# Aflevering 1

Af Jesper Bertelsen, AU-ID au689481

Indholdsfortegnelse

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## Opgave 1

Derive an approximation to the output of a phase modulator with input , under the condition that and . What is the approximate spectrum of this phase-modulated signal.

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Automatisk genereret beskrivelseHint: Use the same approach as slides 17 and 18 of chapter 4, this time for a PM signal as shown below:



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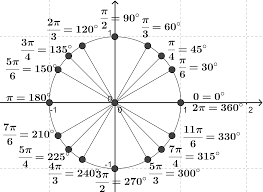
Approksimer

If I look at our signal compared to the general PM signal, then

takes it first value at 0 and



Now expanding the PM signal with a trigonometric identity.



If then only takes values from



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Automatisk genereret beskrivelseThen expanding the sin cos part by a trigonometric identity

Seeing that the sinusoidal functions just take to different frequencies. I say that

Making the expression:

Now doing fourier transform of that:



Drawing it:



For simplicity,



## Opgave 2.

An FM signal is applied to a square-law device with output voltage related to input voltage by

,  
where *a* is a constant. Explain how such device can be used to obtain an FM signal with a

greater frequency deviation than that available at the input.

Definition of a FM signal:

Where

If

Then

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Then the frequency deviation gets timed 2.

The frequency deviation for the signal will then be of time 2 of the original frequency deviation.

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## Opgave 3

Consider a zero-crossing detector for demodulating an FM signal. Show that the instantanous frequency of the input FM signal is proportional to the number of zero crossings in the time interval , divided by . Assume that the modulating signal is constant during this time interval.

**Hint 1:** Assuming *n* zero crossings in the interval, the phase difference will be:

.

**Hint 2:** The angle of a FM signal is:

**Hint 3:** The instantanous frequency of a FM signal is

Okay then let me substitute some values for the equations:

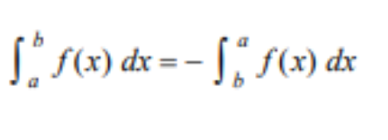
Now looking at the parts:



Now substituting that back:

Factoring the integrals:

Seeing some known integration properties.

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Solving for *n* and simplifying.

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Taking our previous expression were was in and solving for :

Now substituting:

Which is of form.

Where

The only thing changing in the proportional factor is the amount of zero crossings.

Depending on the time, the function divided by its integral from the T1 to T2 might change as these limits are set around the time. This may also affect the system.