

Periodic symmetry

- Every function $g(\)$ may be made π -periodic with an overlap and add

Review of nomenclature

FT type	time	limits	freq.	limits
DTFT 48	h	\leq		

Periodic sampling 140



Periodic sampling

■ Every periodic function $g(\cdot)$

Basic symmetry

- Periodic impulses 143

Applications of PSF

■ Let $(\cdot) = (j\Omega)$.

■ Modulation formula:

$$\overline{(\cdot)} = (\cdot) (\cdot -) - \int_{-\infty}^{\infty} j\Omega - j \overline{(\cdot)}$$

Pulse train modulation

- General case of time modulation

$$\text{---} () (-)$$

Effect of increased sampling rate



Effect of decreased sampling rate

■ When T_s is doubled (f_s halved),

Harry Nyquist

Nyquist sampling theorem 1928

Some issues to think about



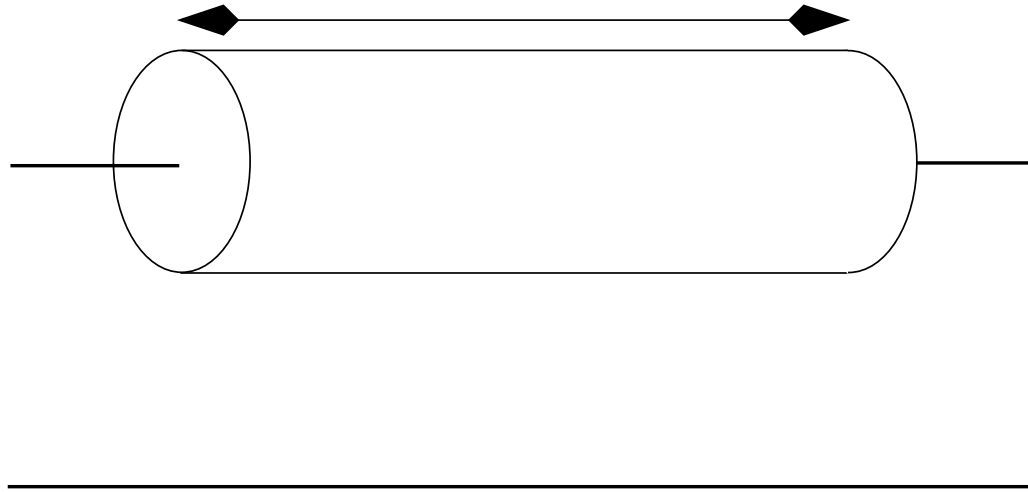
Poisson Summation Formula





Nyquist's 2^d famous problem

- At $\omega = 0$, remove the resistors



DT processing of CT signals 4.4

Two basic type of C/D/C systems

- There are two basic categories of C/D/C systems:
- **Real-time** processing:
 - Any application where 1 sample in gives 1 sample out is a **real-time** method
- **Non-real-time** processing:
 - **non-real-time I** applications are those where input time and output time are different,
or
 - **non-real-time II** where the computation time takes so much time that the processing cannot keep up



Non-real-time

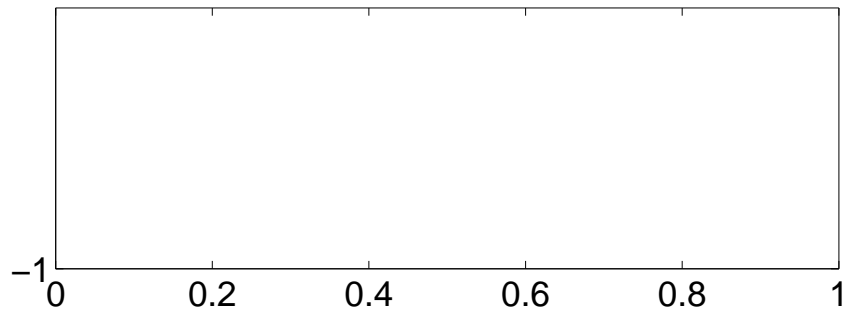


From frequency to time by OLA

- Expand signal ()

Aliasing 4.1-4.3 147-149

- Example of decimation-aliasing of a tone:



Down-sampling 158



Ideal differentiator 158

- Suppose we wish to differentiate a continuous input signal

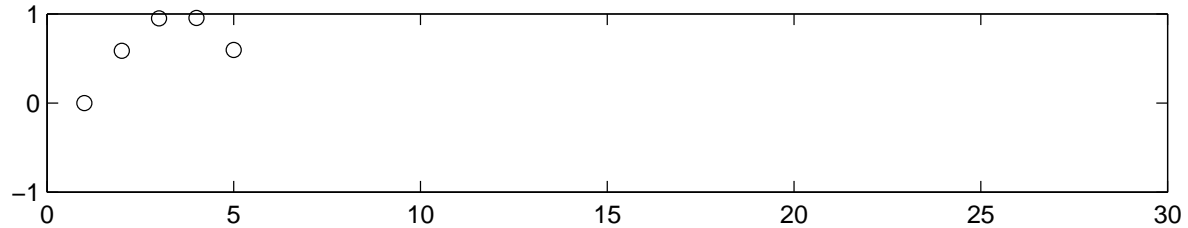
$$y(t) = \frac{dx(t)}{dt}$$

- This causal



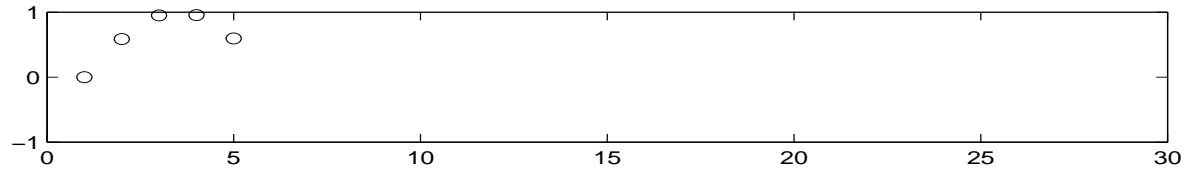
Upsampling by linear interpolation I

- When upsampling, we need to interpolate the new samples ([Matlab help upsample, interp](#))



Upsampling by linear interpolation II

- Frequency response of a linear interpolator



DT processing of analog signals 4.8 185

Traditional C/D conversion

- Traditional converter requires a high order filter





Oversampling C/D conversion I

- Modern C/D conversion: 768x (2^8) oversampled -

<http://courses.ece.uiuc.edu/ece310/Allen/sigmadelta.html>

Amplitude Quantizer

- Digital signals are both discrete in time and amplitude
- Values [are two's complement

Quantization noise 4.51 195

■ Error for a 3 and 8 level quantizer



Analog Devices AD-1835A



References

Nyquist, H. (1928). "Thermal agitation of electric