# Eksamen 2023

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Indholdsfortegnelse

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[b. What’s the Nyquist sampling frequency? Sketch the spectrum S(f) considering that fs = 2 kHz from −10 kHz to 10 kHz. Write in the sketch the key amplitudes and frequencies. [7 Points] 2](#_Toc170284312)

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## Opgave 1

For a message signal

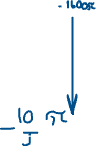
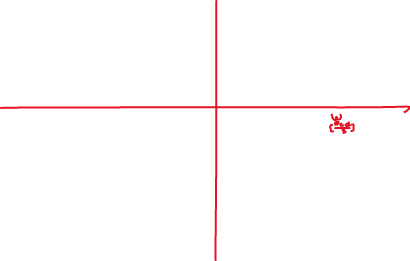
### Compute the Fourier transform of the message signal. Sketch the spectrum. Write in the sketch the key amplitudes and frequencies.

Fourier transform is a linear operator so I can just take the Fourier transform of all the parts and add them together afterwards.

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Automatisk genereret beskrivelse

Using the linearity property as well.

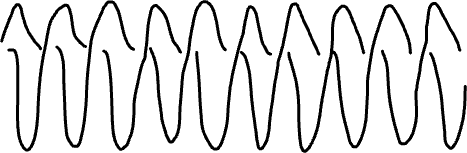
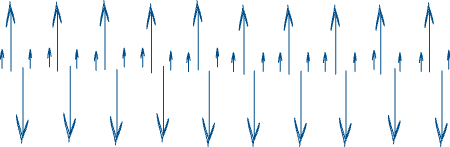


### What’s the Nyquist sampling frequency? Sketch the spectrum S(f) considering that fs = 2 kHz from −10 kHz to 10 kHz. Write in the sketch the key amplitudes and frequencies. [7 Points]

As the frequencies are going from , the bandwidth is then

The nyquist rate would then be twice the bandwidth.

Now sketching it:



With the switching curves I’ve drawn it should be easier to see that with this sample frequency, the signals would overlap.

### The signal is then fed into a uniform quantizer of the midrise type. The total number of representation levels L = 32. Calculate the power of the quantization noise σQ2 . [7 Points]

As it’s a uniform quantizer of the midrise type doesn’t affect the power for us.   
Midrise just centers within two levels, whilst the midtread is put at a level.  
  
For both of these the average signal noise power can be calculated from:

In where ∆ being the step size.

The step size can be calculated from

Where is the amounts of bits required to represent these amounts of levels *L*.

The power of the quantization noise is then.

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### Modulate the quantized signal using BPSK: ’-1’ and ’1’. Transmit it over an AWGN channel with noise power σN2 . What’s the error probability when symbol ’1’ is transmitted? [7 Points]

So I’ve been implementing it all in matlab.   
As the way we plot on computers are by a discrete array, we are already using sampling.

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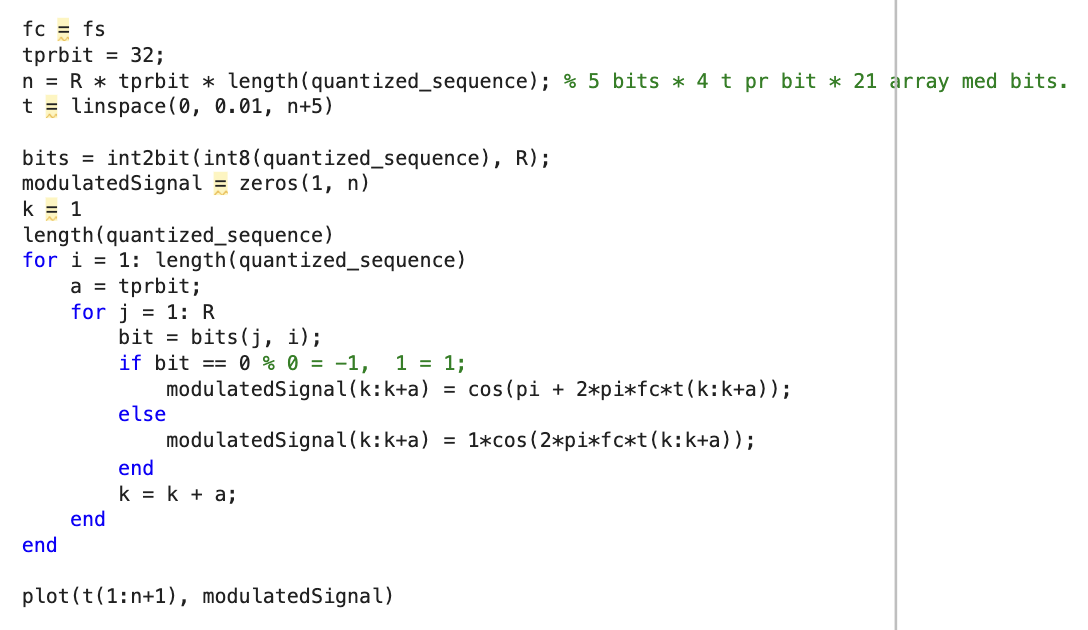
Automatisk genereret beskrivelseI am then just making an array at every from 0 -> 10ms

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Automatisk genereret beskrivelseI then make the quantization sequence with levels ranging from , by taking the amplitude, dividing it by the step height, and finding the nearest level.

To make it a signal again the level \* the height pr. Level, aka the delta can be assigned to a variable.



For the BSPK modulation I iterated over every bit sequence, over every bit. If it were a 0 I added function values of size to an array of BPSK modulated values



Equivalent to

For the bit being 1 I added the function values of value

being a value of I added, for the plot not two be of a single point for every bit, but rather a wave form. As I didn’t get any wanted carrier frequency, I set my carrier frequency equal to the sample frequency.

Plotting it with the time points for every bit set two 32:

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With a full plot on the right and zoomed in on what looks like one fundamental period.

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Now wanting to add noise of AWGN I use the matlab command for awgn which takes in a vector, and a SNR, and returns and array with noise.

When plotted I get a signal identical to the one without noise. It’s weird that it’s as identical to the nonnoise signal. But I guess, that it had a large SNR of 1533 and SNRdB of about 63, which is pretty high and can justify tself even hswgint aoisle nl ookinglike it

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## Opgave 2

## Opgave 3

## Opgave 4