Aim: Exposure to sampled signals and their quirks, specifically (a) a periodic frequency representation, and (b) the fact that the period of a periodic signal is not necessarily the inverse of its frequency.
Task: Do the following assignment using Matlab. If you struggle with Matlab, remember the `help` and `lookfor` functions. Document the task in your practical book, indicating your methodology, theoretical results, numerical results and discussions. Graphs should have labelled axes with the correct units indicated.
Hint: plot "continuous-time" signals with Matlab's `plot` function, en discrete-time signals with `stem` instead.

1. **Simulation of continuous-time (analogue) sinusoidal signals:** We would like to have an analogue signal generator (like the ones in the fourth-floor lab) to generate signals that can then be digitised using the soundcard of the computer. Unfortunately this is currently not achievable and therefore we will simulate a signal generator in software in this section of the practical.

   Implement a Matlab function `function x = sinewave(A,F,t)` that computes the amplitude values of the sine wave $x(t) = A\sin(2\pi Ft)$ with maximum amplitude A, frequency F in Hz (cycles/second) and t an *arbitrary* time in seconds. Specifically ensure that `t` can be a vector of time values, for which `x` will be the corresponding vector of amplitudes. This function can now be regarded as a symbolic entity that simulates an analogue sine-wave generator. Test it by setting the parameters to $A = 2$ and $F = 50$ and checking the results by hand.

2. **Sampling of the continuous-time signal:** Take the sample indices as $n = 0, 1, \ldots, 39$ and the sampling frequency as $f_s = 2000$ Hz. Let $A = 10$ and $t = nT$ in all the following cases, where $T = 1/f_s$ is the sampling period. Evaluate the above function for $F = 0, 100, 900, 1000, 1100, 1900, 2000$ and 2100Hz and plot the result using the Matlab finction `stem`. Provide your plots with correctly scaled axes so that you can directly read off the correct time (in seconds) and amplitude. Explain your observations. How would you determine the digital frequency f_ω (cycles/sample) in the above cases? Verify your simulator above by determining the function $x[n] = A\sin(2\pi f_\omega n)$ directly for one of the above cases.

3. **Look closely:** You probably would have wondered about the strange shape of the sampled 900 Hz signal in Question 2. Sample this signal again, but this time let $n = 0, \ldots, 799$ and $f_s = 40000$ Hz. Plot the result using `plot` together with your previous version (plotted with `stem`) on the same axes. Comment on the result. (Repeat this process for the other signals above to obtain extra insight.)

4. **Sampling a sum of sinusoids:** Now use your Matlab function `sinewave(A,F,t)` to superimpose a 100Hz and a 2100Hz signal, each with an amplitude of 10, i.e. generate the signal $x(t) = 10\sin(200\pi t)+ 10\sin(4200\pi t)$. As before, take the sample indices as $n = 0, 1, \ldots, 39$ and the sampling frequency as $f_s = 2000$ Hz, with $t = nT$. Plot the sampled signal, and explain your observations.

5. **The period of a discrete-time signal:** What are the periods T_p (in seconds) of the continuous-time 100 Hz en 900 Hz signals $x(t)$ above? What are the periods N_p (in samples) of their sampled versions $x[n]$? (No, the sampled 900 Hz signal does not have a period of 2.2! Make sure that $x[n + N_p] = x[n], \forall n$.) What is the equivalent period in terms of seconds? Explain! What would N_p be for $\Omega = 900$ rad/s? (No, it is not 13.96!)