

Sampling Theorem \rightarrow

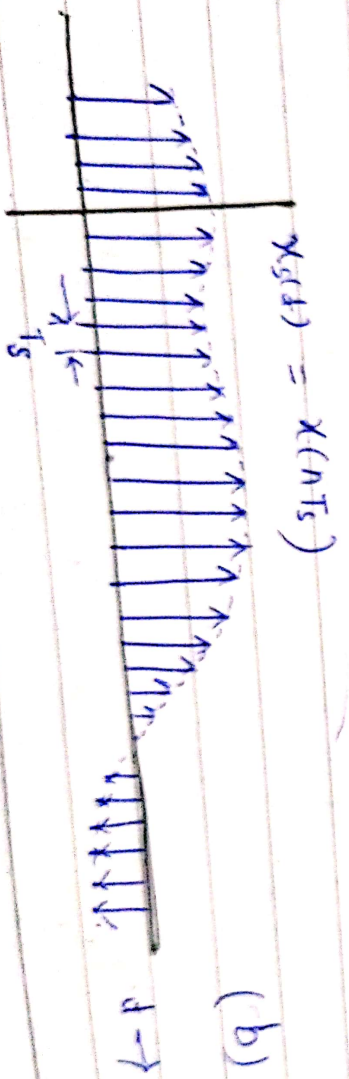
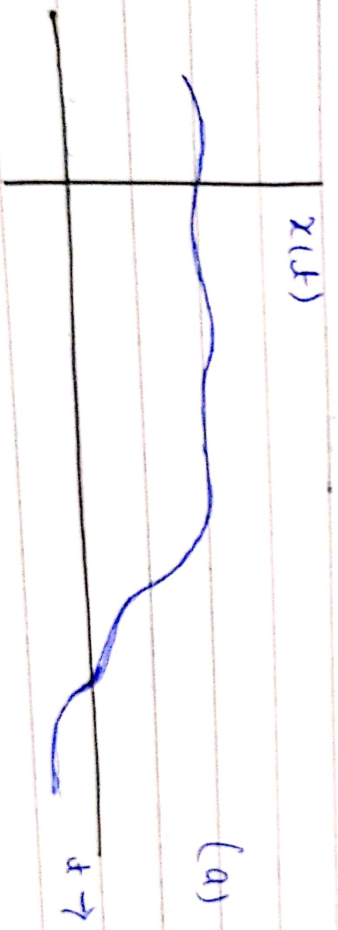
A continuous signal band limited to f_m Hz can be reconstructed exactly if $f_s \geq 2f_m$.
 The maximum frequency component in it is f_m .

The minimum required sampled rate $f_s = 2f_m$ Hz is known as Nyquist rate (NR) and $\frac{1}{2f_m}$ is known as Nyquist interval.

\rightarrow If $f_s > 2f_m$ or $T_s < \frac{1}{2f_m}$; Over Sampling

\rightarrow If $f_s = 2f_m$ or $T_s = \frac{1}{2f_m}$; Critical Sampling

\rightarrow If $f_s < 2f_m$ or $T_s > \frac{1}{2f_m}$; Under Sampling



[Fig. 1]

Proof of Sampling Theorem :-

low pass signal $x(t)$ shown in fig
 Consider an arbitrary
 let

$$x_s(t) = x(t) \left[\sum_{n=-\infty}^{\infty} \delta(t - nT_s) \right]$$

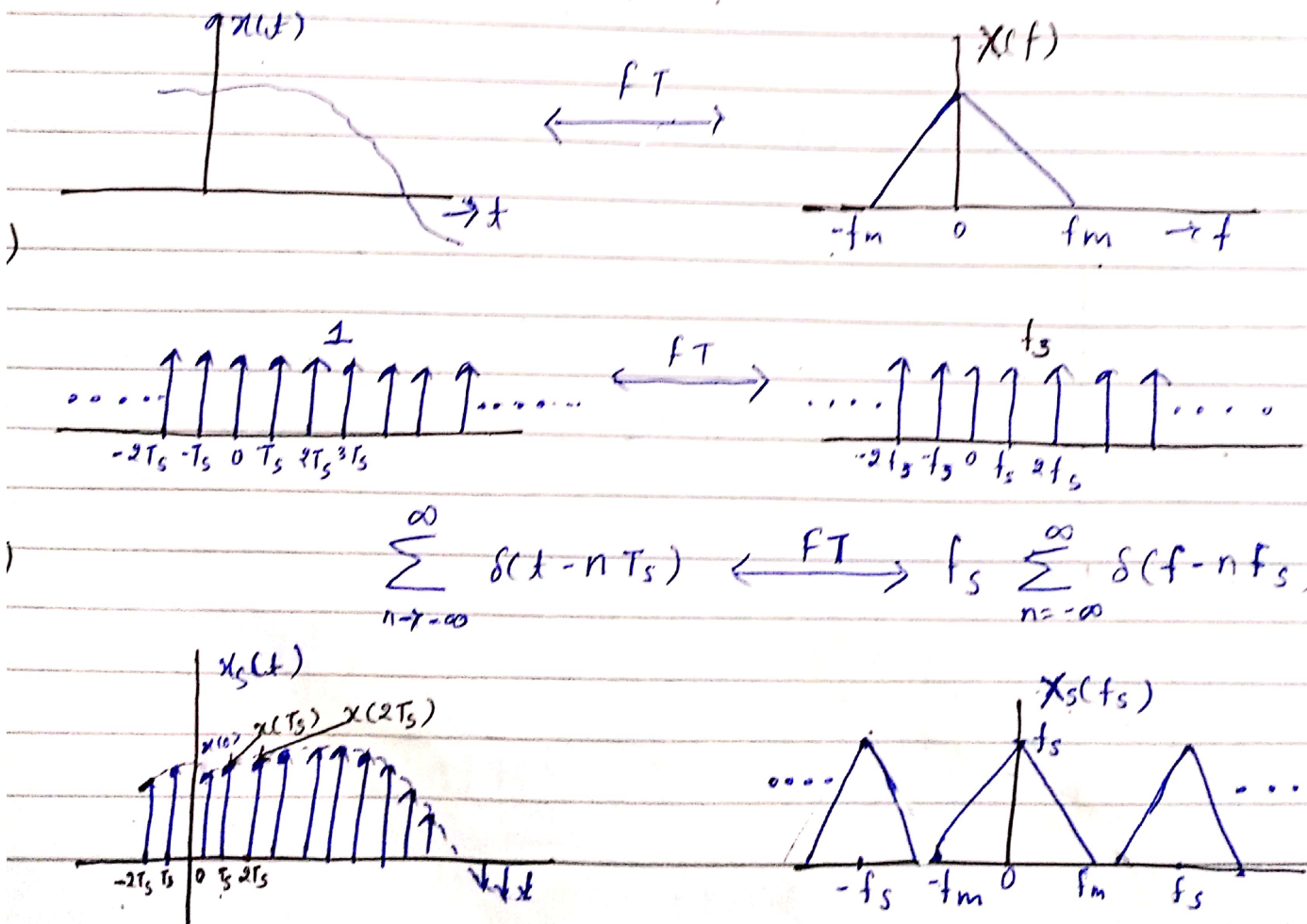
Taking fourier transform both sides

$$X_s(f) = x(f) \otimes f_s \sum_{n=-\infty}^{\infty} \delta(f - nf_s)$$

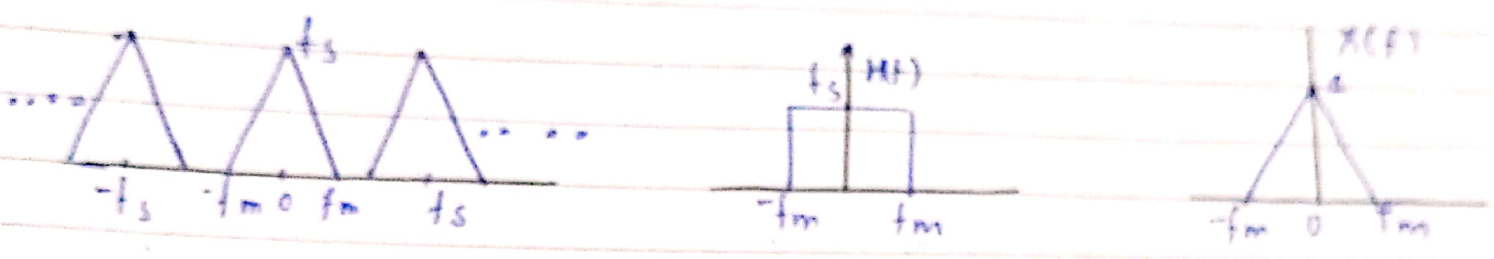
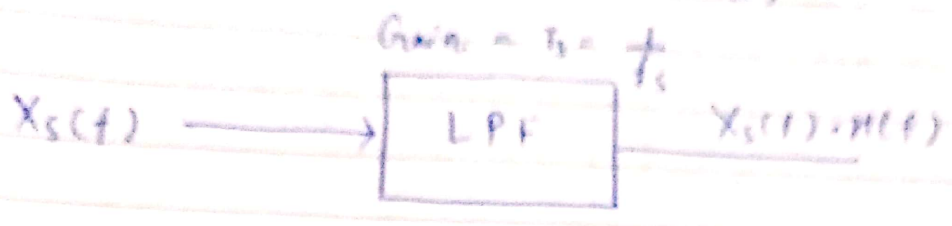
$$\therefore x(t) \otimes \delta(t) = x(t)$$

$$x(t) \otimes \delta(t - t_1) = x(t - t_1)$$

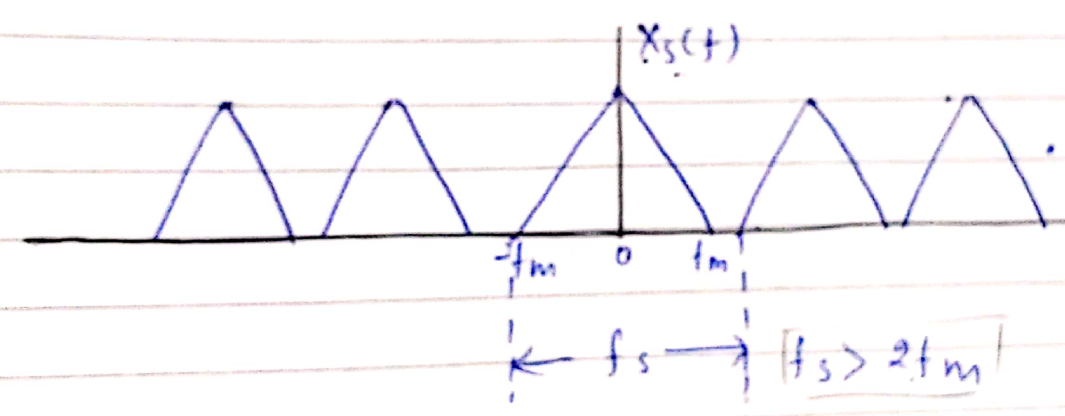
$$X_s(f) = f_s \sum_{n=-\infty}^{\infty} x(f - nf_s)$$



If $X_s(f)$ is passed through an ideal lowpass filter we can recover $X(f)$ or $x(t)$

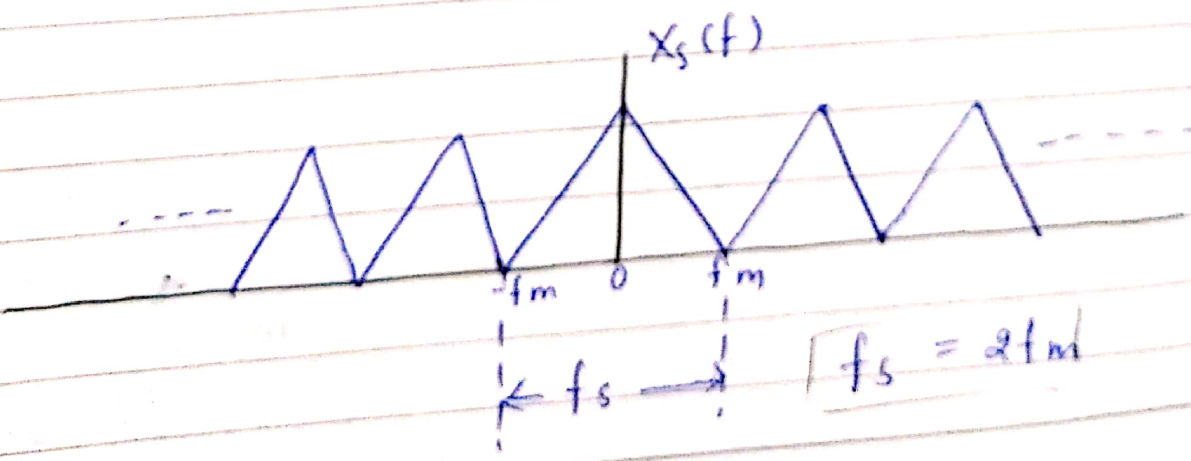


case (i) $f_s > 2f_m$ or $T_s < \frac{1}{2f_m}$ (over sampling)



over sampling
is not what
we want
becs
of large
no. of samples
over

case (ii) $f_s = 2f_m$ or $T_s = \frac{1}{2f_m}$ (critical sampling)



Case (iii)

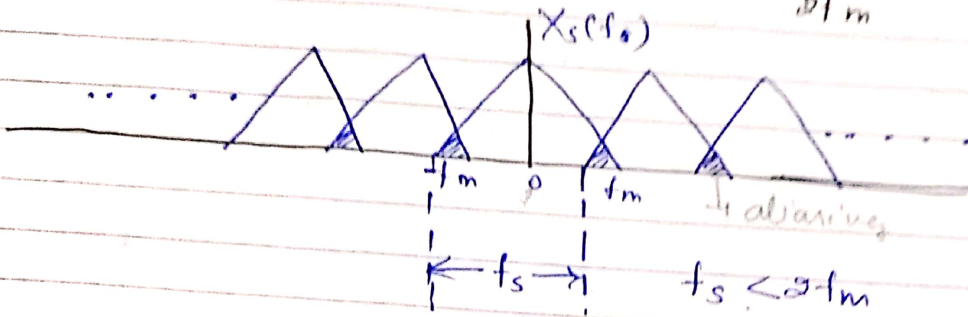
$$f_s < 2f_m$$

or

$$T_s > 2T_m$$

$$\frac{1}{2f_m}$$

(Under Sampling)



It give
rise to
aliasing
so it is
least used

→ Minimum possible sampling rate and maximum sampling interval allowed to avoid aliasing are called as Nyquist rate and Nyquist interval respectively.

$$\text{Nyquist Rate} = 2f_m \text{ Samples/Sec}$$

$$\text{Nyquist interval} = \frac{1}{2f_m} \text{ Sec}$$

Pulse Amplitude Modulation :-> (PAM)

→ Pulse Amplitude modulation is a pulse Analog modulation scheme in which the amplitude of a train of carrier pulses are varied according to the amplitude variations of message signal.

In pulse analog modulation pulse by pulse transmission will occurred. Each of the pulse to be transmitted corresponds to baseband signal and can be directly transmitted through baseband channel only.