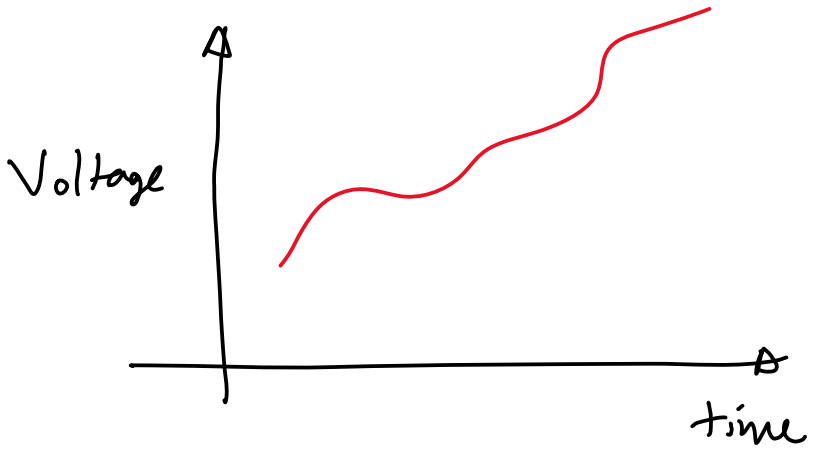
Data acquisition

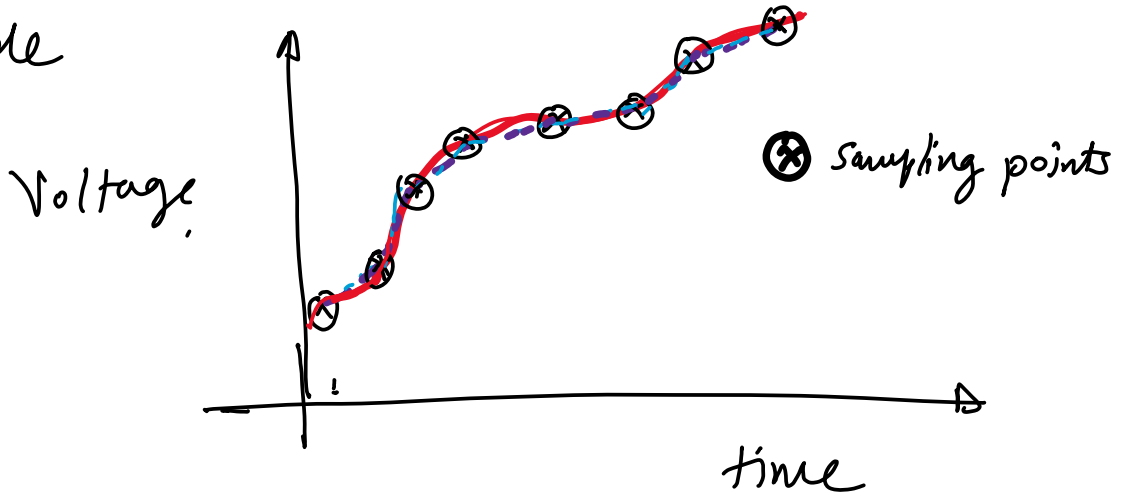
1. Data sampling
2. Data quantization



How a computer / microcontroller can acquire, save, use this analog voltage?

① Data Sampling

Example



actual signal — reproduced signal - - -

look similar, so the sampling frequency is good.

What is a good sampling frequency?

Shannon sampling theorem

- f_s is the sampling frequency (?)
- f_{max} is the maximum frequency of the signal
  - ↳ fourier series

To capture the frequency content of a signal

$f_s \geq 2 f_{max}$ $\quad 2f_{max}$ ~ Nyquist frequency.

Illustrates Shannon's sampling theorem.

$V = \sin(2\pi t) \rightsquigarrow \sin \omega t$

$\omega = 2\pi$

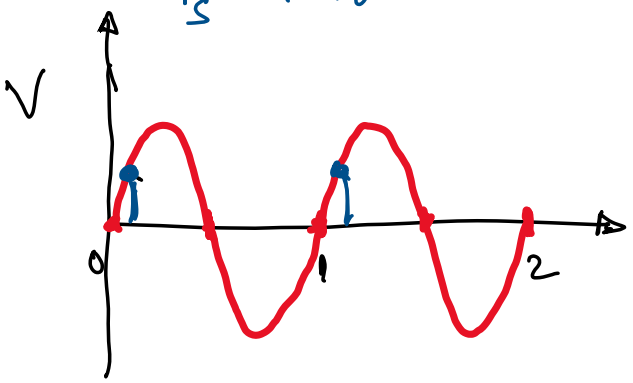
$T = \frac{2\pi}{\omega} = \frac{2\pi}{2\pi}$

$T = 1$; $f = 1$ Hz

$T = 1$ sec

$f = \frac{1}{T} = 1$ Hz

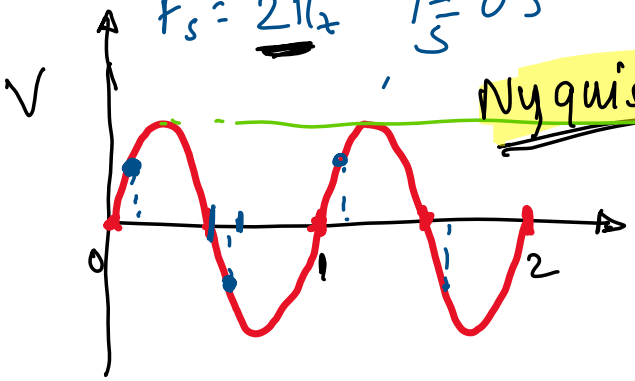
$f_s = 1$ Hz

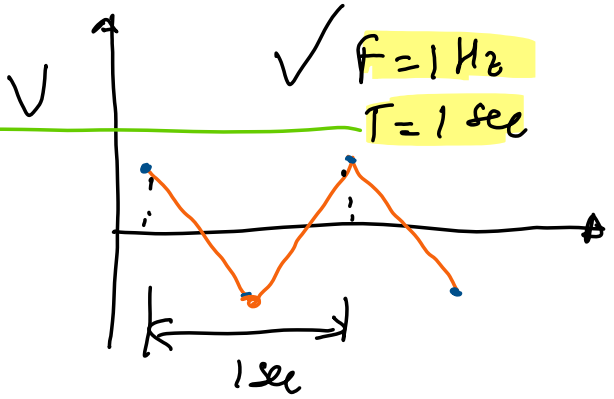


no frequency content

$f_s = 2$ Hz $T_s = 0.5$

Nyquist

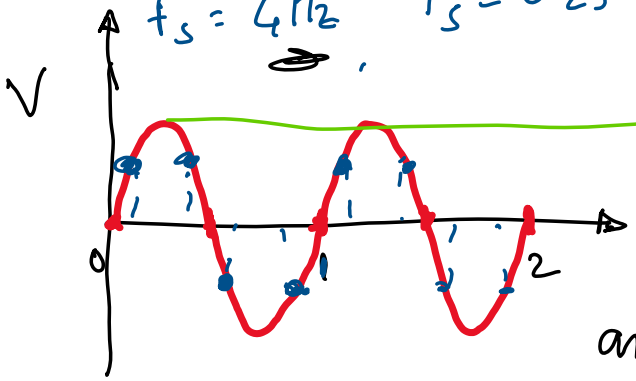




✓ $f = 1$ Hz

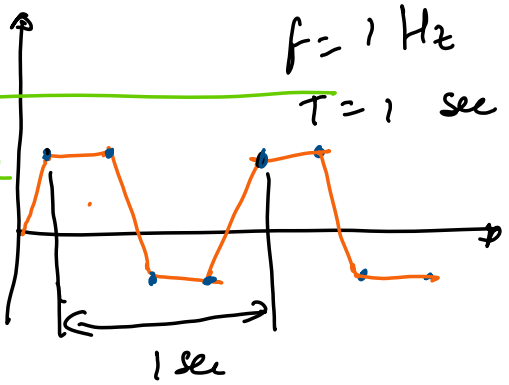
$T = 1$ sec

$f_s = 4$ Hz $T_s = 0.25$



amplitude is wrong

anti-aliasing



$f = 1$ Hz

$T = 1$ sec

EXAMPLE:

$$V = 5\cos(\pi t)\cos(4\pi t)\cos(8\pi t)\cos(16\pi t)$$

Compute the Nyquist frequency.

Solution:

$16\pi t$ is the fastest frequency. We will base our calculation on this frequency

$$\cos(2\pi f_{max} t) = \cos(16\pi t)$$

$$2\pi f_{max} = 16\pi$$

$$f_{max} = 8 \text{ Hz}$$

Nyquist frequency $= 2 f_{max} = 16$ Hz