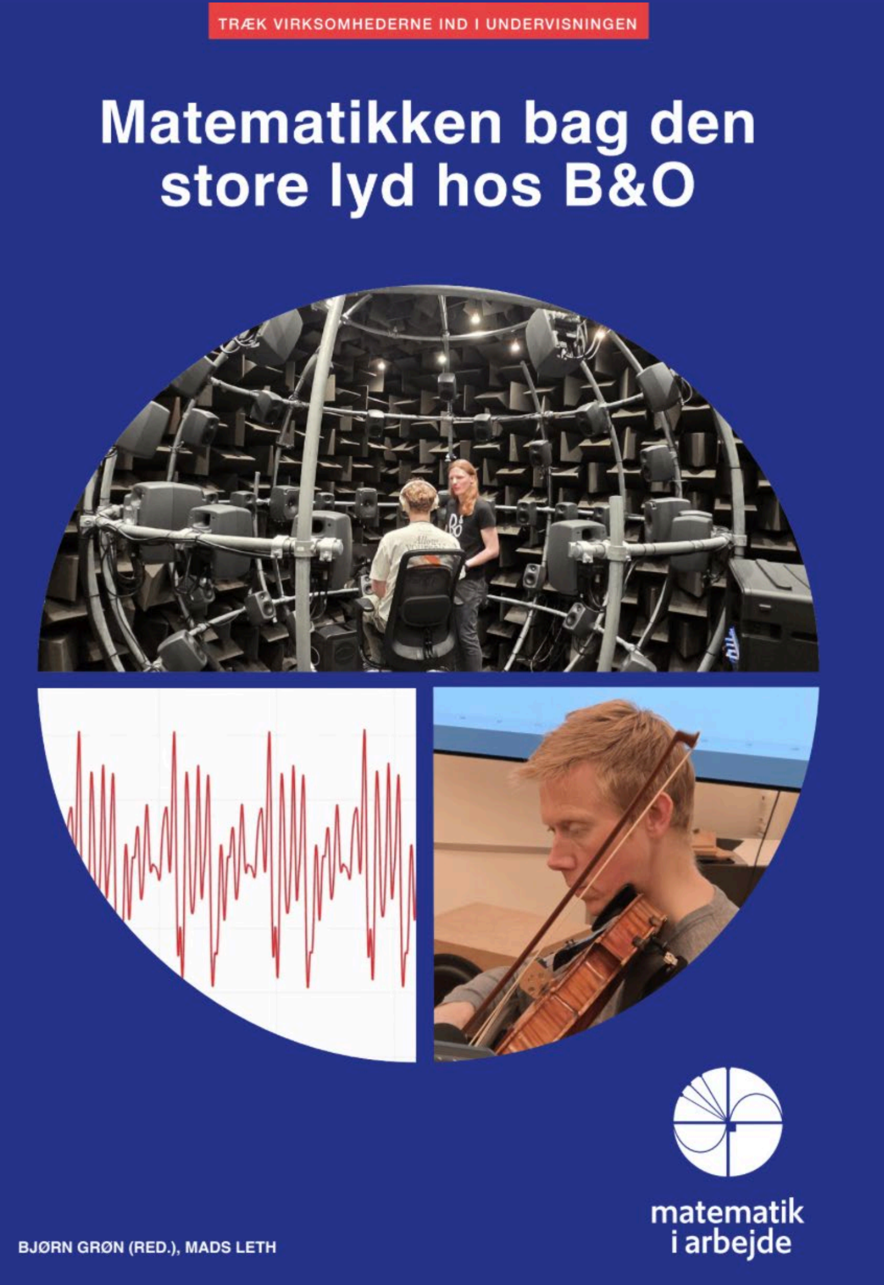
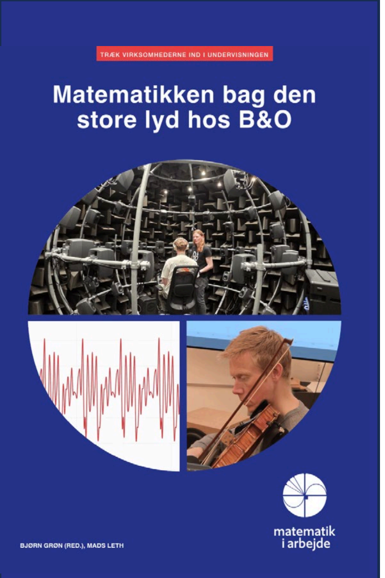


B&O

Mikkel Rønne
Bjørn Grøn

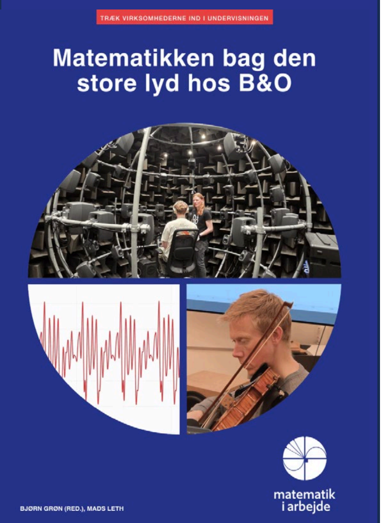
Træk virksomhederne ind i undervisningen
November 2025

matematik i arbejde



Indholdsfortegnelse

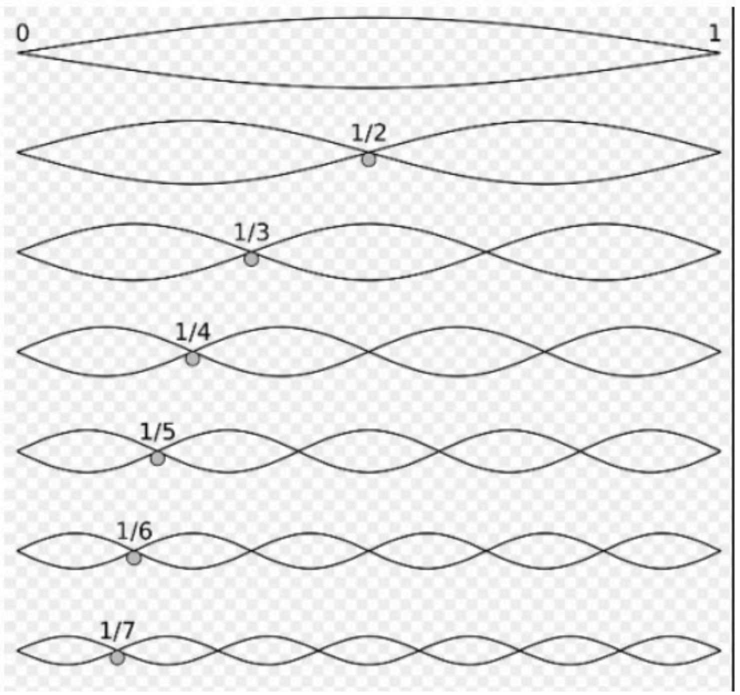
matematik i arbejde



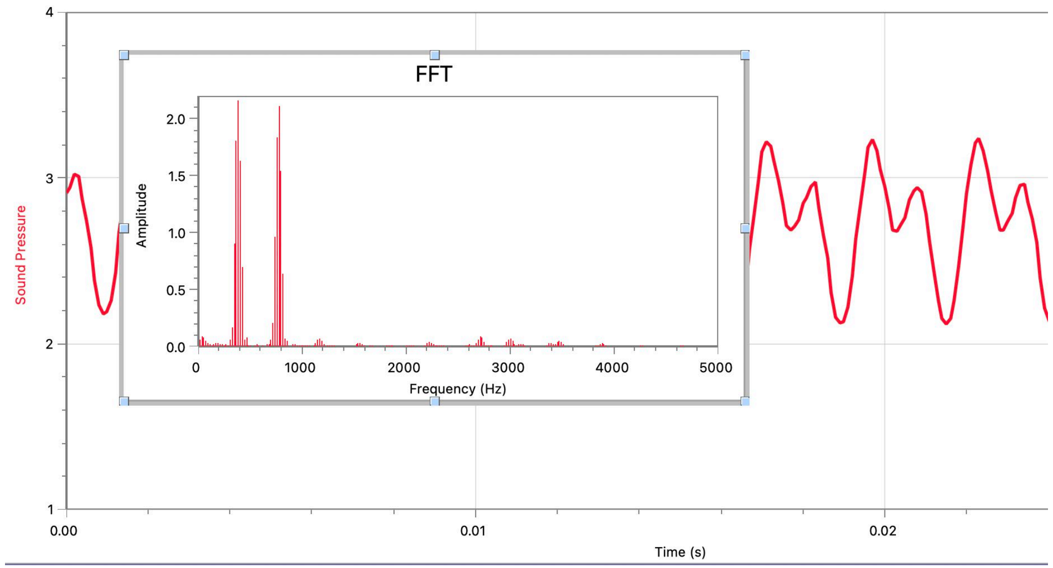
matematik i arbejde

Overtoner og musikinstrumenter Frekvensspektre

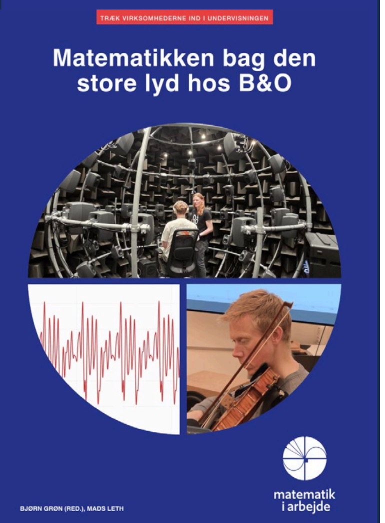
Stående bølger



Eksempel på en mennesketone analyseret med FFT (Fast Fourier Transform) - LoggerPro)

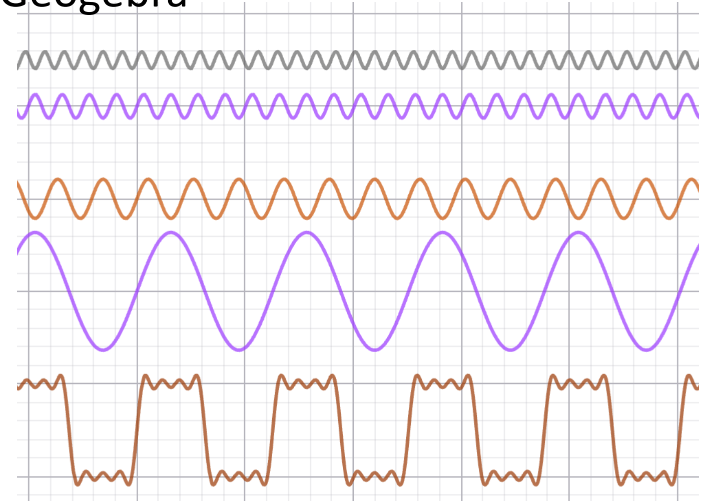


Materiale: s.23-24, s.63-73
Film: Overtoner 11.45-16.53,
Frekvensspektrum: 16.53-18.09



Fourierrækker

Geogebra

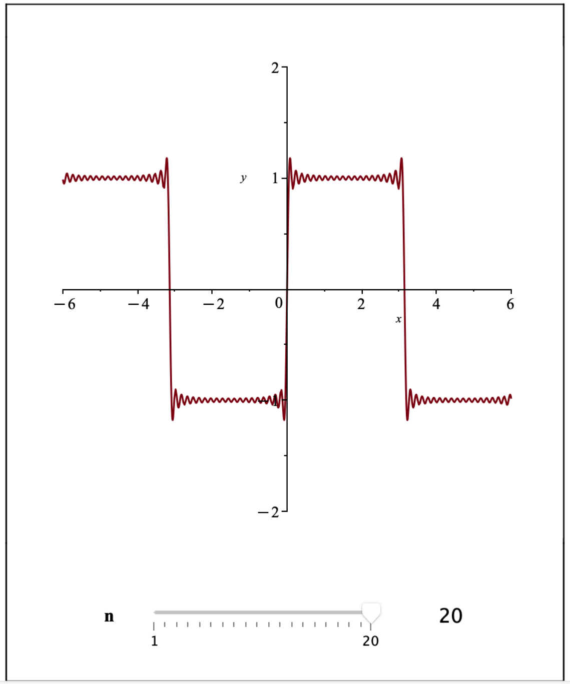


$$\sum_{1}^{4} f_i(x)$$

$$f_n(x) = \frac{4}{\pi \cdot (2n+1)} \cdot \sin((2n+1)x)$$

$$Explore\left(plot\left(\frac{4}{\pi} \cdot \sum_{i=1}^{n}\left(\frac{1}{2 \cdot i - 1} \cdot \sin((2 \cdot i - 1) \cdot x)\right), x = -6..6, y = -2..2\right), parameters = [n = 1..20]\right)$$

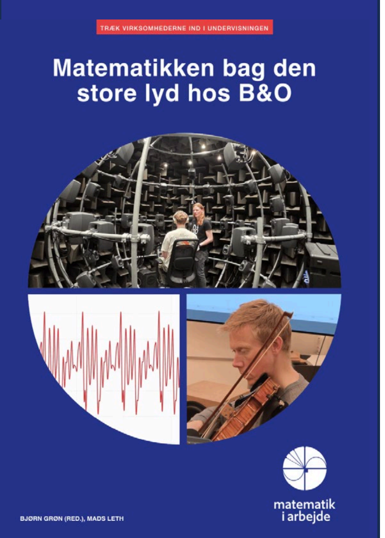
Maple



$$\sum_{1}^{20} f_i(x)$$

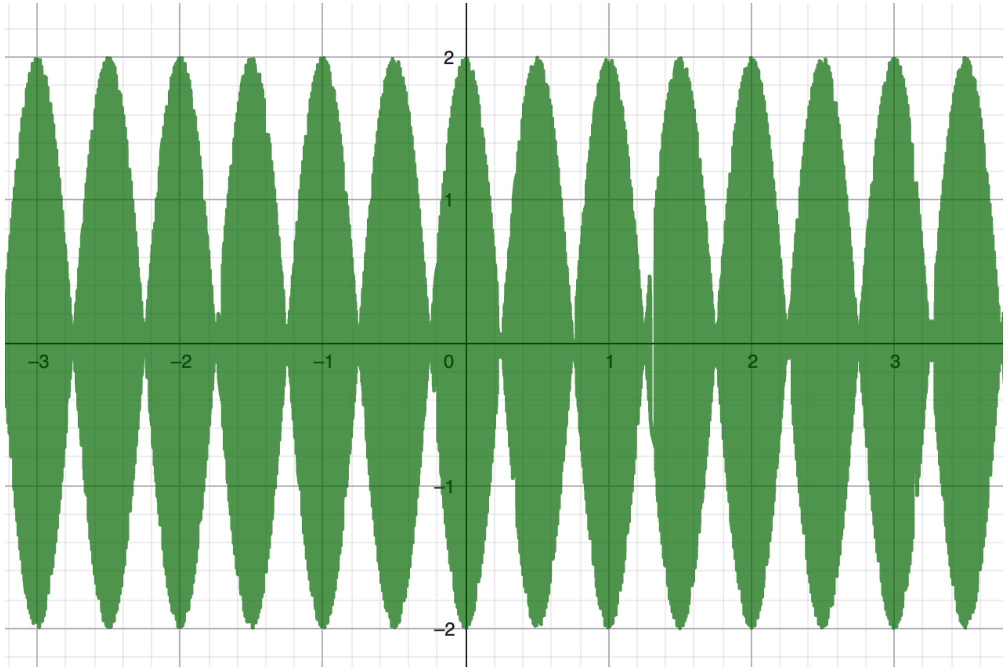
Materiale: s.62-73

matematik i arbejde



Stødtoner

$$f(x) = \sin(2\pi \cdot 440x) + \sin(2\pi \cdot 442x)$$



Additionsformler

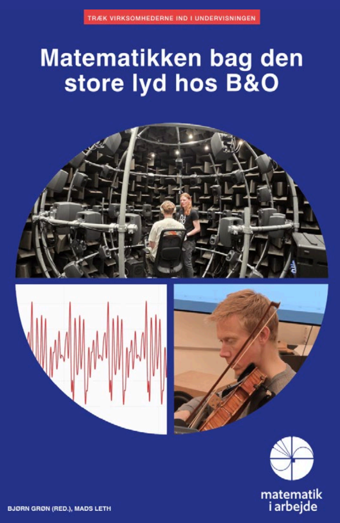
$$\sin(u+v) = \sin(u)\cdot\cos(v) + \cos(u)\cdot\sin(v)$$
$$\sin(u-v) = \sin(u)\cdot\cos(v) - \cos(u)\cdot\sin(v)$$

Logaritmiske formler

$$\sin(x) + \sin(y) = 2\cdot\sin\left(\frac{x+y}{2}\right)\cdot\cos\left(\frac{x-y}{2}\right)$$

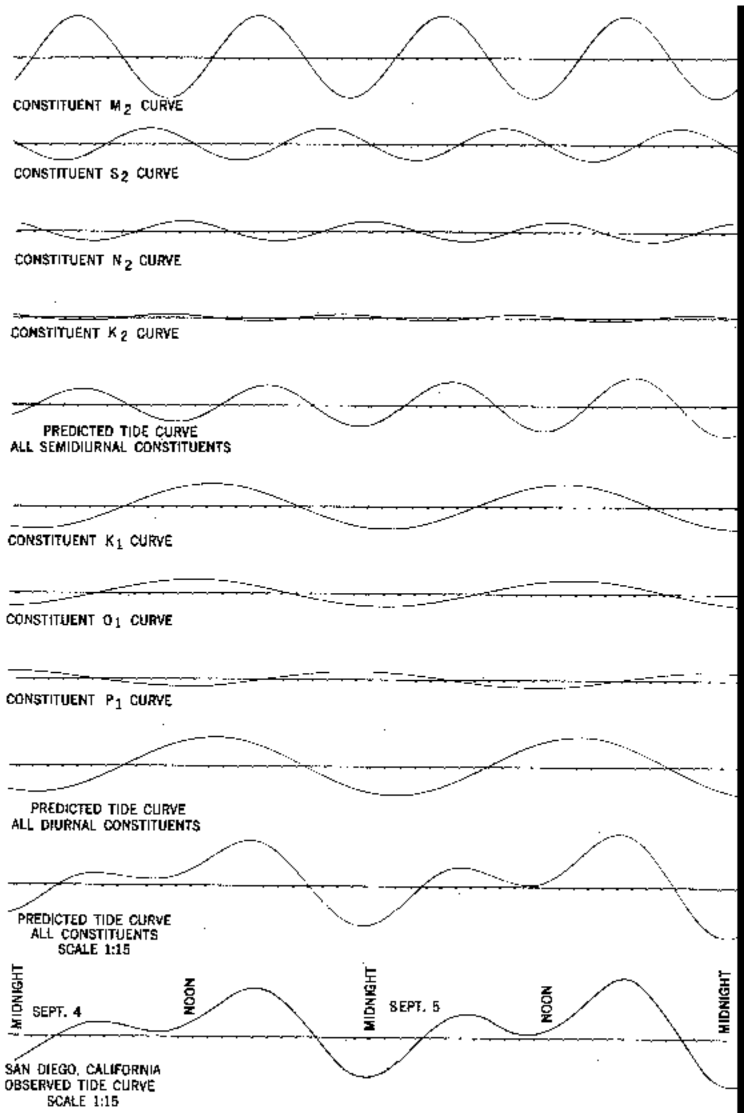
Materiale: s.25-28

matematik
i arbejde



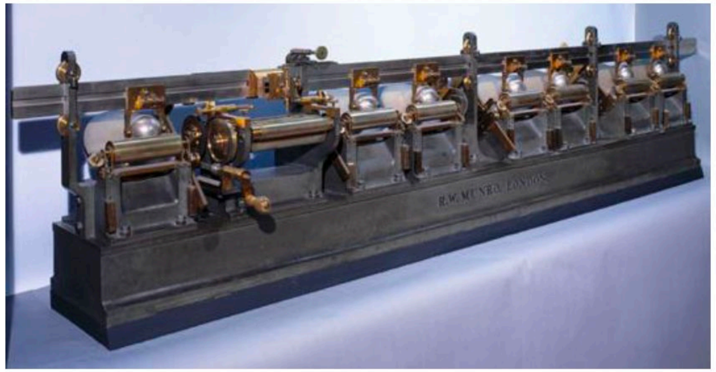
matematik
i arbejde

Modellering med trigonometriske funktioner



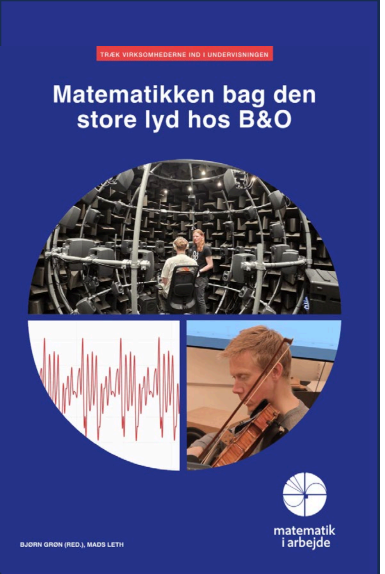
Tidevand

Højvande og lavvande i Port St. Ives, Cornwall, England.

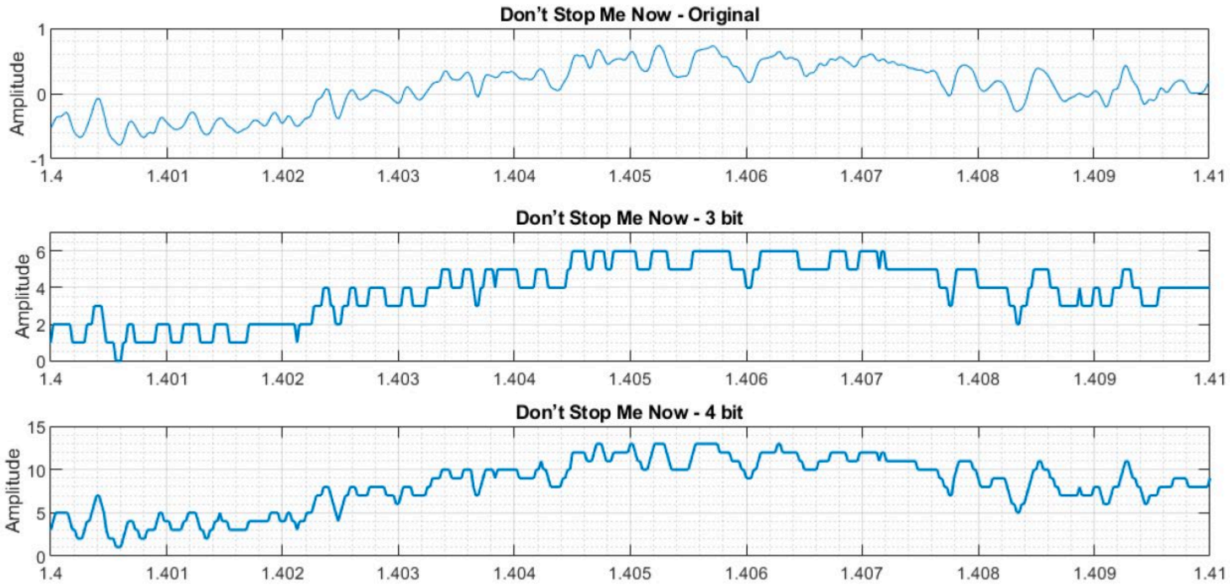


Kelvins harmoniske analysator fra 1878. Den opbevares i dag på Science-museet i London.

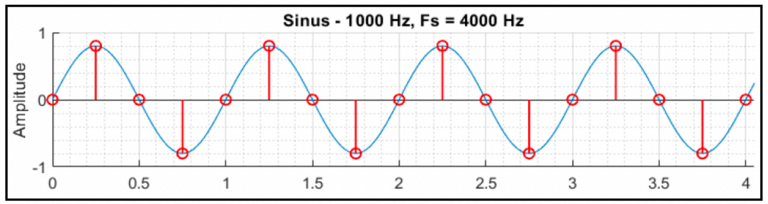
Materiale: s.50-61
Film: Modellering af lyd 6.35-11.45



Sampling og det binære talsystem



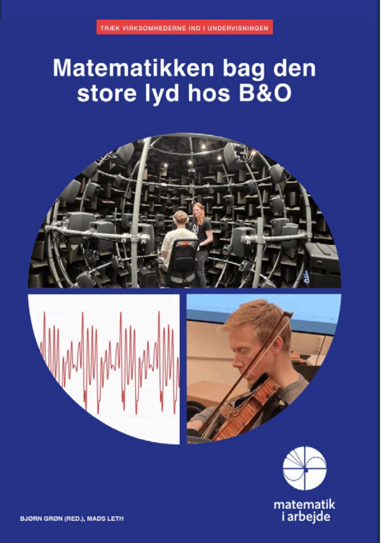
Nyquist-teoremet



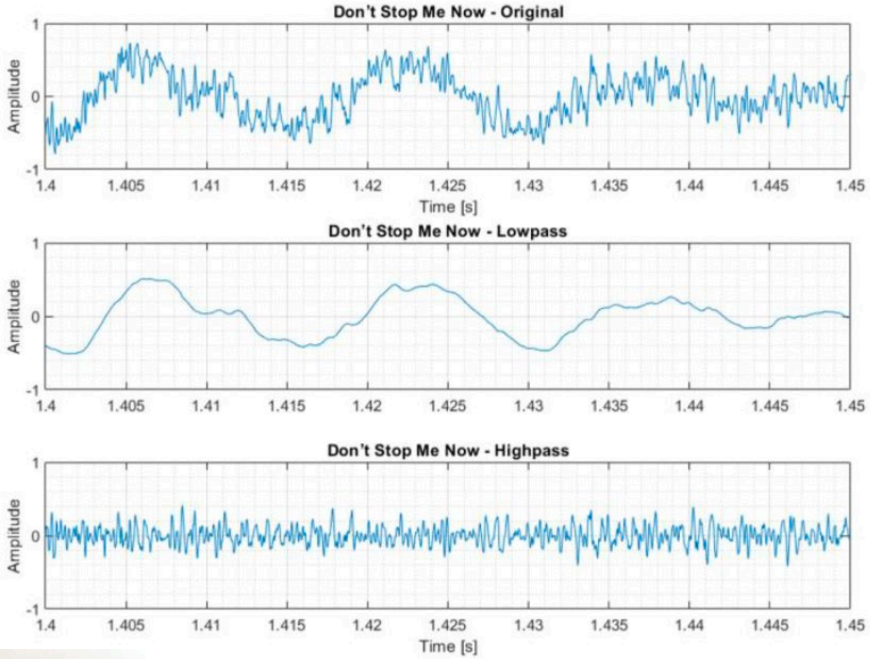
Position	7	6	5	4	3	2	1
Værdi	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Tæller antal…	64'ere	32'ere	16'ere	8'ere	4'ere	2'ere	1'ere

Materiale: s.74-89
Film: 21.26-34.26

matematik i arbejde



Filtre og støjreduktion

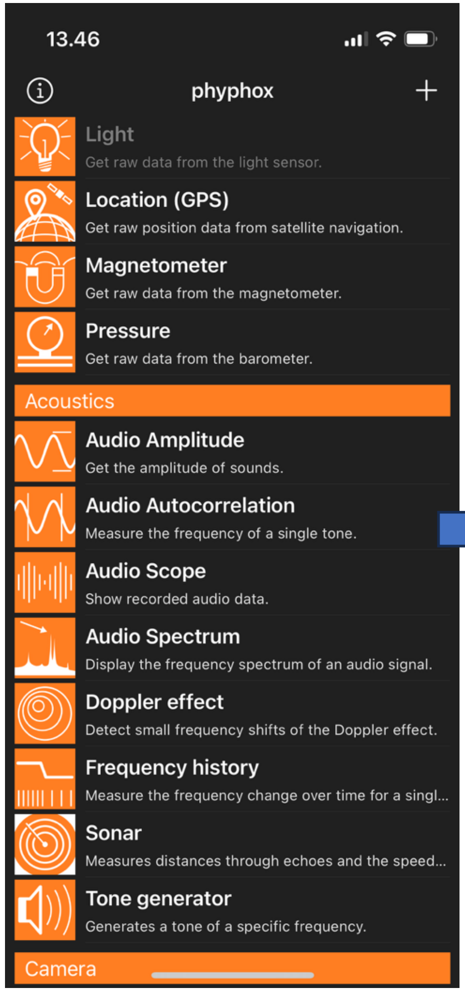


Materiale: s.90-96
Film: 34.26-

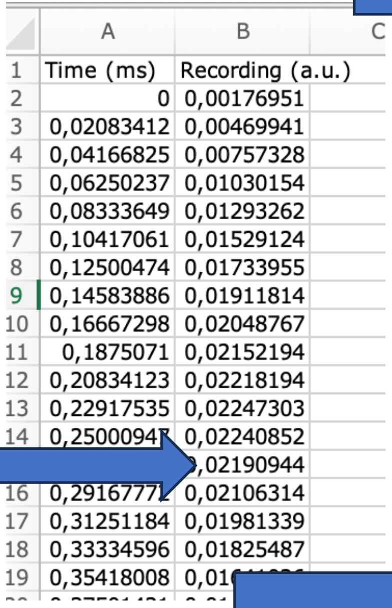
matematik i arbejde

Måling af lyd med mobiltelefonen

PhyPhox

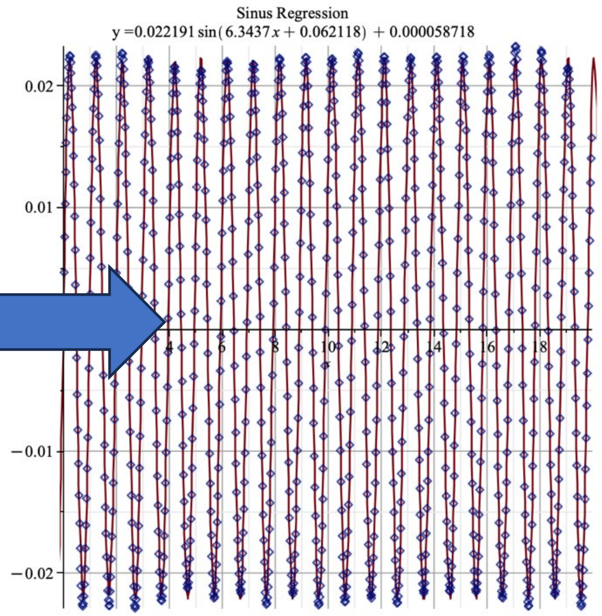


Excel

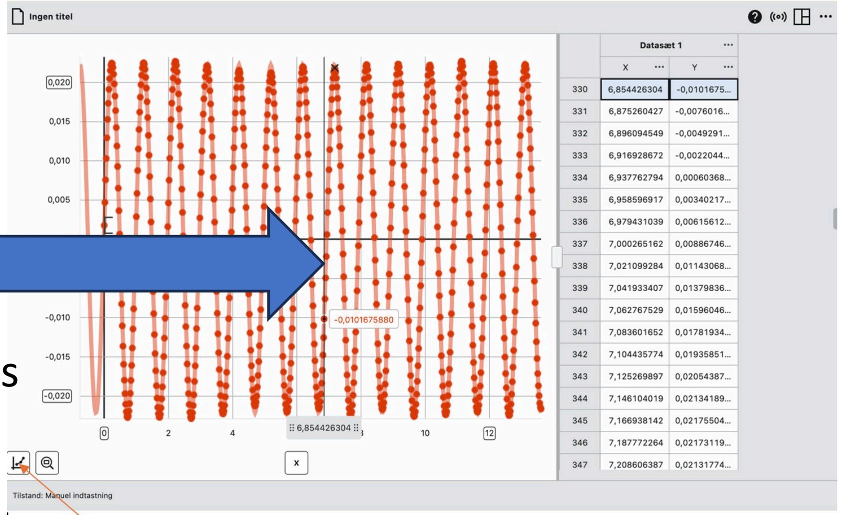


	A	B	C
1	Time (ms)	Recording (a.u.)	
2	0	0,00176951	
3	0,02083412	0,00469941	
4	0,04166825	0,00757328	
5	0,06250237	0,01030154	
6	0,08333649	0,01293262	
7	0,10417061	0,01529124	
8	0,12500474	0,01733955	
9	0,14583886	0,01911814	
10	0,16667298	0,02048767	
11	0,1875071	0,02152194	
12	0,20834123	0,02218194	
13	0,22917535	0,02247303	
14	0,2500094	0,02240852	
		,02190944	
16	0,2916777	0,02106314	
17	0,31251184	0,01981339	
18	0,33334596	0,01825487	
19	0,35418008	0,01	

Maple

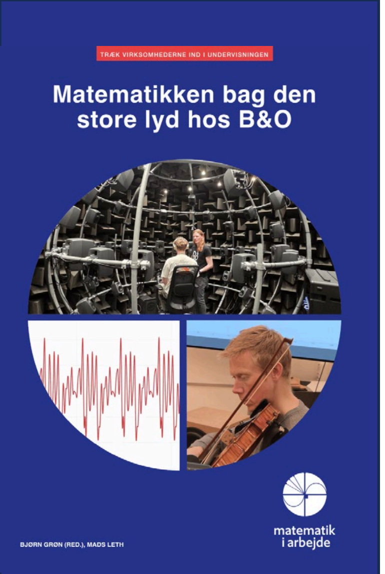


Vernier: Graphical Analysis



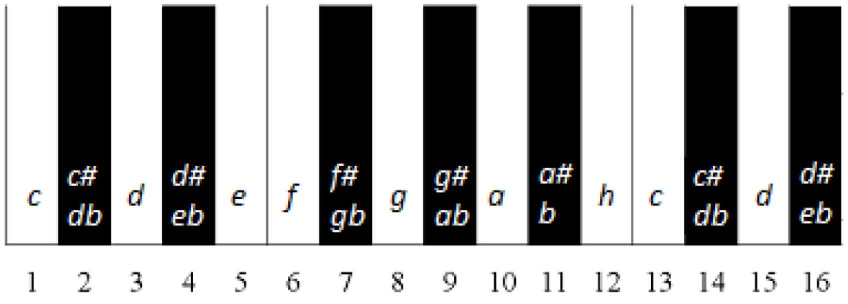
Kurvetilpasning

Materiale: Findes ikke i materiale



Matematik og musik: Talteori, når frekvensen fordobles

Hvordan stemmes de 12 toner indbyrdes



$$a^{12} = 2\ ?$$

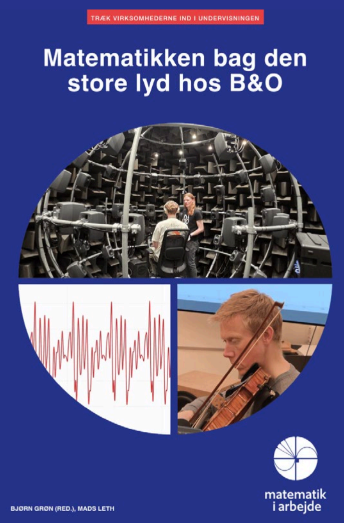
frekvenserne er bestemt af bølgelængden

De *rene*)* intervaller	Strengelængde L = hele strengen	Frekvensforhold
Oktaven	$\frac{1}{2} \cdot L$	2
Kvint	$\frac{2}{3} \cdot L$	$\frac{3}{2}$
Kvarten	$\frac{3}{4} \cdot L$	$\frac{4}{3}$
Stortertsen	$\frac{4}{5} \cdot L$	$\frac{5}{4}$
Lilletertsen	$\frac{5}{6} \cdot L$	$\frac{6}{5}$

https://upload.wikimedia.org/score/2/c/2cta7in0ywge9ht097nes0607drdakq/2cta7in0.mp3

Materiale: s.32-48
Film: 21.26-34.26

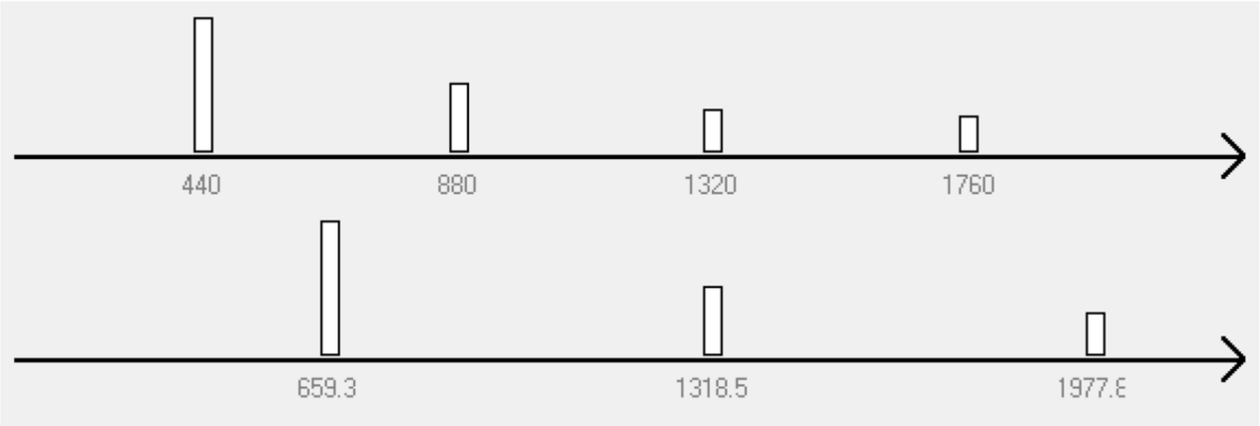
matematik i arbejde



matematik i arbejde

Matematik og musik: Trigonometri og logaritmer

Kvinten og oktaven? Svævning



Tonen *a* har partialtonerne 440 Hz - 880 Hz – 1320 Hz -1760 Hz -2200 Hz …

Tonen *e* har partialtonerne 659.3 Hz -1318.5 Hz – 1977.8 Hz -2637.0 Hz …

Materiale: s.32-48

Film: 21.26-34.26

Cent-funktionen

$$\text{cent}\left(\frac{f_1}{f_2}\right) = 1200 \cdot \frac{\log_{10}\left(\frac{f_1}{f_2}\right)}{\log_{10}(2)}$$

$$\text{cent}\left(\frac{3}{2}\right) = 1200 \cdot \frac{\log_{10}\left(\frac{3}{2}\right)}{\log_{10}(2)} = 702$$