

SAMPLING TECHNIQUES

Communication 3rd year

Mohsin alkarawi

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Sampling techniques

- **The sampling of a signal is done in several ways.**
- **There are three types of sampling techniques as under:**

- I. Instantaneous sampling**
- II. Natural sampling**
- III. Flat top sampling**

- **The first one is called ideal sampling, the second and third are called practical sampling.**

Ideal sampling or Instantaneous Sampling -1

- In this sampling type , the sampling function is train of impulses $\delta(nTs)$.
- The CKT is known as the SWITCHING SAMPLER.
- In this type , the sample width τ approaches **zero**.
- Because of this , the power content in it is negligible.
- Hence the method is not suitable for transmission purpose.

Ideal sampled signal

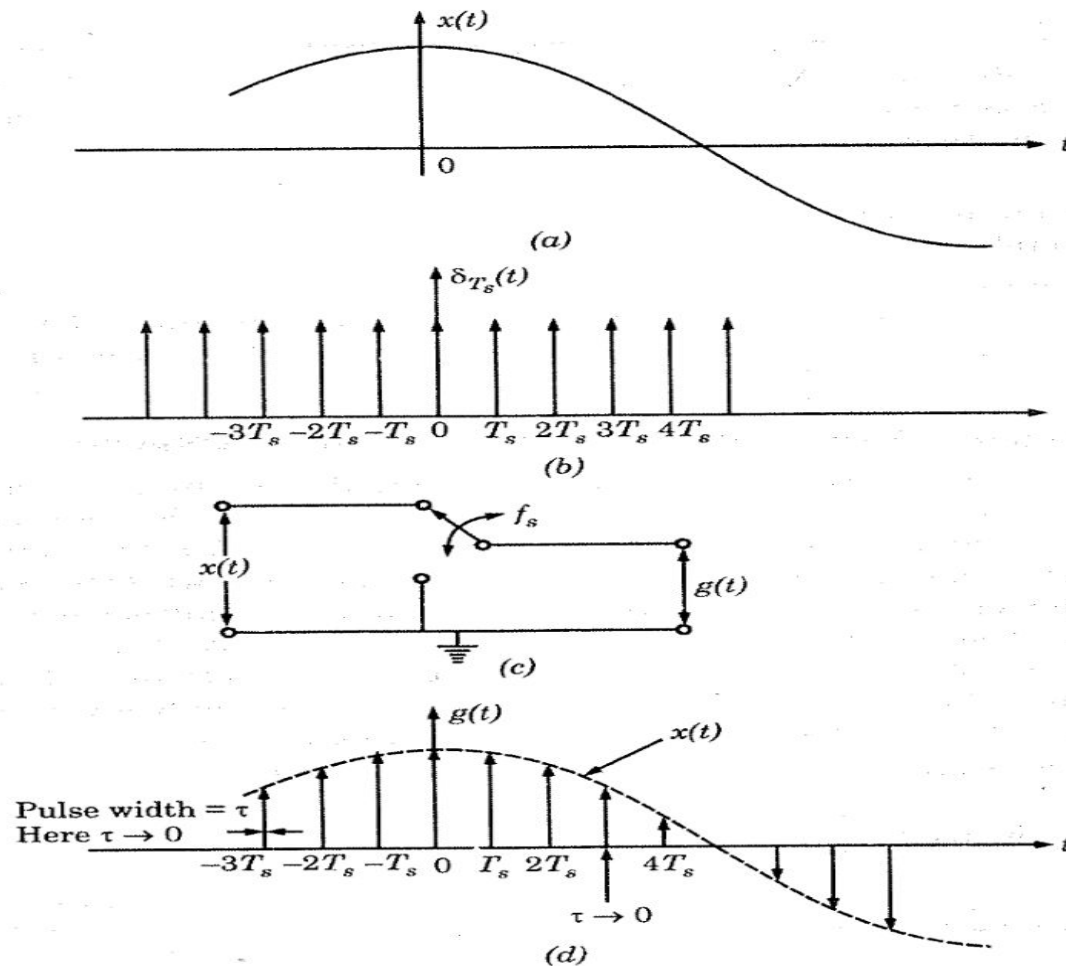


Fig. 5.11 (a) Baseband signal (b) impulse train
(c) functional diagram of a switching sampler (d) sampled signal.

Natural Sampling -2

- It is practical method .
- The sampling function in this type is a train of periodic pulses of width Δ and frequency equal to F_s Hz.

Natural sampled signal

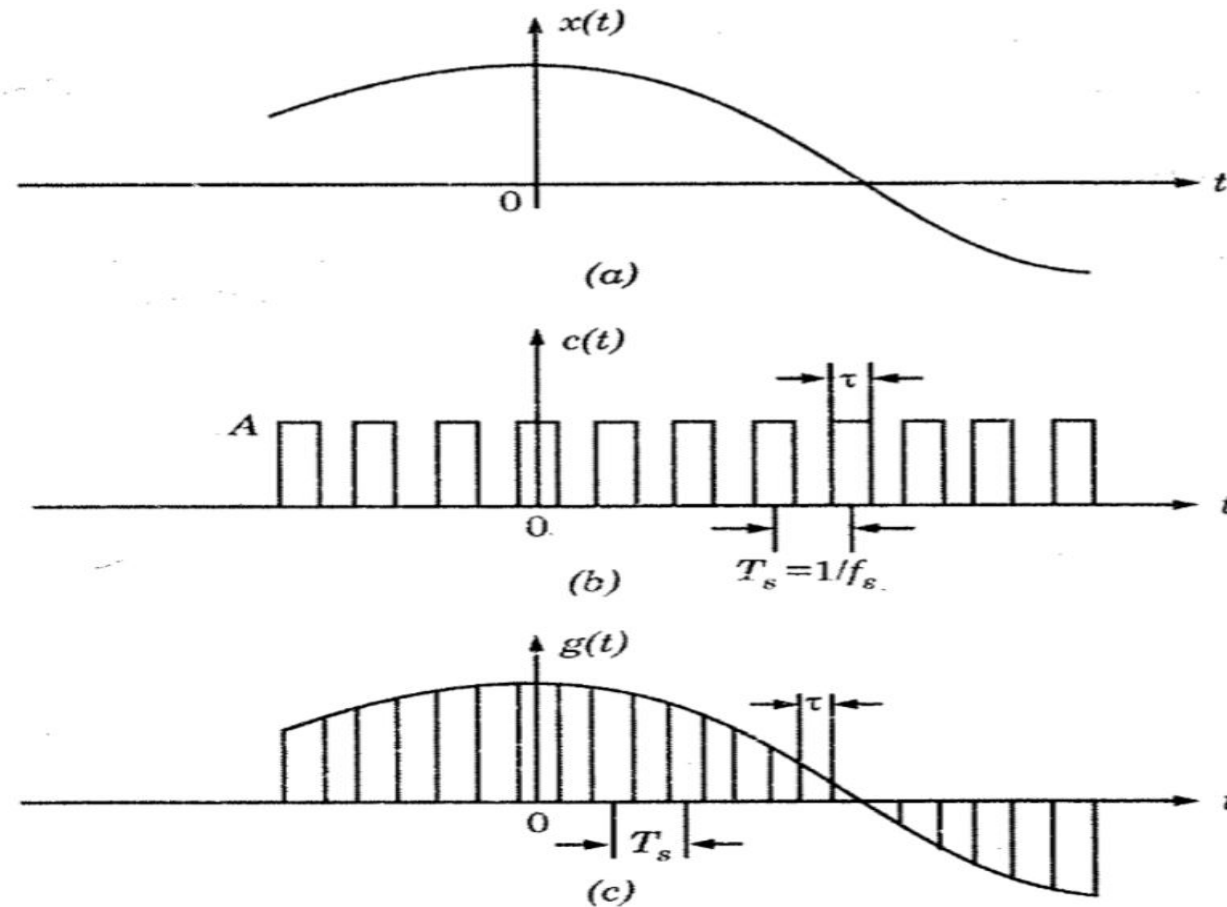


Fig. 5.13. (a) Continuous time signal $x(t)$.
(b) Sampling function waveform i.e. periodic pulse train
(c) Naturally sampled signal waveform $g(t)$.

Flat top Sampling or Rectangular -3 Sampling

It is like natural sampling , it is also practically possible sampling method.

It is quite easy to get it.

In this type the top of the samples remains constant and equal to the instantaneous value of the baseband signal at the start of sampling.

The result samples has duration equal to  and sampling rate equal to $F_s=1/T_s$

The CKT used to generate this type is called **Sample and Hold CKT**

Flat top sampled method

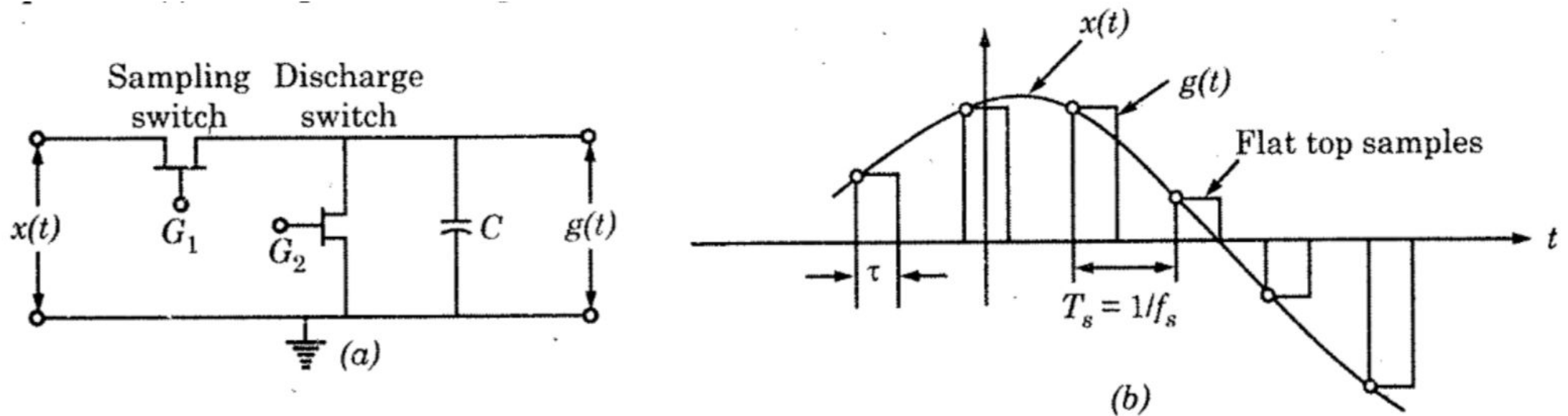


Fig. 5.15 (a) A sample and hold circuit to generate flat top samples.
(b) A general waveform of flat top sampling.

Flat sampling method

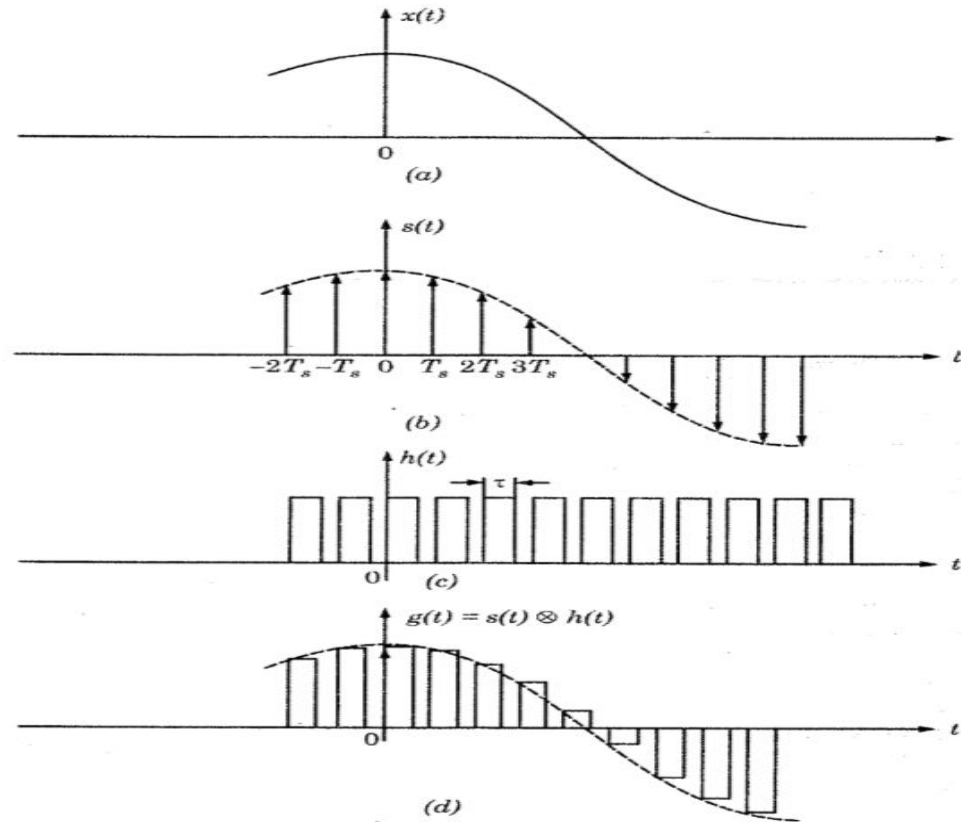
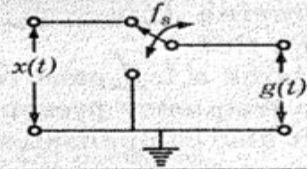
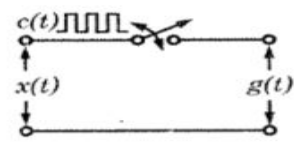
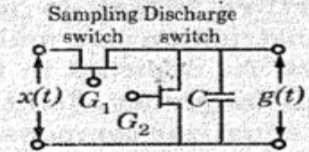
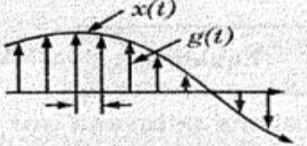
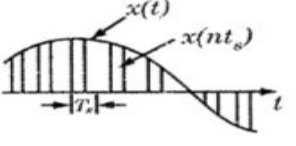
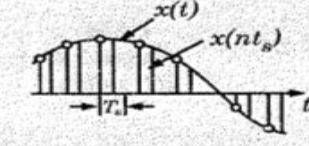


Fig. 5.17 (a) Baseband signal $x(t)$ (b) Instantaneously sample signal $s(t)$
(c) Constant pulse width function $h(t)$ (d) Flat top sampled signal $g(t)$ obtained through convolution of $h(t)$ and $s(t)$

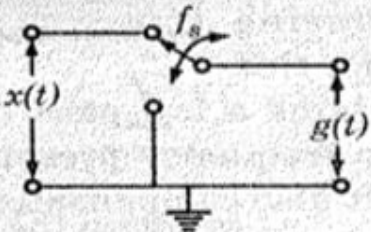
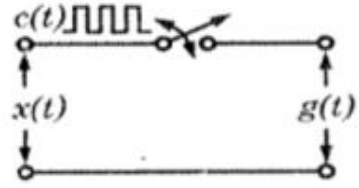
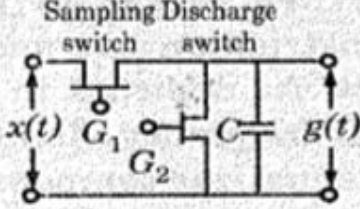
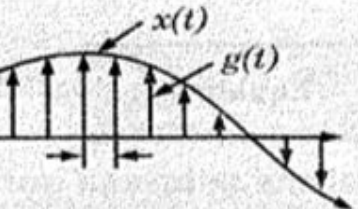
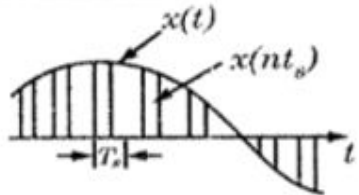
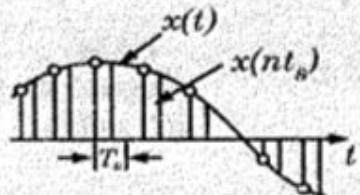
Performance comparison of three sampling techniques

TABLE 5.1. Performance comparison of three sampling techniques

S.No.	Parameter of comparison	Ideal or instantaneous sampling	Natural sampling	Flat top sampling
1.	Sampling principle	It uses multiplication	It uses chopping principle	It uses sample and hold circuit
5.	Generation circuit			
3.	Waveforms involved			
4.	Feasibility	This is not a practically possible method	This method is used practically	This method is also used practically
5.	Sampling rate	Sampling rate tends to infinity	Sampling rate satisfies Nyquist criteria	Sampling rate satisfies Nyquist criteria
6.	Noise interference	Noise interference is maximum	Noise interference is minimum	Noise interference is maximum
7.	Time domain representation	$g(t) = \sum_{n=-\infty}^{\infty} x(nT_s) \delta(t - nT_s)$	$g(t) = \frac{\tau A}{T_s} \sum_{n=-\infty}^{\infty} x(t) \sin c(nf_s \tau) e^{j2\pi n f_s t}$	$g(t) = \sum_{n=-\infty}^{\infty} x(nT_s) h(t - nT_s)$
8.	Frequency domain representation	$G(f) = f_s \sum_{n=-\infty}^{\infty} X(f - nf_s)$	$G(f) = \frac{\tau A}{T_s} \sum_{n=-\infty}^{\infty} \sin c(nf_s \tau) X(f - nf_s)$	$G(f) = f_s \sum_{n=-\infty}^{\infty} X(f - nf_s) H(f)$

Performance comparison of three sampling techniques -1

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Performance comparison of three sampling techniques -2

5.	Sampling rate	Sampling rate tends to infinity	Sampling rate satisfies Nyquist criteria	Sampling rate satisfies Nyquist criteria
6.	Noise interference	Noise interference is maximum	Noise interference is minimum	Noise interference is maximum
7.	Time domain representation	$g(t) = \sum_{n=-\infty}^{\infty} x(nT_s) \delta(t - nT_s)$	$g(t) = \frac{\tau A}{T_s} \sum_{n=-\infty}^{\infty} x(t) \sin c(nf_s \tau) e^{j2\pi n f_s t}$	$g(t) = \sum_{n=-\infty}^{\infty} x(nT_s) h(t - nT_s)$
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