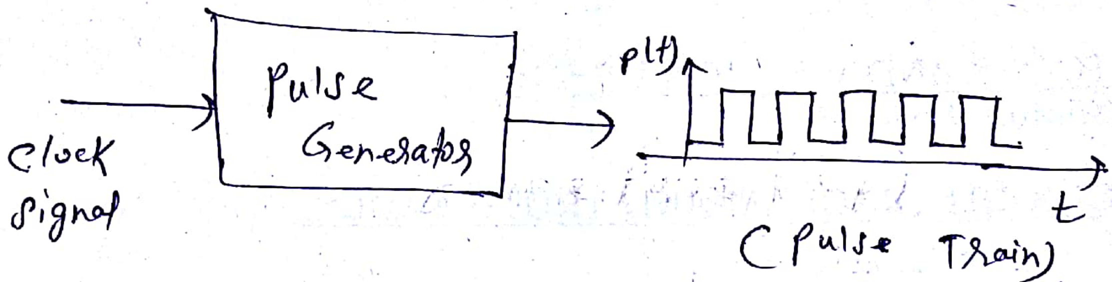
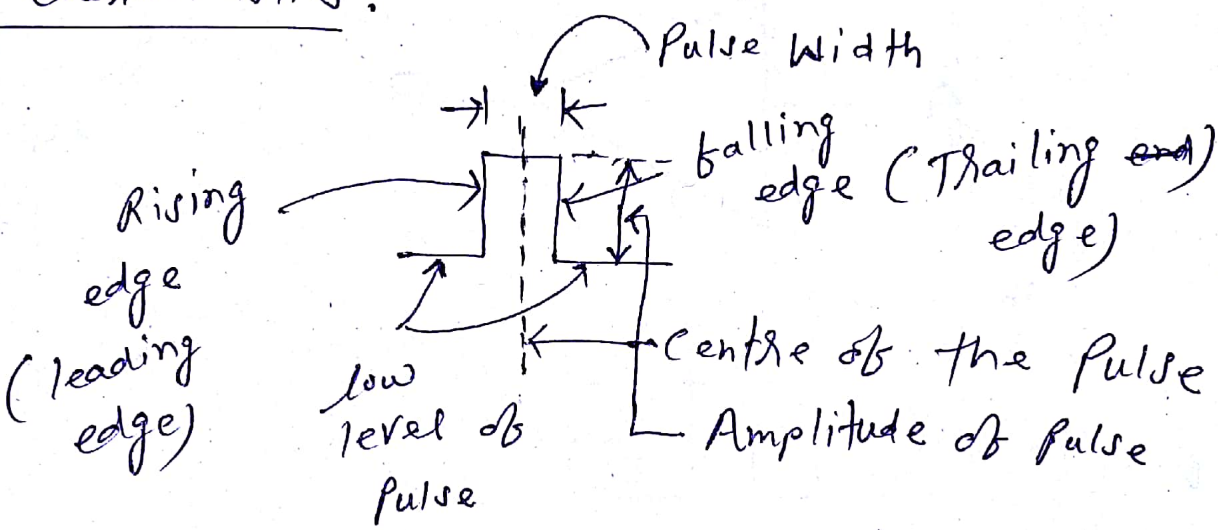
Unit-4

Pulse Modulation

In this type of modulation, the carrier is not a continuous wave but a pulse train



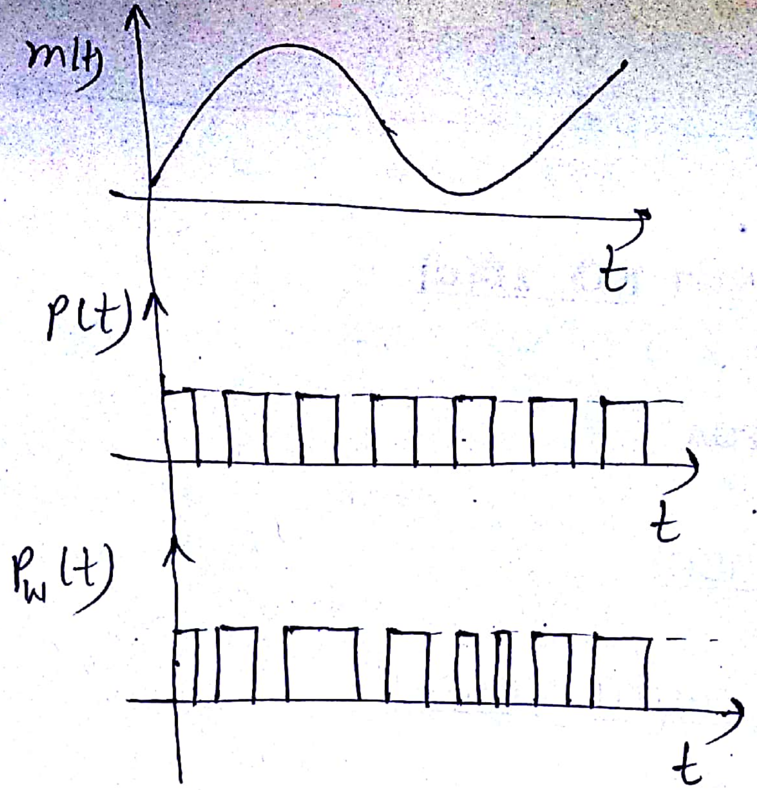
Pulse characteristics:



Pulse Modulation

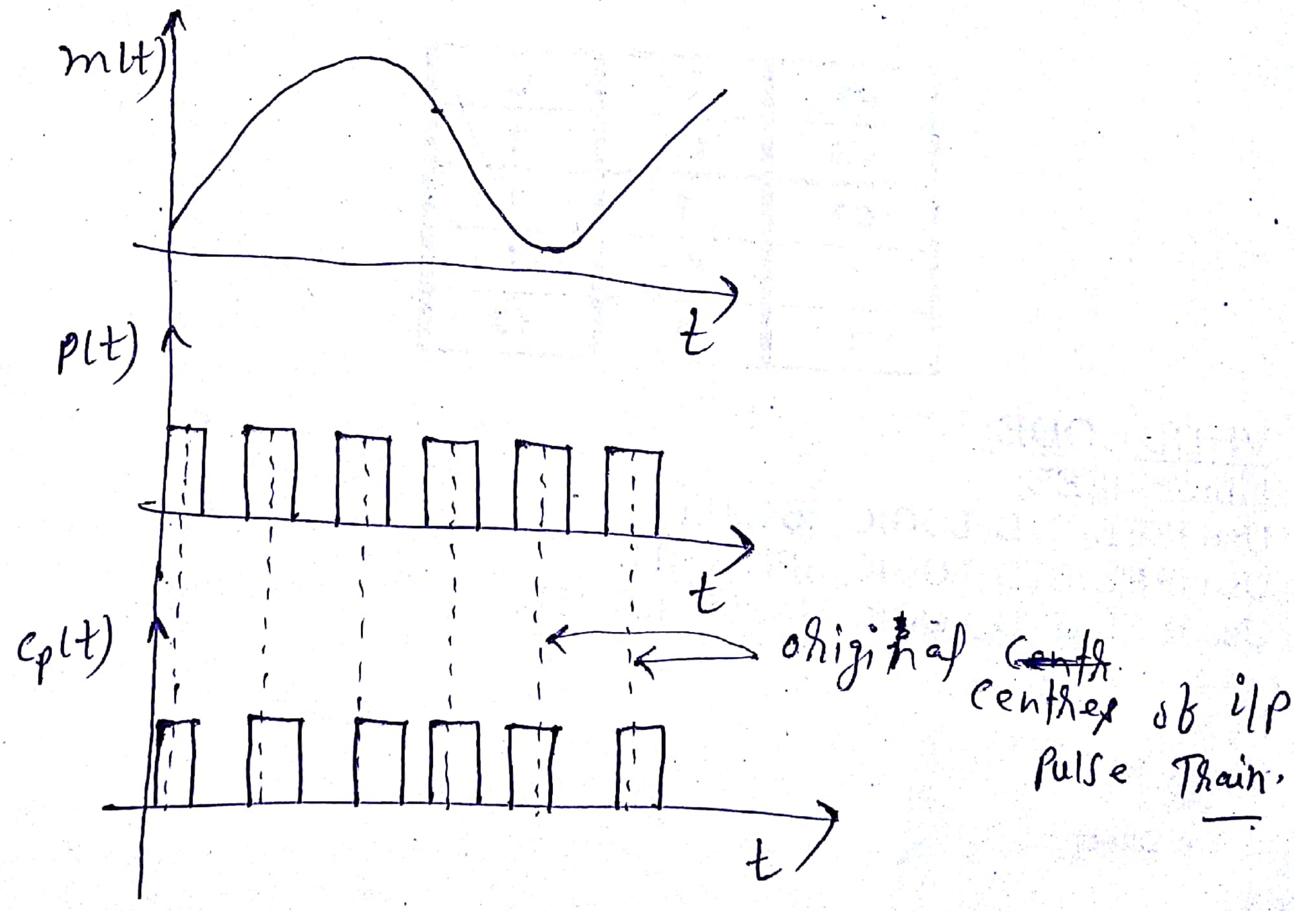
→ Pulse Analog Modulation

→ Pulse Digital Modulation.



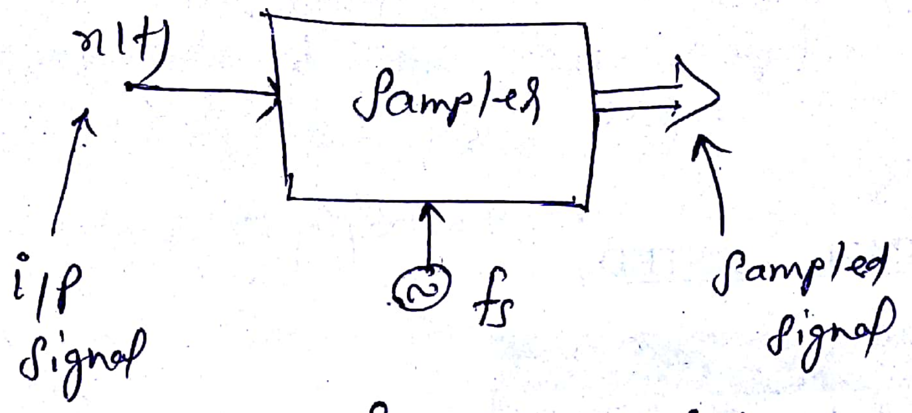
Pulse Position Modulation:

Here in this type central position of the pulse change with respect to the change in the amplitude of ~~m(t)~~ modulating signal



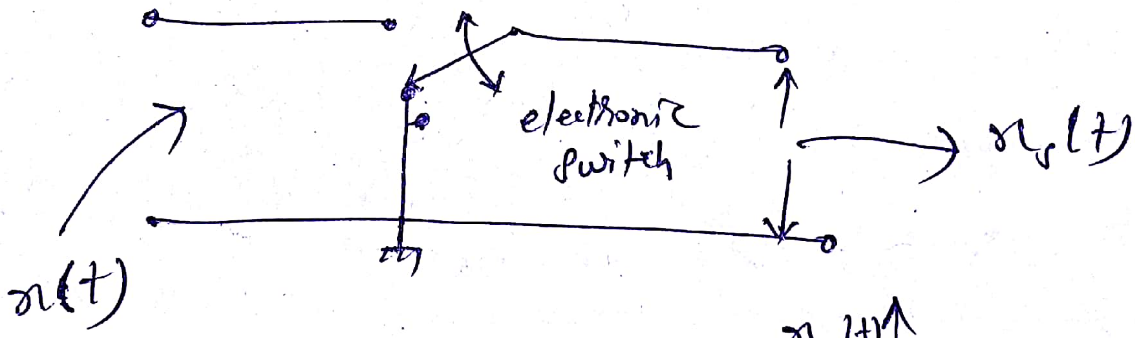
Sampling

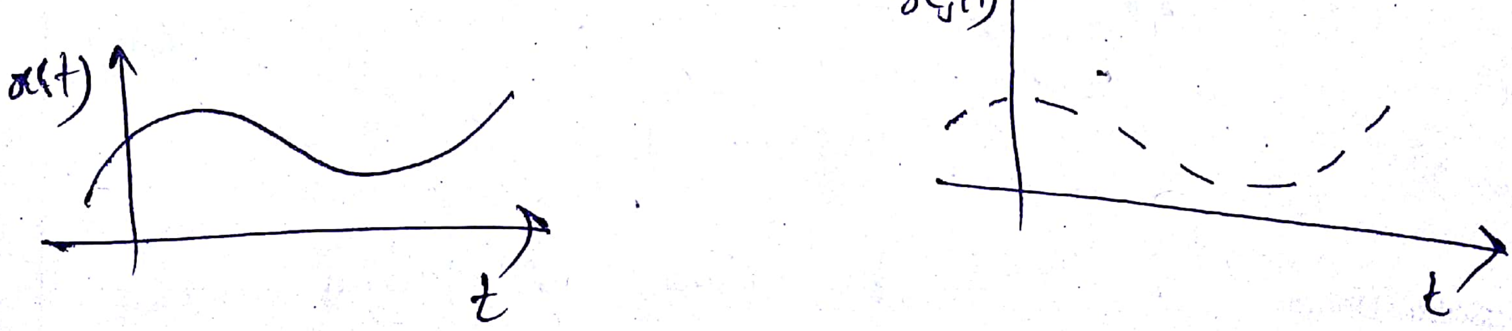
Sampling is a process of taking samples of i/p signal at certain regular interval of time defined by the i/p sampling function.



f_s : Sampling rate $= \frac{1}{T_s}$

The simplest sampler is the switch





Pulse Analog Modulation:

Under this type of modulation pulse characteristics changes in accordance with the modulating signal $m(t)$.

These characteristics may be:

1. Amplitude of the pulse (A_p)
2. Width of the pulse (W_p)
3. Central Position of the pulse (C_p)

Hence on the basis of this, there can be following type of Pulse Analog Modulation:

a) Pulse Amplitude Modulation (PAM)

b) Pulse Width Modulation (PWM)

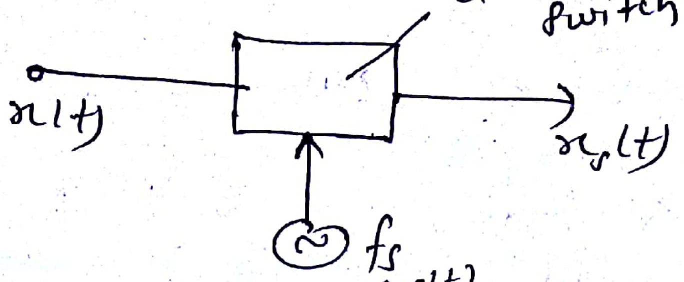
c) Pulse Position Modulation (PPM)

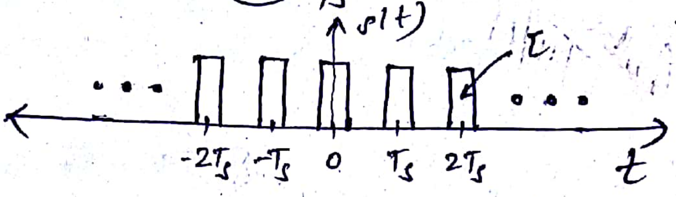
Now if A_p changes w.r.t. the instantaneous change in the amplitude of modulating signal then it is called as Pulse Amplitude Modulation (PAM)

$$\text{e.g.} \quad A_p = f(m(t)) \qquad (4.1)$$

Here width & centre of pulse remains fix as that of the original pulse train.

electronic switch samples it can also be realised as





τ : duration of pulse

$$x_s(t) = x(t)\,s(t) \tag{4.3}$$

s(t) is the sampling or switching function and

$$s(t) = C_0 + \sum_{n=1}^{\infty} 2C_n \cos 2\pi n f_s t \tag{4.4}$$

or in terms of exponential function

$$s(t) = \sum_{n=-\infty}^{\infty} C_n e^{j2\pi n f_s t}$$

using equation (4.4) equation (4.3) can be written as

$$x_s(t) = C_0 x(t) + 2C_1 x(t)\cos 2\pi f_s t + 2C_2 x(t)\cos 4\pi f_s t + 2C_3 x(t)\cos 6\pi f_s t + \dots$$

Type of Sampling

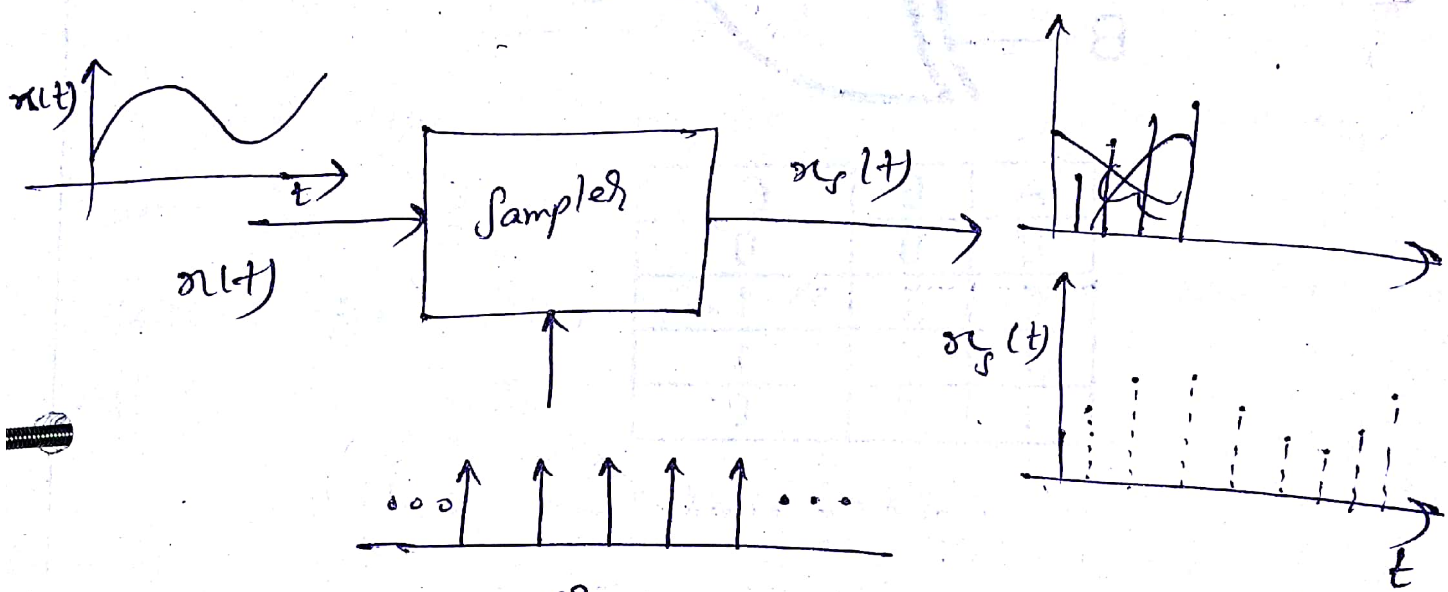
Sampling can be of following types:

a). Instantaneous Sampling

b). Natural Sampling

c) Flat-Top Sampling

1). Instantaneous Sampling: Here this type of sampling is done at a faster rate & at the instantants of sampling



$$\delta(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT_s) = \text{Sampling function}$$

$$x_s(t) = x(t)\,\delta(t)$$

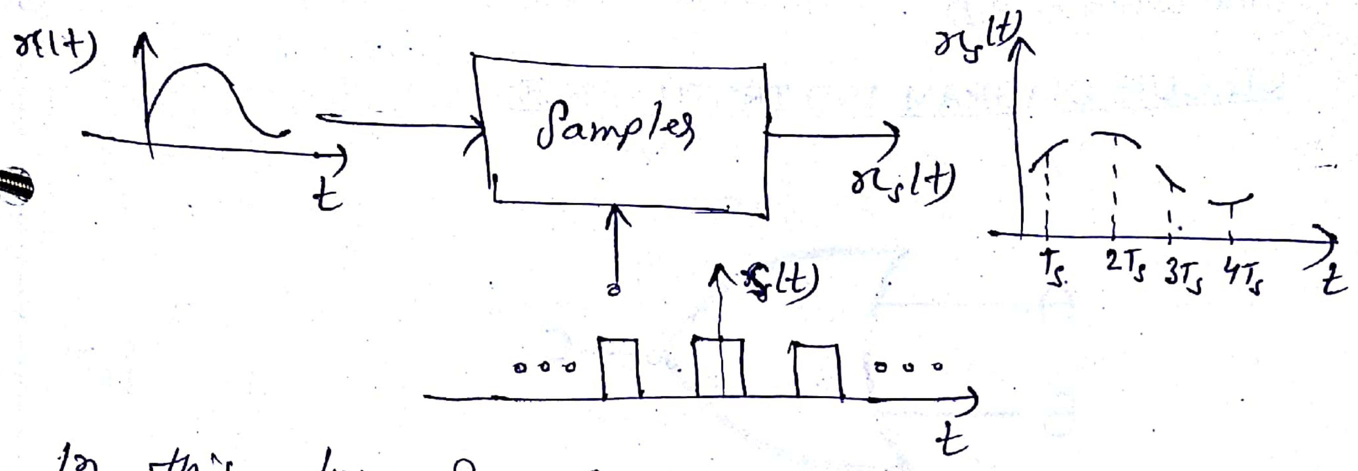
$$= x(t) \sum_{n=-\infty}^{\infty} \delta(t - nT_s)$$

$$= \sum_{n=-\infty}^{\infty} x(t)\,\delta(t - nT_s)$$

Hence $x_s(t) = \sum_{n=-\infty}^{\infty} x(t)\,\delta(t-nT_s)$

Natural Sampling :

In this type of sampling the samples of the output waveform matches with that of input signal.



In this type of sampling the switch remains on for longer time.

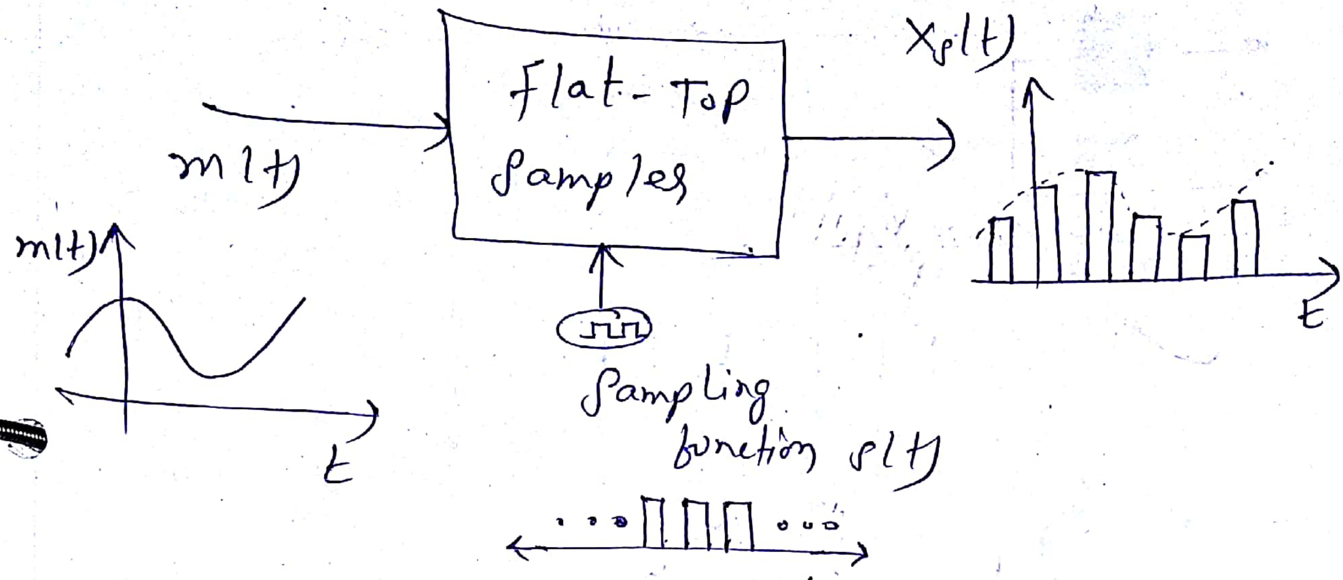
Here the pulses can be expressed mathematically as

$$s(t) = \sum_{k=-\infty}^{\infty} rect\left(\frac{t-kT_s}{\tau}\right)$$

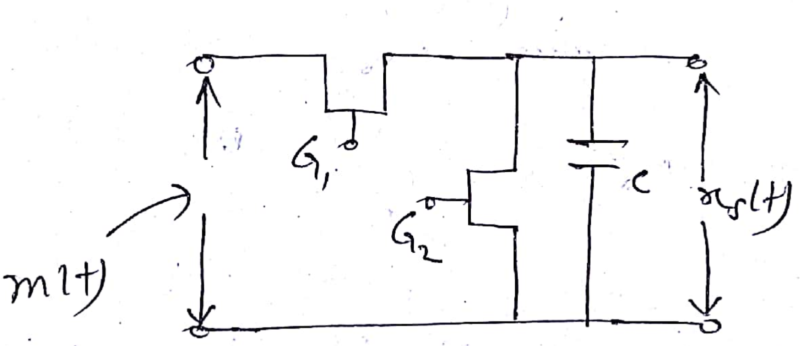
Here pulse duration is τ

Flate-Top Sampling :

In this type of sampling the o/p pulses have amplitude variation as per the instantaneous value of signal but the pulse amplitude remain constant for the duration of pulse.



Flat-Top Signal Generator:

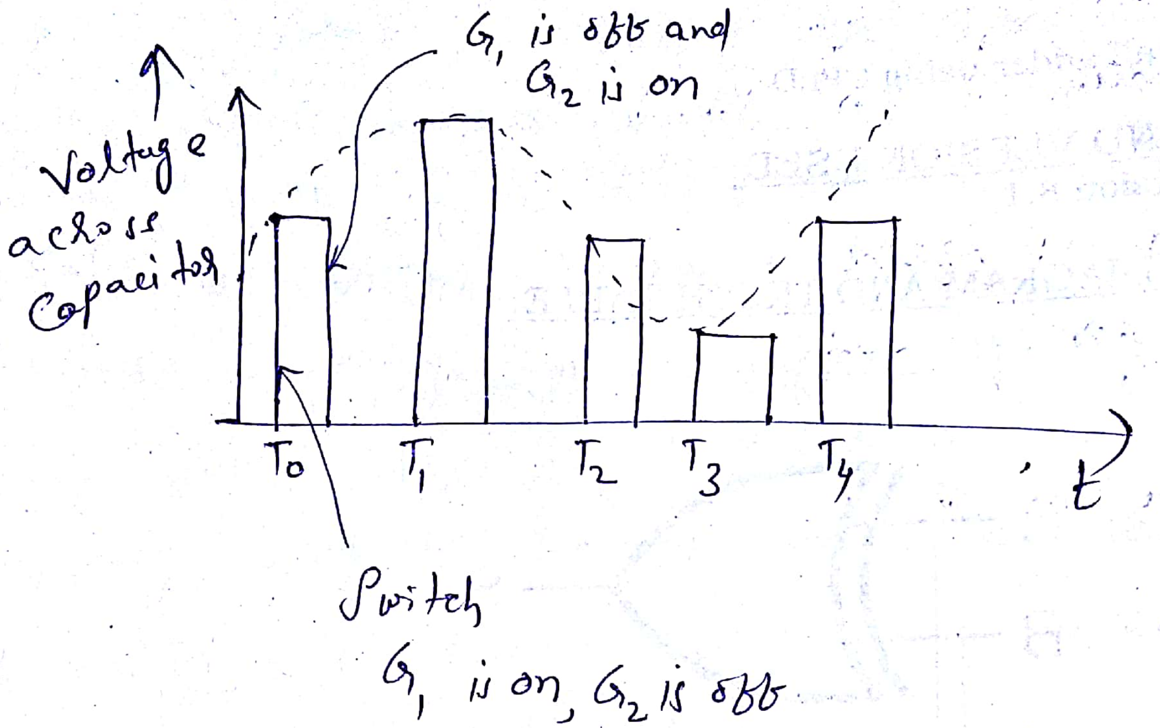


Here G_1 : Sampling switch

G_2 : Dump switch

G_1 & G_2 are specially designed switch based on FET technology, characteristics of such switches are that G_1 is having very low 'on' resistance & very high 'off' resistance

Similarly G_2 is also having ~~low~~ very low ~~on~~ resistance in on condition & very high resistance in off condition.



Hence to get such waveform G_1 & G_2 should have the following type of clocking signal