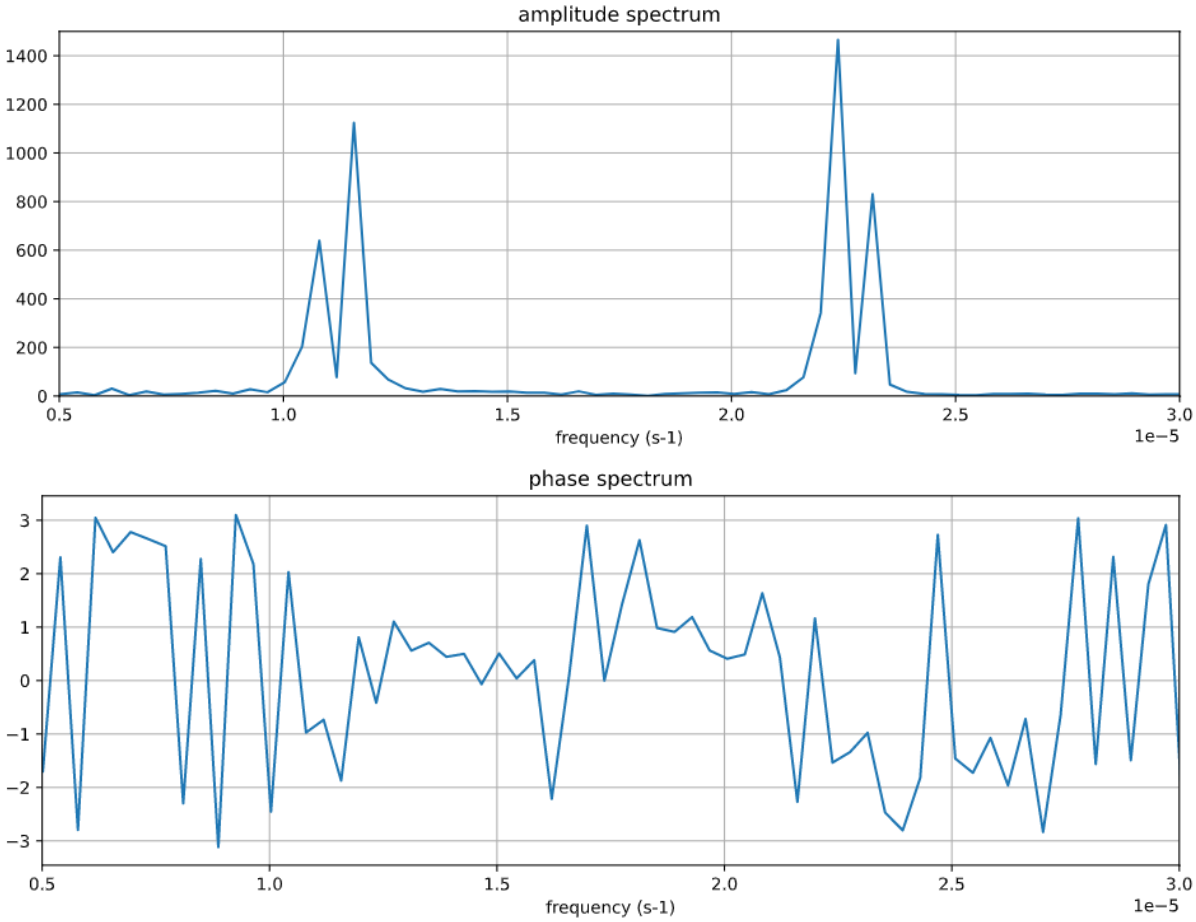
   Yes, it seems like there are some transient elements to this signal. I see huge spike at 6.5 days (0.5 * 1e6 at the plot), and two spikes at 8 and 9 days (0.7 * 1e6 and 0.8 * 1e6, respectively). Probably, some heavy vibrational events (maybe even earthquakes). Also, the signal is very noisy.

Question 3. Plot the data in the frequency domain

Ensure you:

- *Use the right time-step;*
- *Remove the mean of the data;*
- *Normalize the amplitude spectrum by 1e6;*
- *Plot only the positive part of the amplitude spectrum between 5μμHz and 30μμHz; scale the y-axis to show as much of the spectrum as possible;*
- *Plot the phase spectrum between the same two frequencies;*
- *Add titles and axis labels to both plots.*

[Add your plot here. Drag-and-drop the image from the Jupyter notebook or take a screenshot and upload the picture here.]



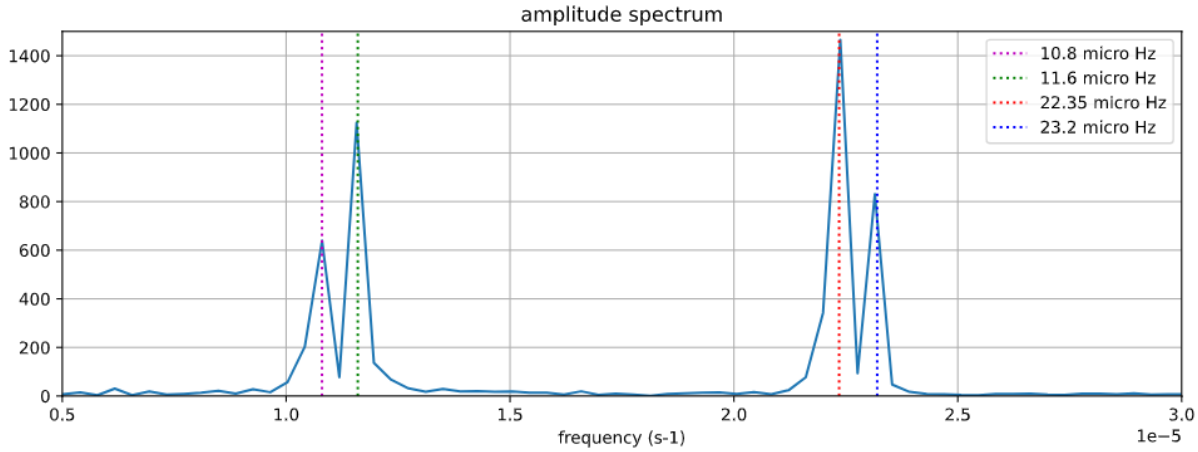
Question 4: Answer the following questions about the frequency domain data:

1. **What is the frequency resolution of your spectra?**

   df = 3.85 * 1e-7

2. **What are the frequencies of the peaks in the amplitude spectrum expressed in μHz?**

   f1 = 10.8 μHz, f2 = 11.6 μHz, f3 = 22.35 μHz, f4 = 23.2 μHz. I produced and add below my frequency peaks plot for better visual understanding.



3. **What are the periods corresponding to the peaks in the amplitude spectrum? Express them in hours.**

   T1 = (1 / (10.8 / 1e6)) / 3600 = 25.7 hours

   T2 = (1 / (11.6 / 1e6)) / 3600 = 23.9 hours

   T3 = (1 / (22.35 / 1e6)) / 3600 = 12.4 hours

   T4 = (1 / (10.8 / 1e6)) / 3600 = 11.97 hours

   So, we deal with approximately 12 hours and 24 hours periods.

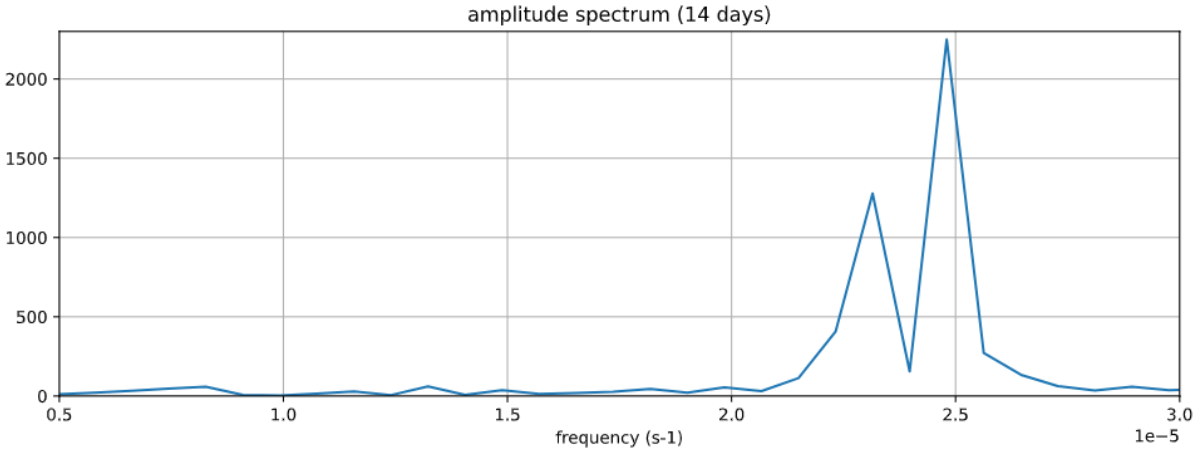
4. **Which (if any) of the peaks are harmonics?**

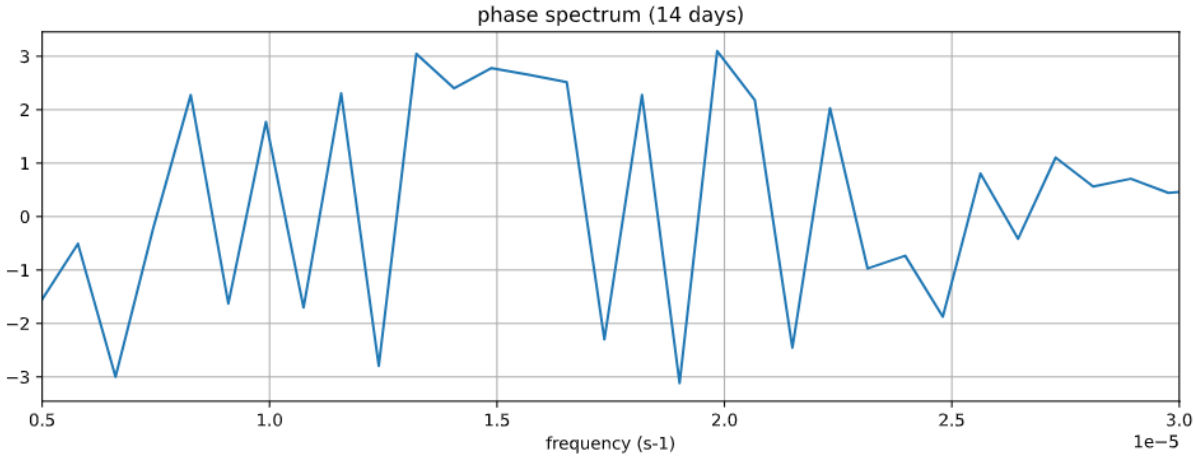
   I would say that 12 and 24 hours peaks are harmonics. So, the most close to them are peak 2 and peak 3.

Question 5: Analyse a shorter recording

1. **Make new frequency domain plots using only the first two weeks of the data.** *Use the same frequency bounds, but normalise by 0.5e6.*

[Add your plot here. Drag-and-drop the image from the Jupyter notebook or take a screenshot and upload the picture here.]





2. **What is the new frequency step**

   df = 8.26 * 1e-7

3. **Describe the changes in the amplitude spectrum and explain why they occurred.**

   Change in peaks placement on the spectrum occurred, because we see now only 14 days, which is half of the whole spectrum. Change in the amplitude of the peaks occurred, because we decreased the normalization value.