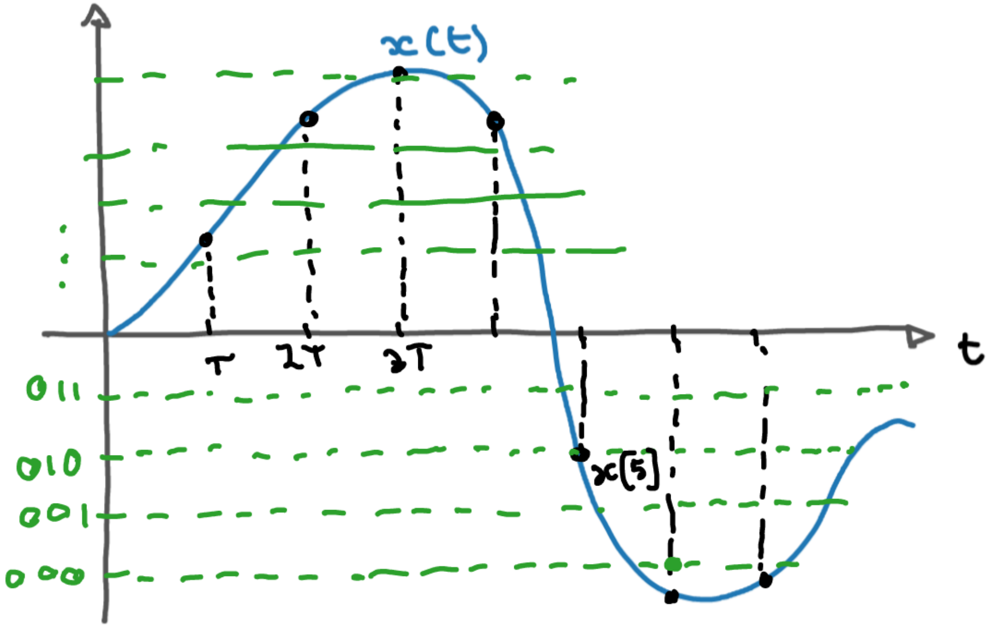
Analog-to-digital conversion

Quantisation and sampling

Herman Kamper

Analog-to-digital conversion

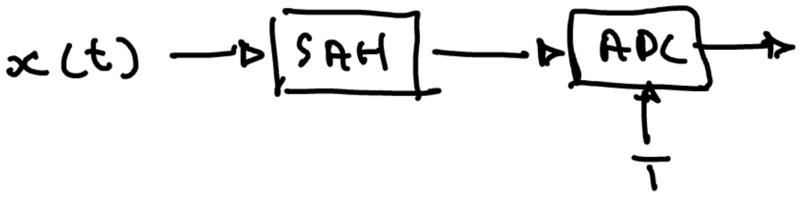


$$x[n] = x(nT)$$

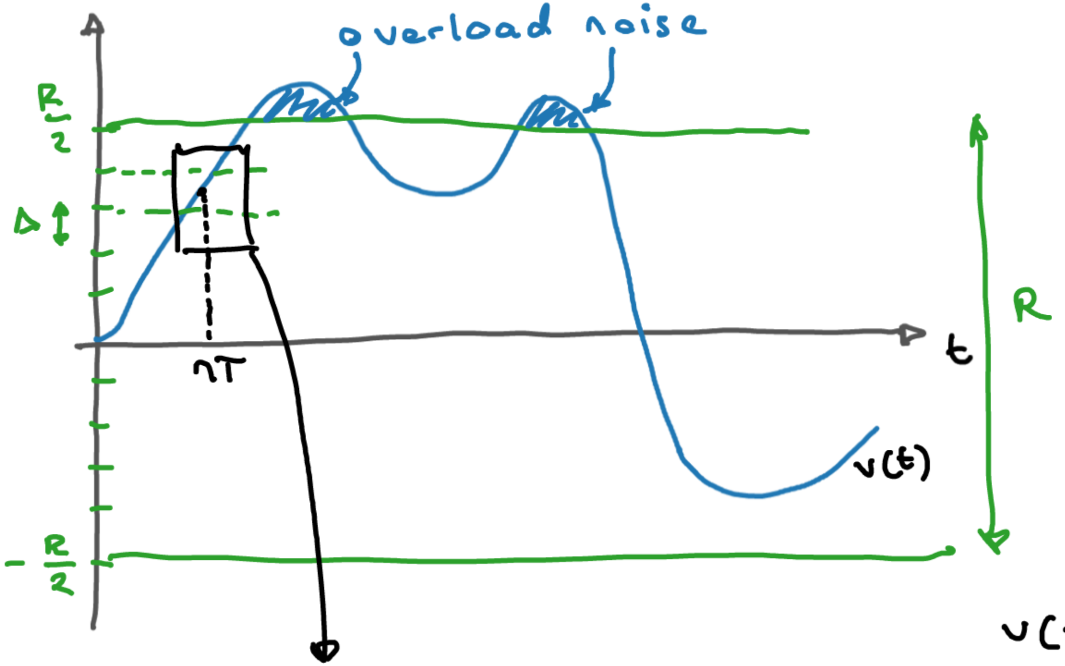
discrete (index n); continuous (nT)

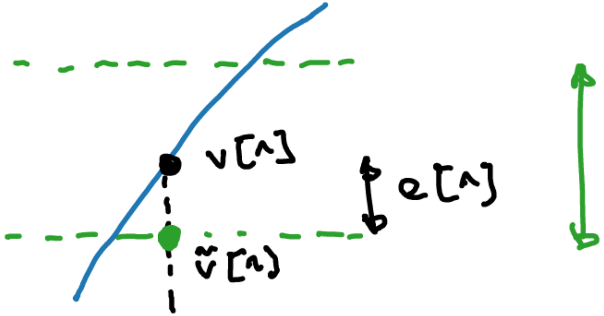
Two ways things get mapped:

1. Discrete in time
2. Discrete amplitude

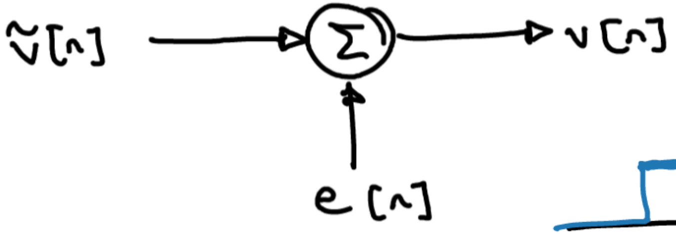


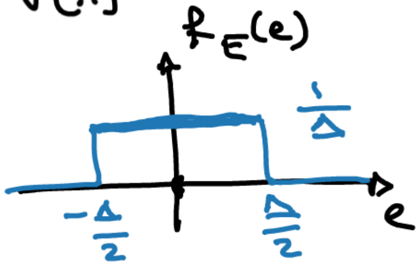
Quantisation error analysis





$$\Delta = \frac{R}{2^B}$$





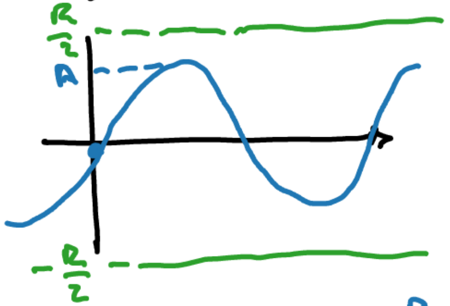
$$SQNR = 10 \log_{10} \frac{P_v}{P_q} \quad (dB)$$

$$P_q = var[e] = \sigma_e^2 = \frac{\Delta^2}{12}$$

$$= \frac{1}{12} \left(\frac{R}{2^B} \right)^2 = \frac{R^2}{12 \cdot 2^B}$$

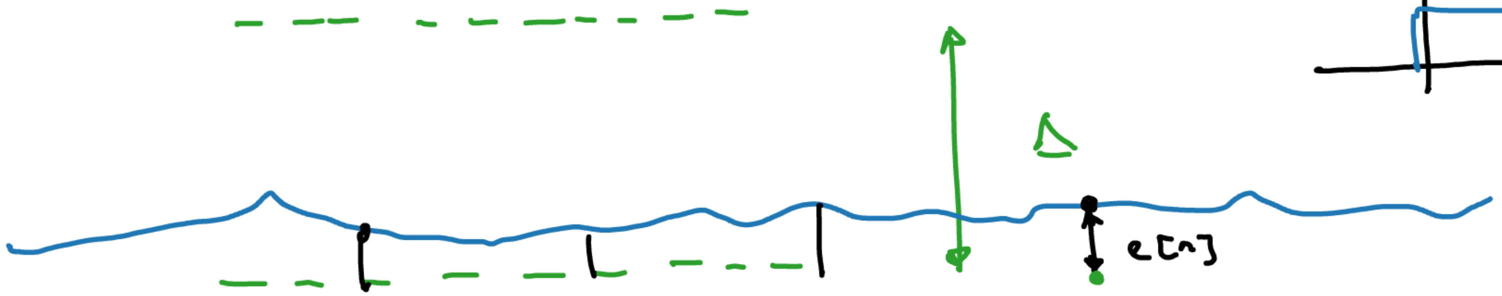
$v(t)$ is sinusoidal

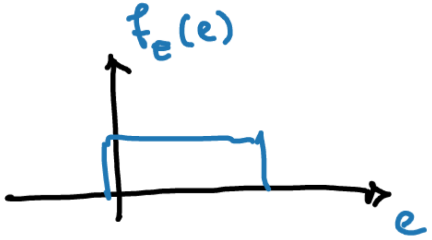
$$P_v = \frac{A^2}{2} = \frac{\alpha^2 R^2}{8}$$



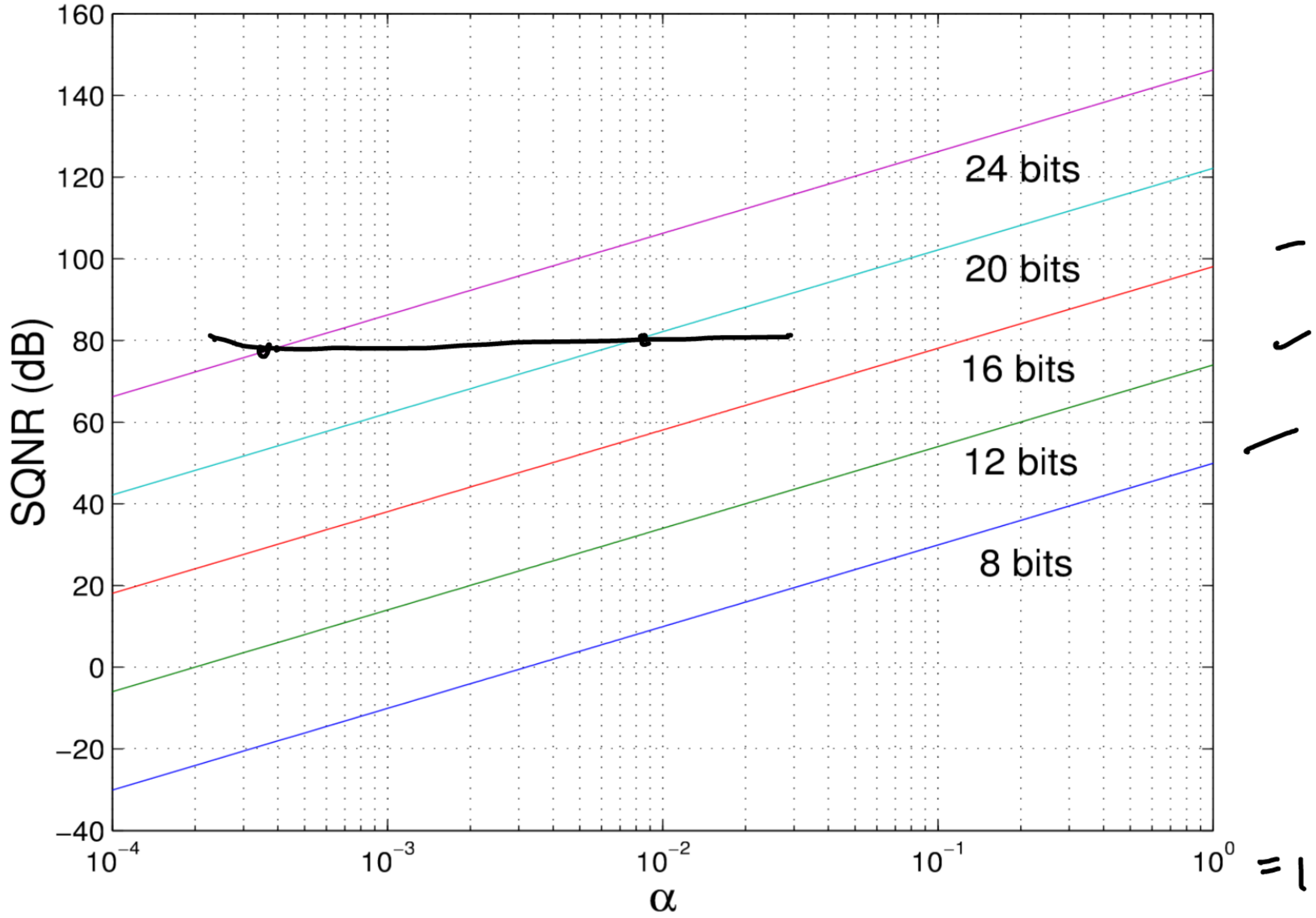
$$A = \alpha \frac{R}{2}$$

$$SQNR = 6.02B + 20 \log_{10} \alpha + 1.76$$

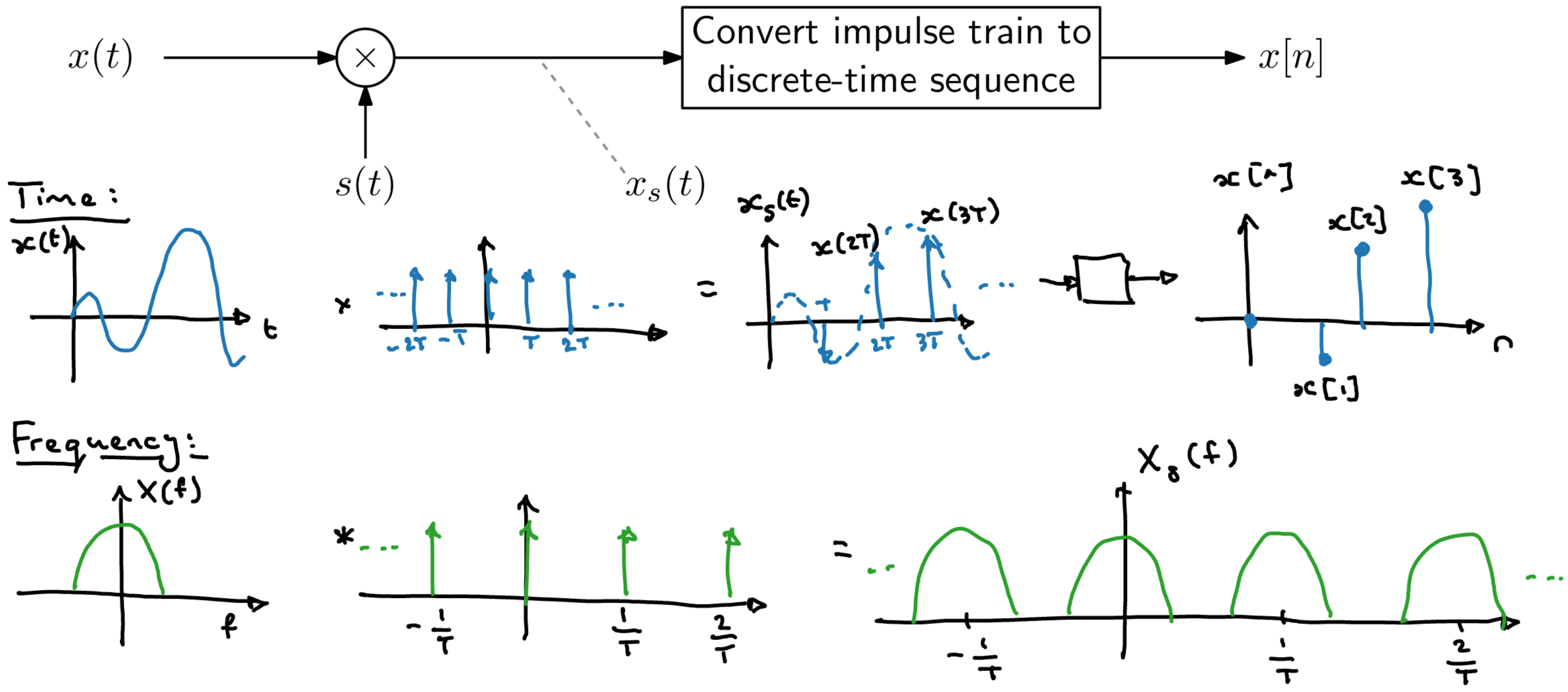

Δ
e[n]


$f_e(e)$
e

SQNR for sinusoidal signals



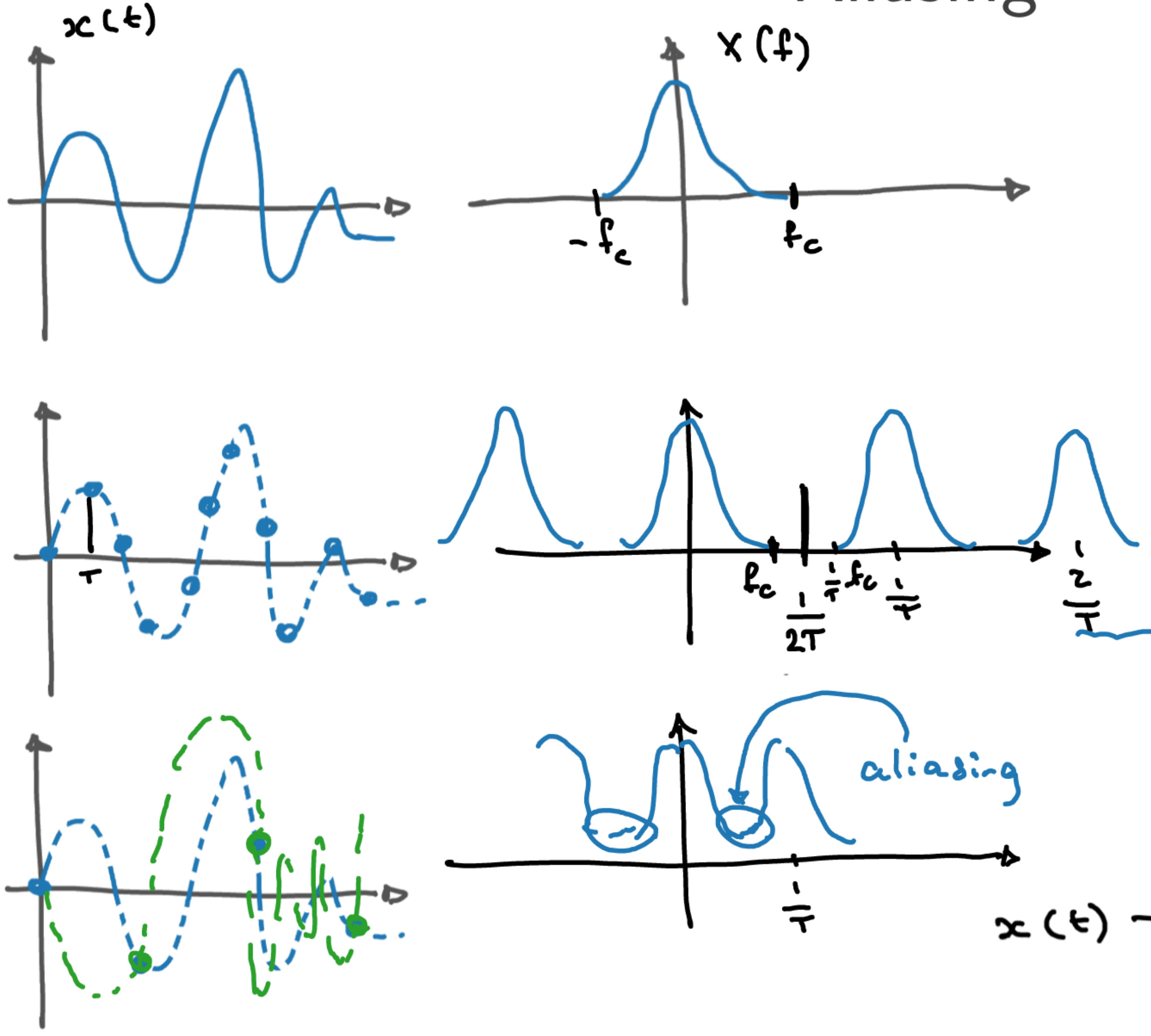
Discretising in time

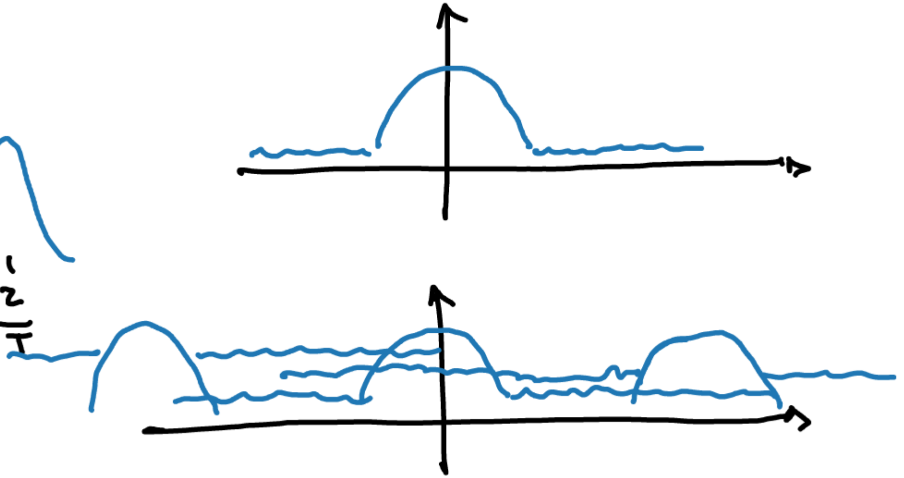


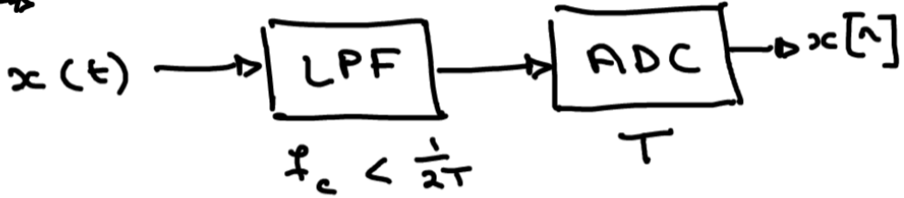
Aliasing

Nyquist: $f_c \leq \frac{1}{2T} = \frac{f_s}{2}$

$f_s \geq 2 f_c$







FT → DTFT → DFT