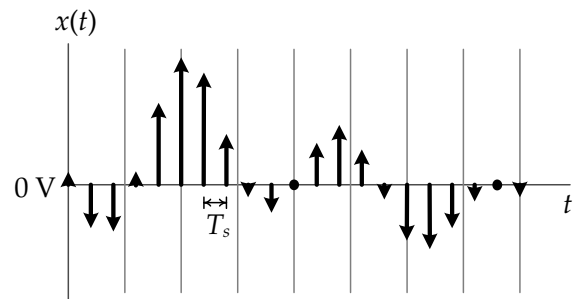
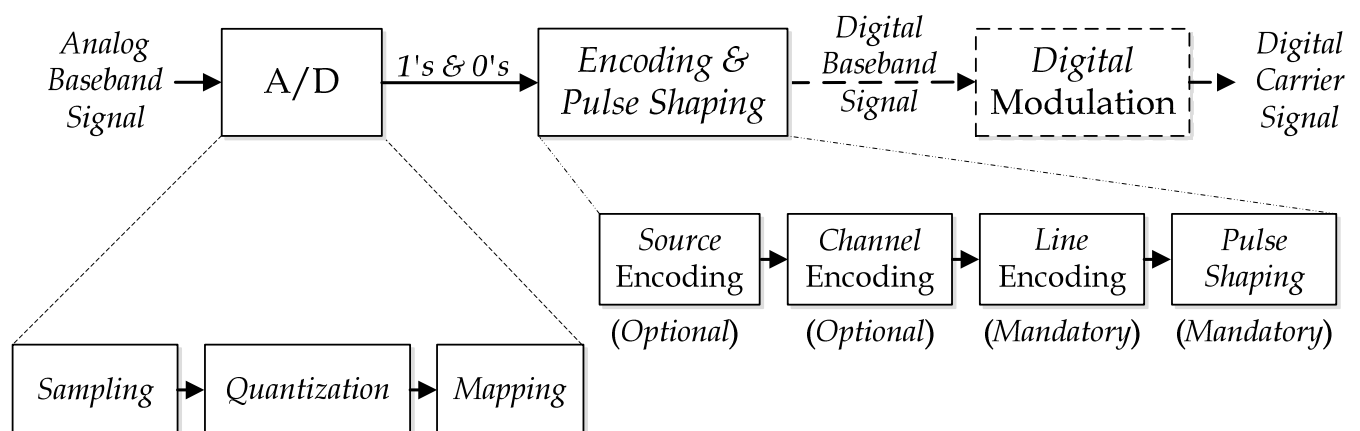


40. Sampling & Nyquist Rate

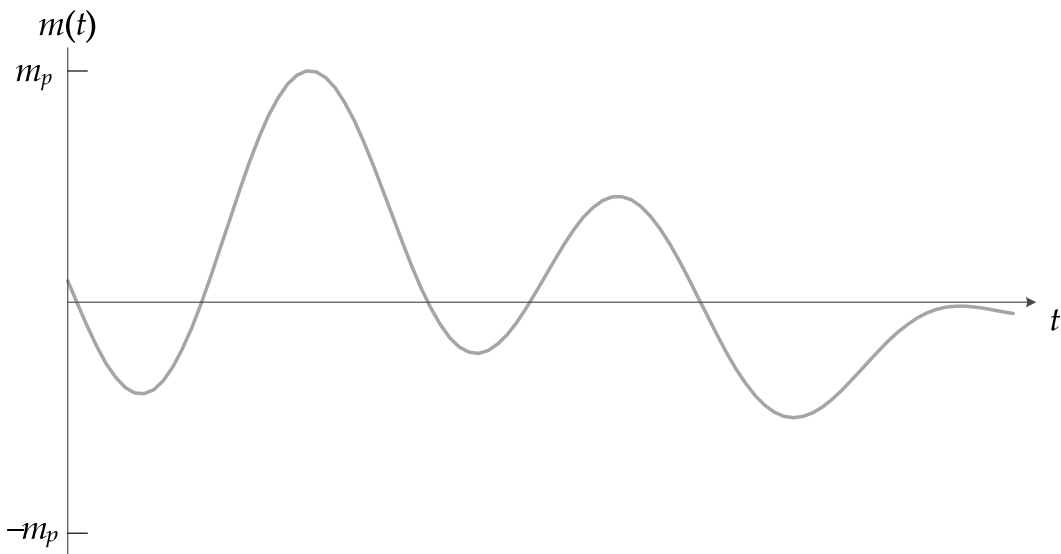
Prof. Mohammed Hawa
Electrical Engineering
The University of Jordan



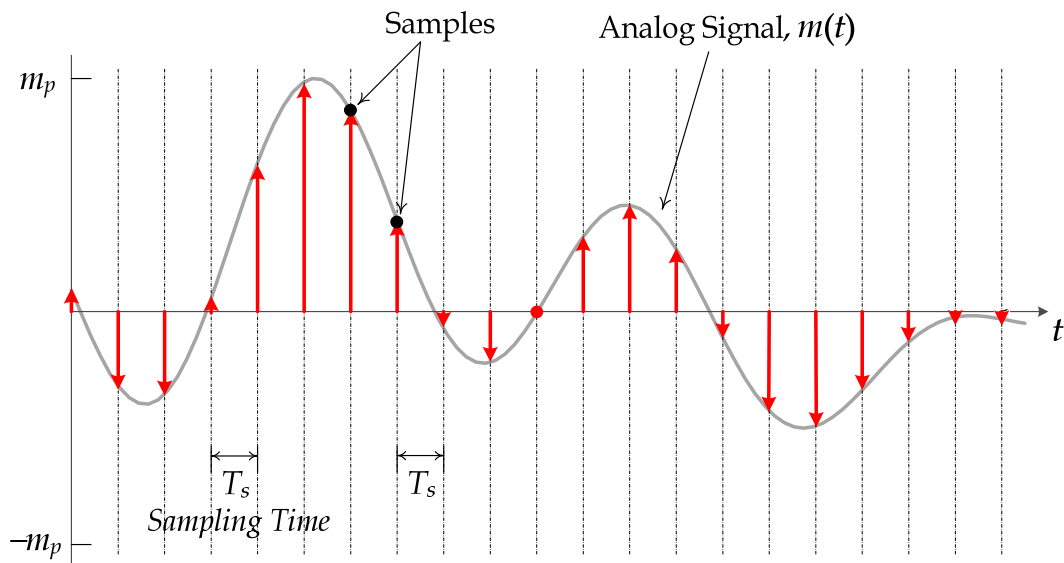
Sampling is part of Analog-to-Digital (A/D) Conversion



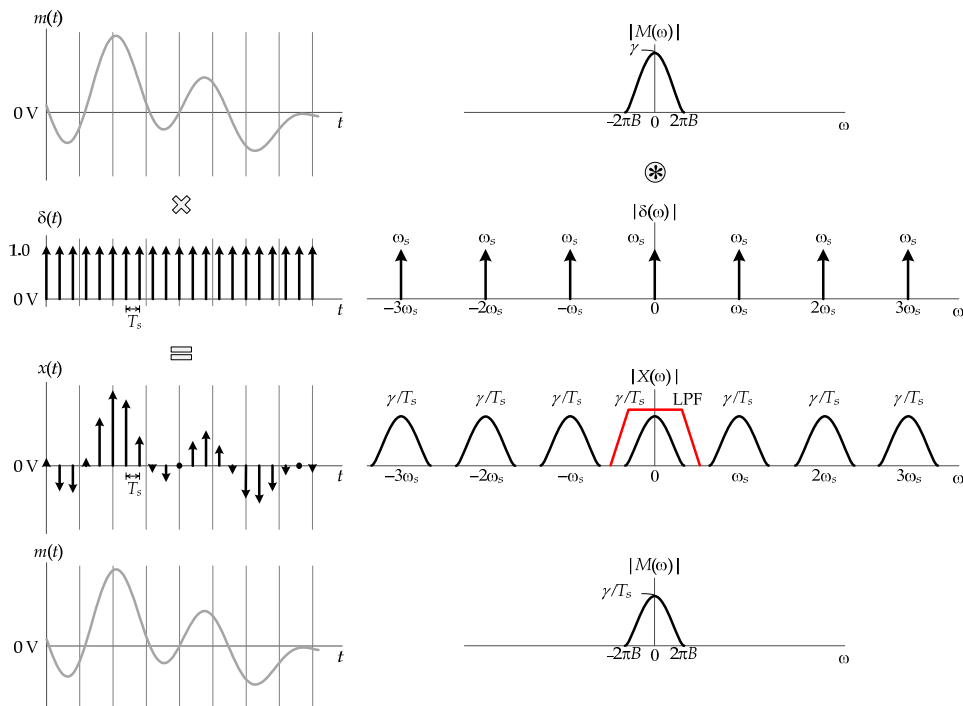
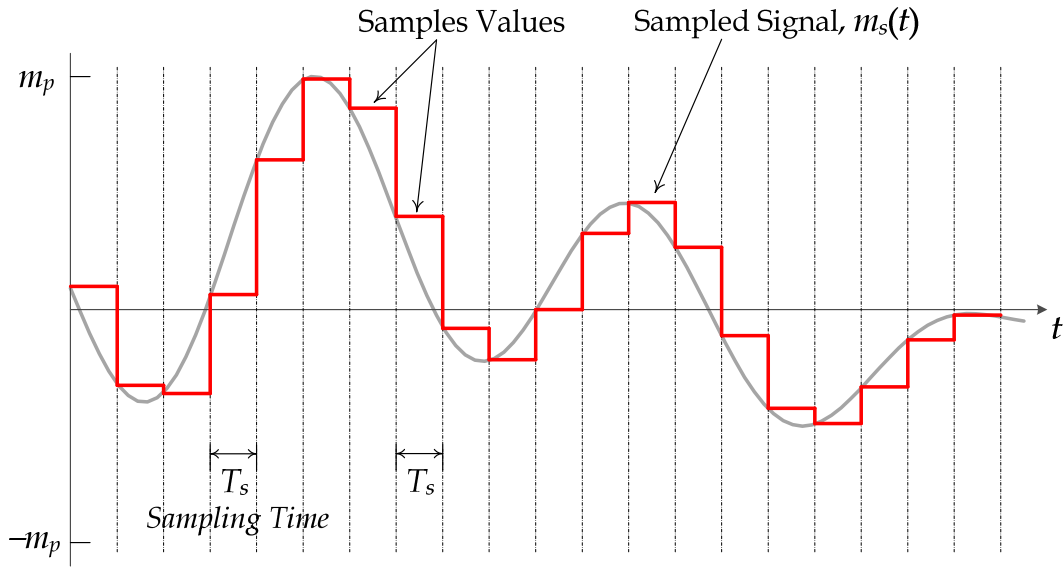
An analog signal $m(t)$ is continuous-time and continuous-value



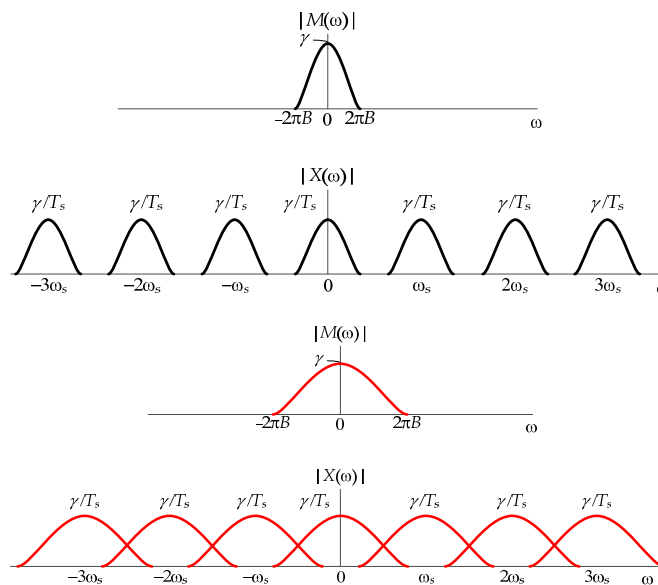
Ideal Sampling at sampling frequency $f_s = \frac{1}{T_s}$ Hz (or $\omega_s = \frac{2\pi}{T_s}$ rad/s)



Practical Sampling at sampling frequency $f_s = \frac{1}{T_s}$ Hz (or $\omega_s = \frac{2\pi}{T_s}$ rad/s)



Overlap is known as **Aliasing**, distorting the recovered signal.



For an analog signal $m(t)$ with bandwidth B_m , the **Nyquist rate** is:

$$f_N = 2B_m$$

To **avoid aliasing**, the sampling frequency f_s needs to be equal to or greater than the Nyquist rate, i.e.,

$$f_s \geq 2B_m$$

Or,

$$\omega_s \geq 2W_m = 2 \times 2\pi B_m$$

To recover the original analog signal $m(t)$ from its samples, use a LPF with cutoff frequency $f_1 = B_m$ [Hz].

Q1. A signal $m(t)$ with bandwidth $B_m = 100$ Hz is to be sampled at four times the Nyquist rate. Determine the sampling frequency, and also the cutoff frequency of the LPF used to recover the original analog signal.

Q1. Solution. The sampling frequency is $4f_N$, hence,

$$f_s = 4f_N = 4 \times 2B_m = 4 \times 2 \times 100 = 800 \text{ [Hz]}$$

The LPF cutoff frequency is always B_m

$$f_1 = B_m = 100 \text{ [Hz]}$$