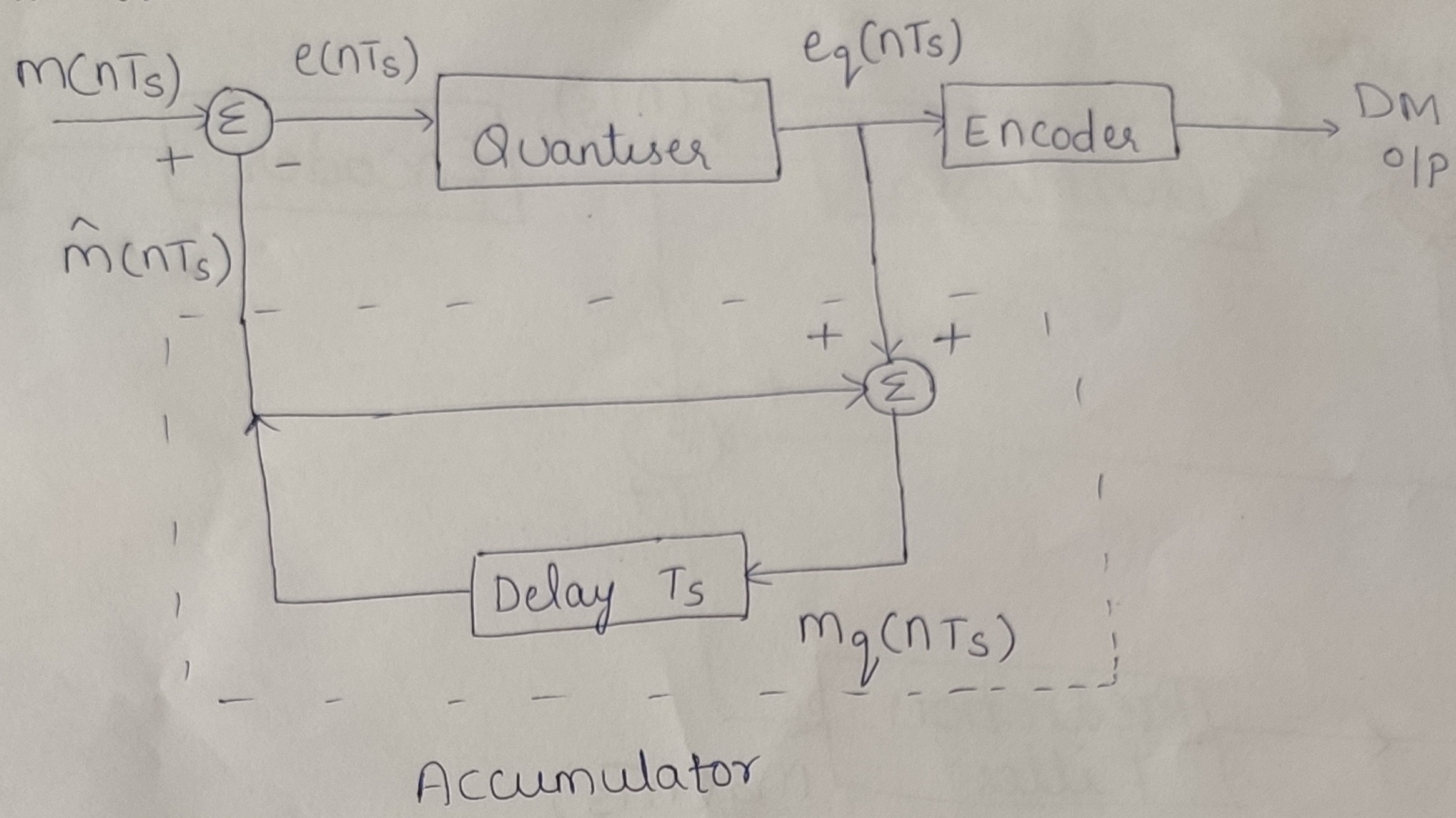
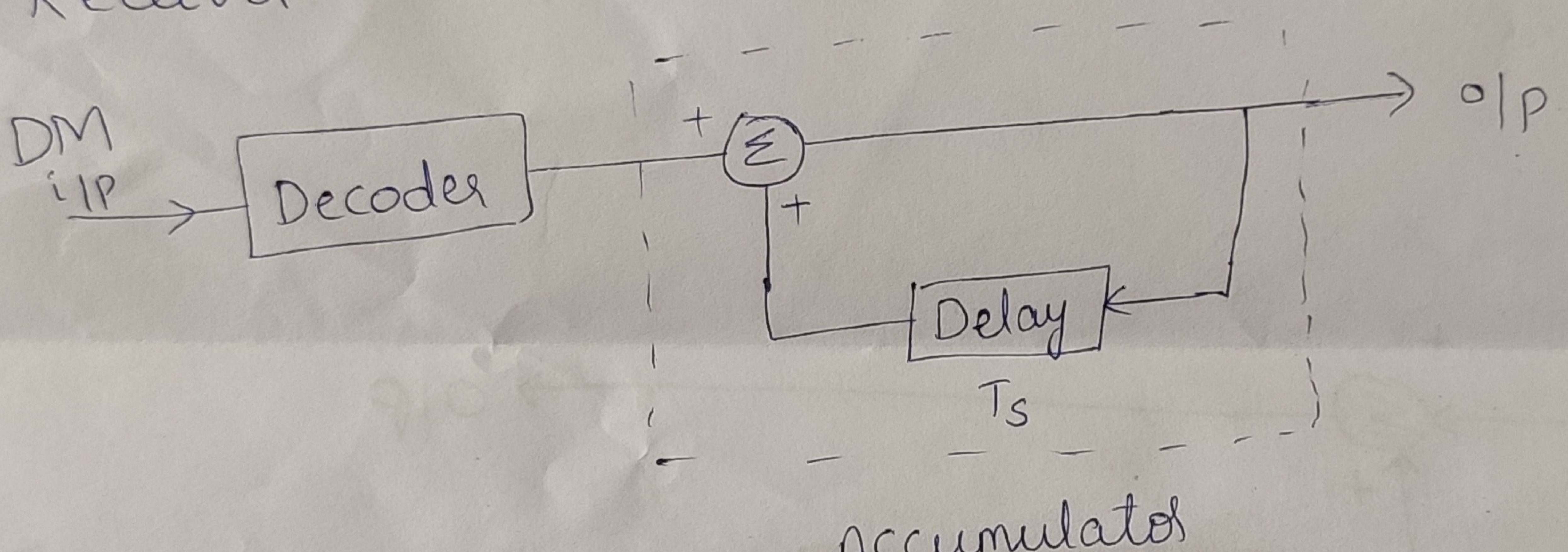
Delta Modulation : [1 bit DPCM]

Transmitter :



Receiver :

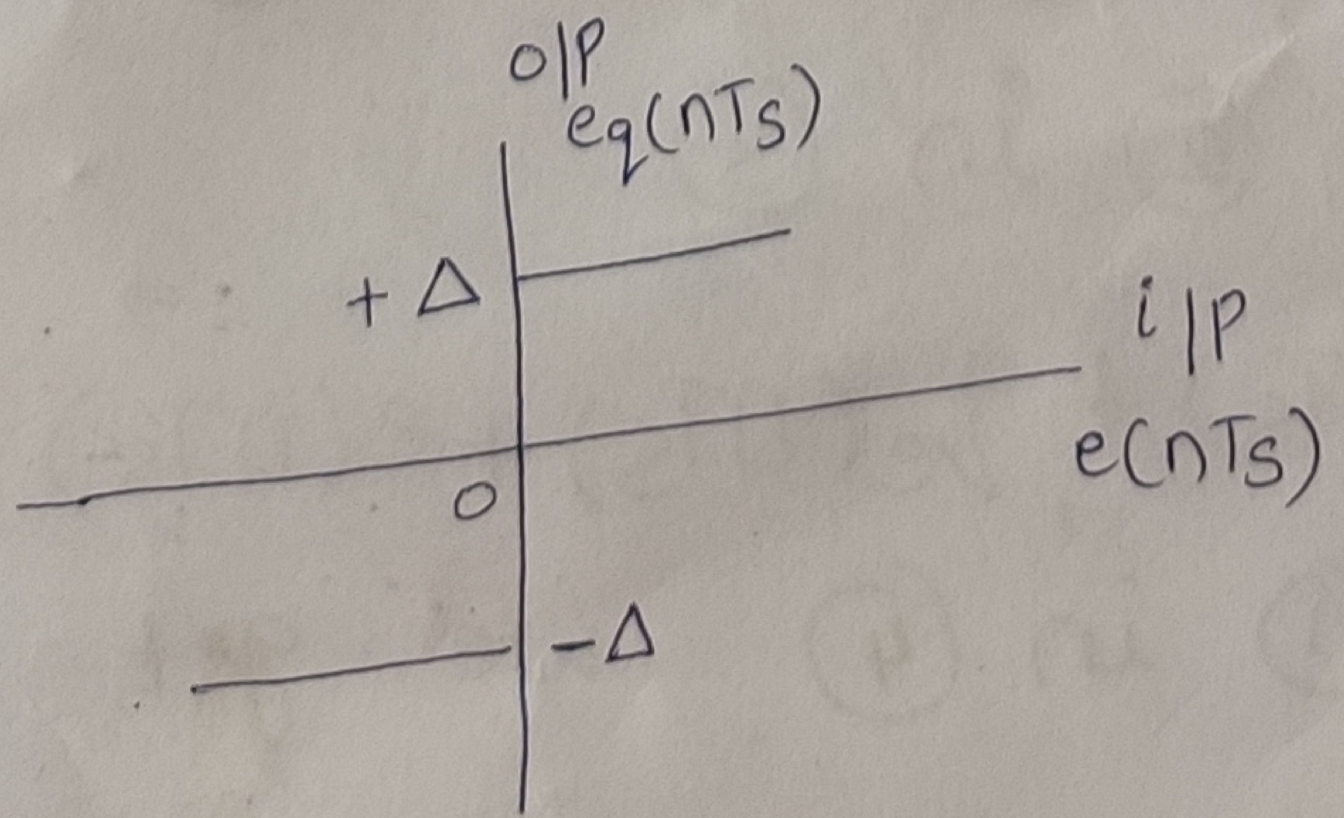


$$e(nT_s) = m(nT_s) - m_q(nT_s - T_s) \quad \text{— ①}$$

$$e_q(nT_s) = \Delta \,\mathrm{sgn}[e(nT_s)] \quad \text{— ②}$$

$$m_q(nT_s) = m_q(nT_s - T_s) + e_q(nT_s) \quad \text{— ③}$$

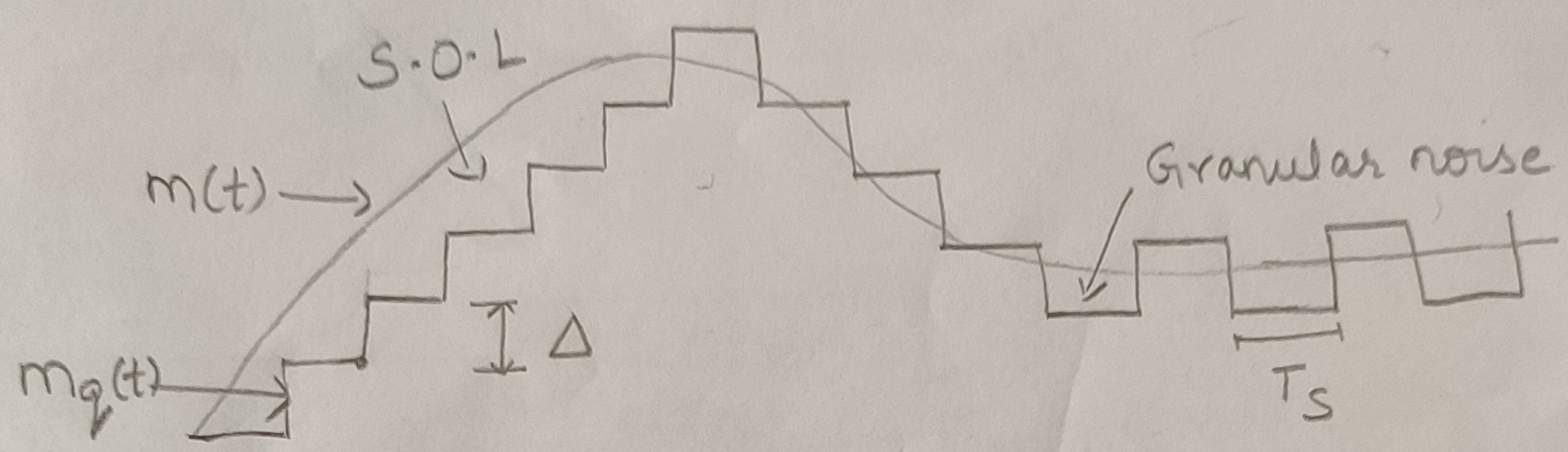
Input - output characteristic of quantiser for DM system :



Quantization noise :

(1) Slope over load noise (S.O.L)

(2) Granular / Hunting noise.



The above figure illustrates the quantization noise in DM system.

Slope over load error occurs when

$$\frac{\Delta}{T_s} \leq \frac{d}{dt} m(t) \text{ (or) } \frac{d}{dt} m(t) \geq \frac{\Delta}{T_s}.$$

The condition to avoid slope over load is

Consider $m(t) = A_m \sin 2\pi f_m t$

$$\frac{d}{dt} m(t) = A_m \cos 2\pi f_m t \, (2\pi f_m)$$

$$= 2\pi f_m A_m \cos 2\pi f_m t.$$

$$\left| \frac{d}{dt} m(t) \right|_{max} \leq \frac{\Delta}{T_s}$$

$$2\pi A_m f_m \leq \frac{\Delta}{T_s}$$

$$\boxed{A_m \leq \frac{\Delta f_s}{2\pi f_m}}$$

① sol: $\Delta = 0.75V$

Sampling frequency is 30 times the Nyquist rate

$$f_s = 30 \times 2 \times f_m$$

$$A_m \leq \frac{\Delta f_s}{2\pi f_m}$$

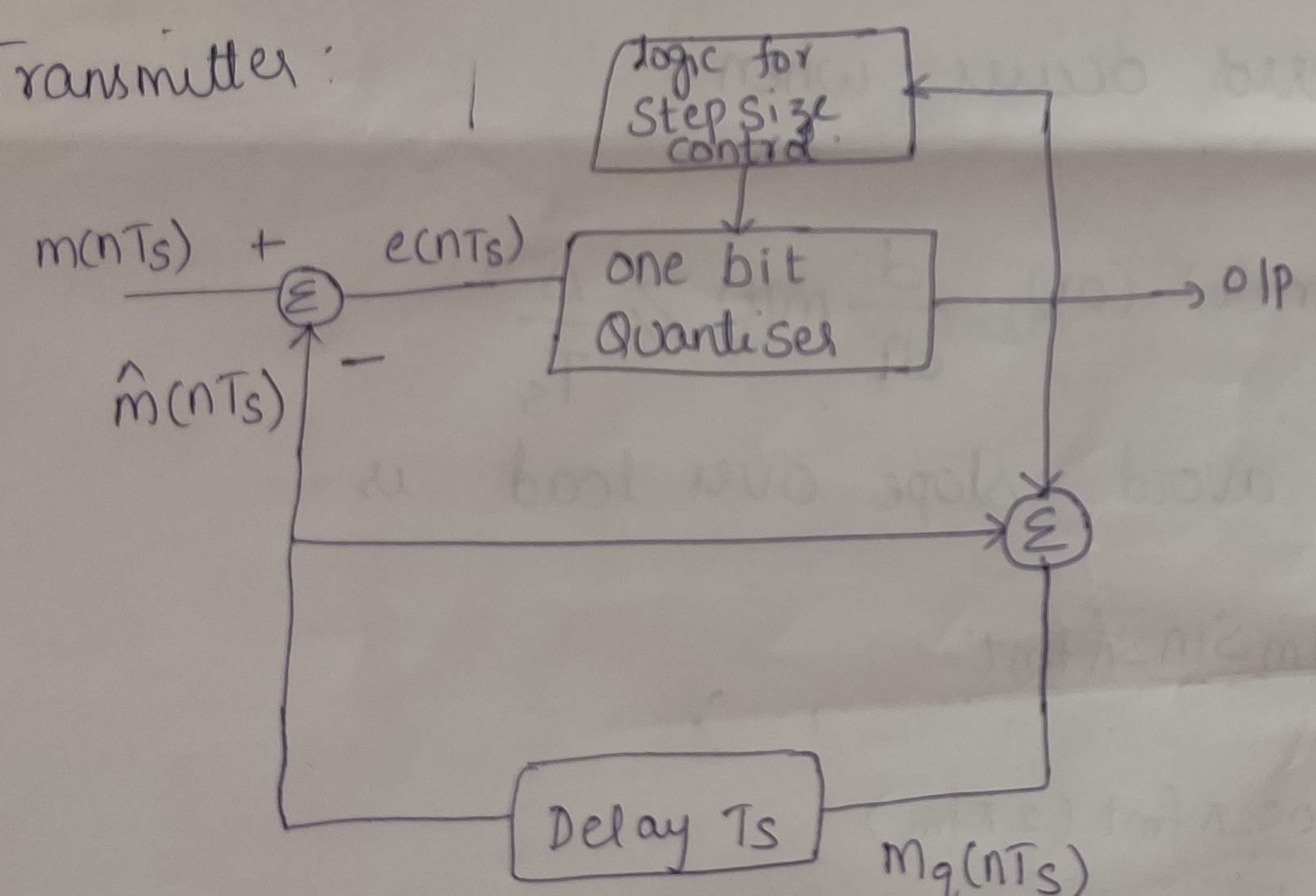
$$A_m \leq \frac{0.75 \times 30 \times 2 \times f_m}{2\pi f_m} \leq 7.16V$$

2) sol: $f_m = 3KHZ$ $f_s = 60{,}000$ pulses/sec [rate] $\Delta = 60mV$

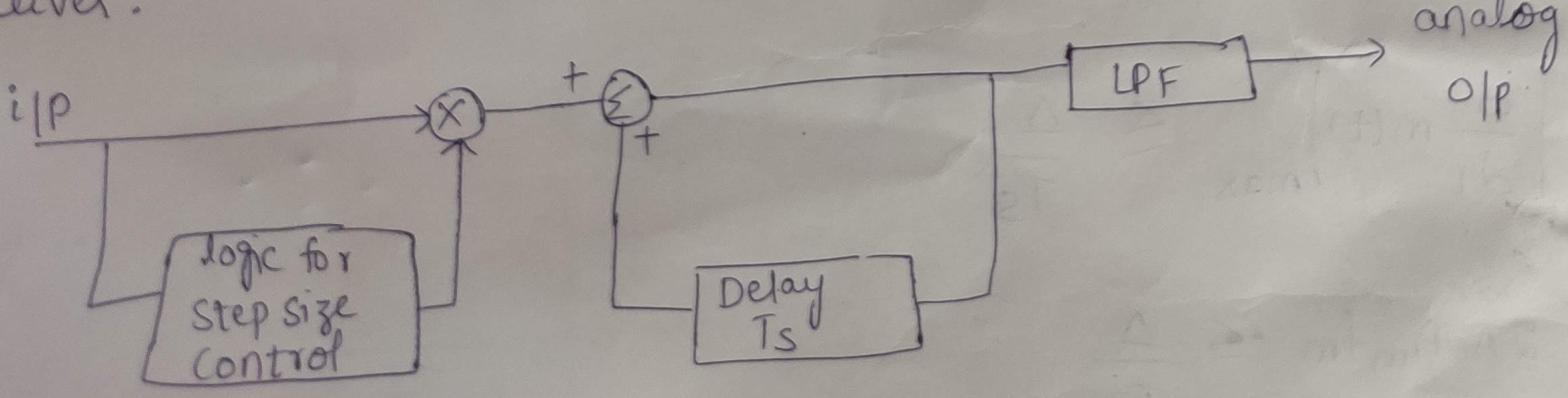
$$A_m \leq \frac{60mV \times 60{,}000}{2\pi \times 3K} \leq 0.19V$$

Adaptive Delta Modulator:

Transmitter:



Receiver:



of aliasing with a neat sketch.

b) A delta modulator with fixed step size of 0.75V is given a sinusoidal message signal. If the sampling frequency is 30 times the nyquist rate, determine the maximum permissible amplitude of the message signal if slope overload is to be avoided. [6+4]

OR

3.a) A voice frequency signal band limited to 3kHz is transmitted with the use of the DM system. The pulse repetition frequency is 60,000 pulses per second, and the step size is 60mV. Determine the permissible speech signal amplitude to avoid slope overload.

b) Draw the block diagram of adaptive delta modulator with continuously variable step size and explain. [4+6]

SQNR in DM :

Quantization noise in DM varies from $-\Delta$ to $+\Delta$

Quantization noise power $N_q = \int_{-\Delta}^{\Delta} q_e^2 \cdot \frac{1}{2\Delta} dq_e$

$$N_q = \frac{1}{2\Delta}\left[\frac{q_e^3}{3}\right]_{-\Delta}^{\Delta}$$

$$N_q = \frac{\Delta^2}{3}$$

At the receiver, the recovered signal is passed through a LPF the noise power at the output of filter is

$$N_q = \frac{\Delta^2 f_m}{3 f_s}$$

Signal power $S = \frac{A_m^2}{2}$

To avoid slope overload error, $A_m \leq \frac{\Delta f_s}{2\pi f_m}$

$$S = \frac{\Delta^2 f_s^2}{8\pi^2 f_m^2}$$

$$SQNR = \frac{S}{N_q} = \frac{\frac{\Delta^2 f_s^2}{8\pi^2 f_m^2}}{\frac{\Delta^2 f_m}{3 f_s}} = \frac{3}{8\pi^2}\left(\frac{f_s}{f_m}\right)^3$$

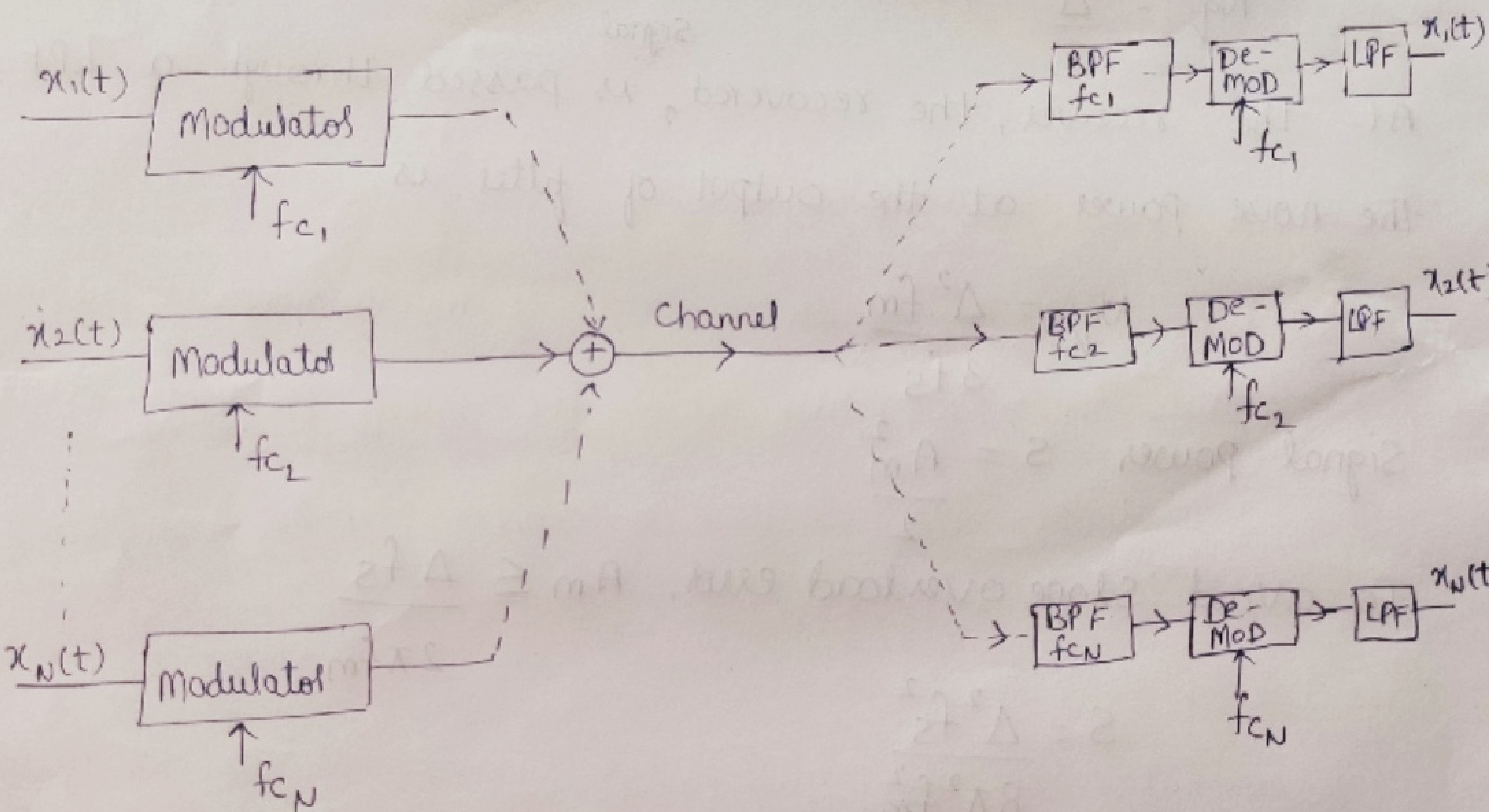
Multiplexing :

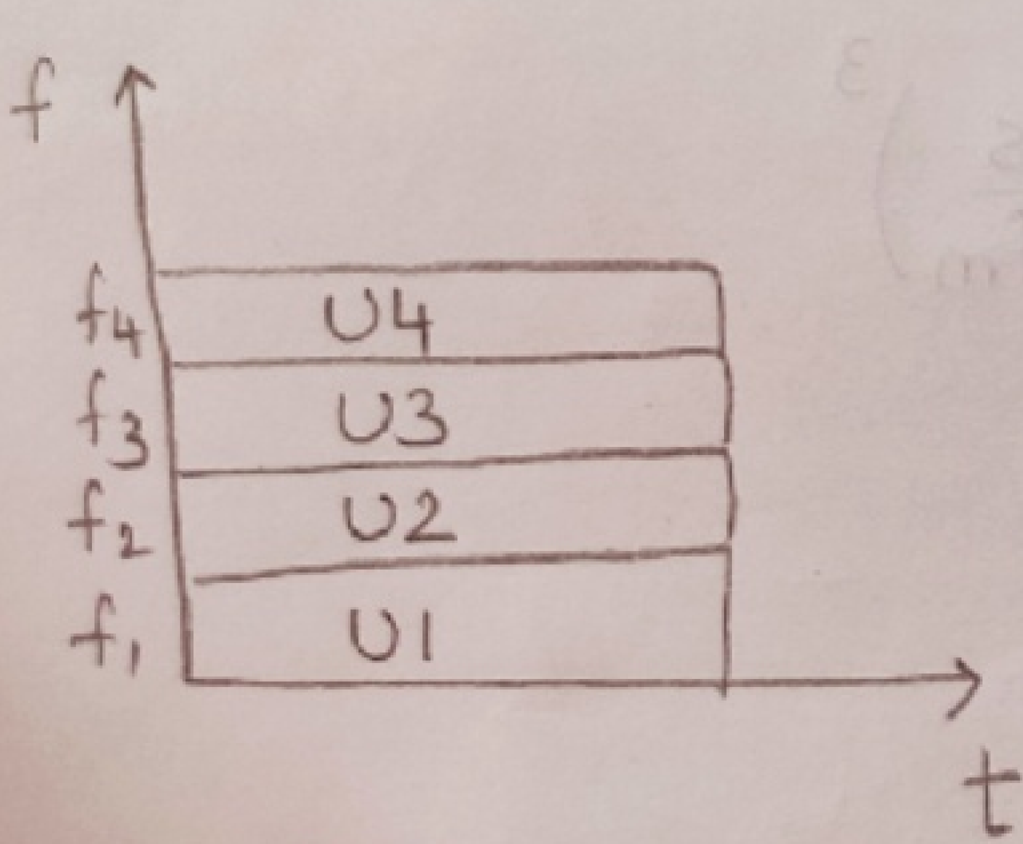
Combining many signals to form a composite signal and transmitting through a common channel without interference.

1) FDM (Analog Technique)

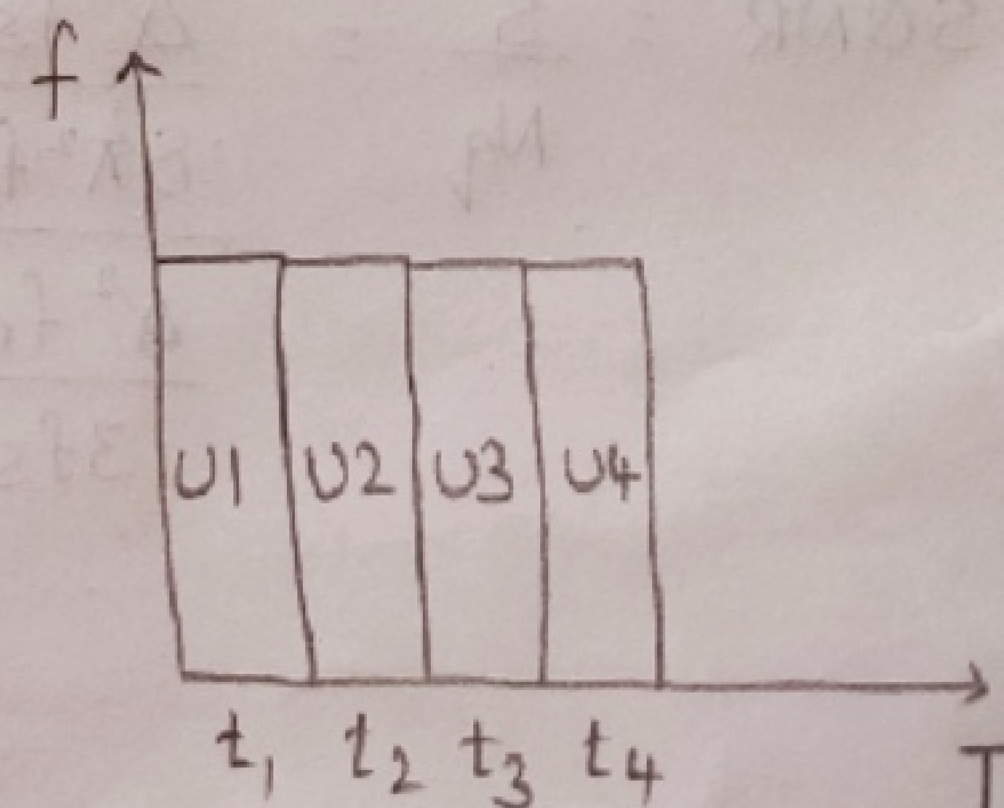
2) TDM (Digital Technique)

Frequency Division Multiplexing :



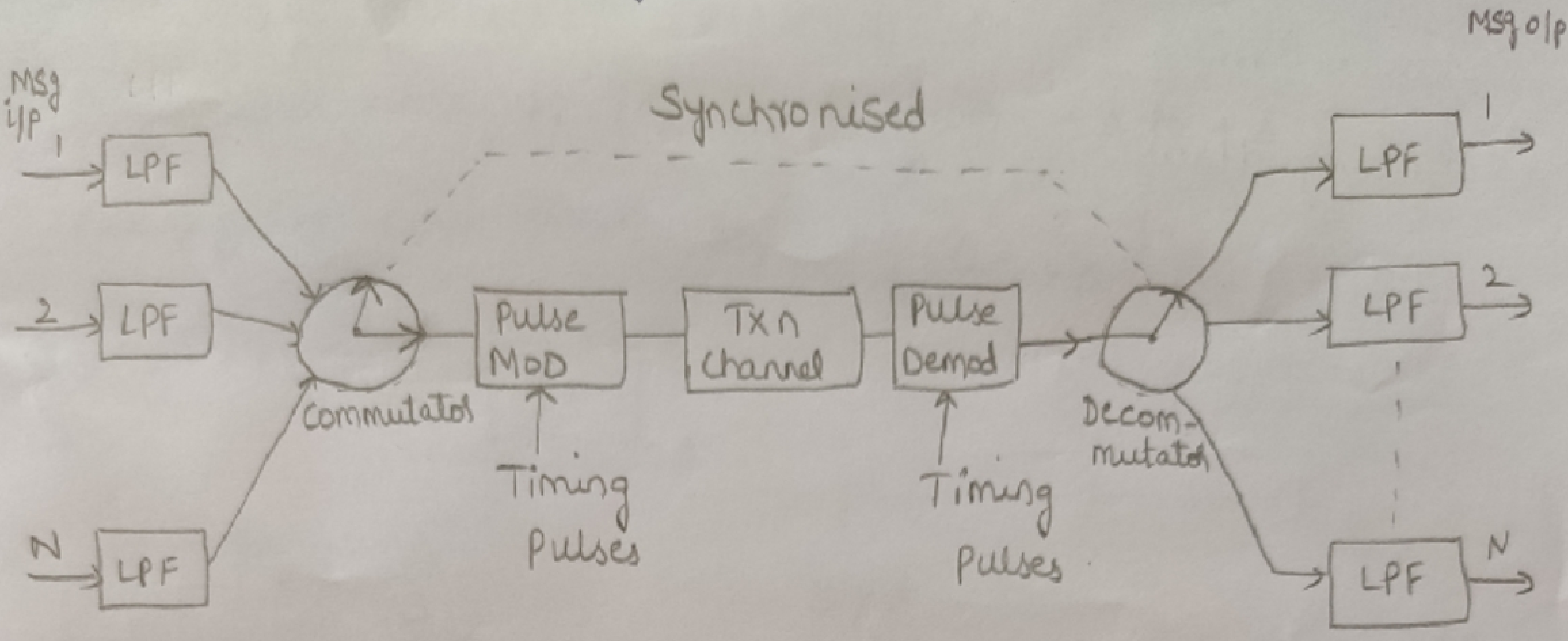


FDM



TDM

Time Division Multiplexing :-



- Functions of a commutator :

  (1) To take a narrow sample of each of the N ~~sample~~ input msgs at a rate $1/T_S \geq 2W$, where W is the cutoff frequency of the LP

  (2) To sequentially interleave these N samples inside a sampling interval T_S.

- Function of pulse Modulator :

  (1) To ~~~~ transform the multiplexed signal into a form suitable for transmission over the common channel

- It is clear that the use of TDM introduces a bandwidth expansion by a factor N because the scheme must squeeze N samples derived from N independent message sources into a time slot equal to one sampling interval

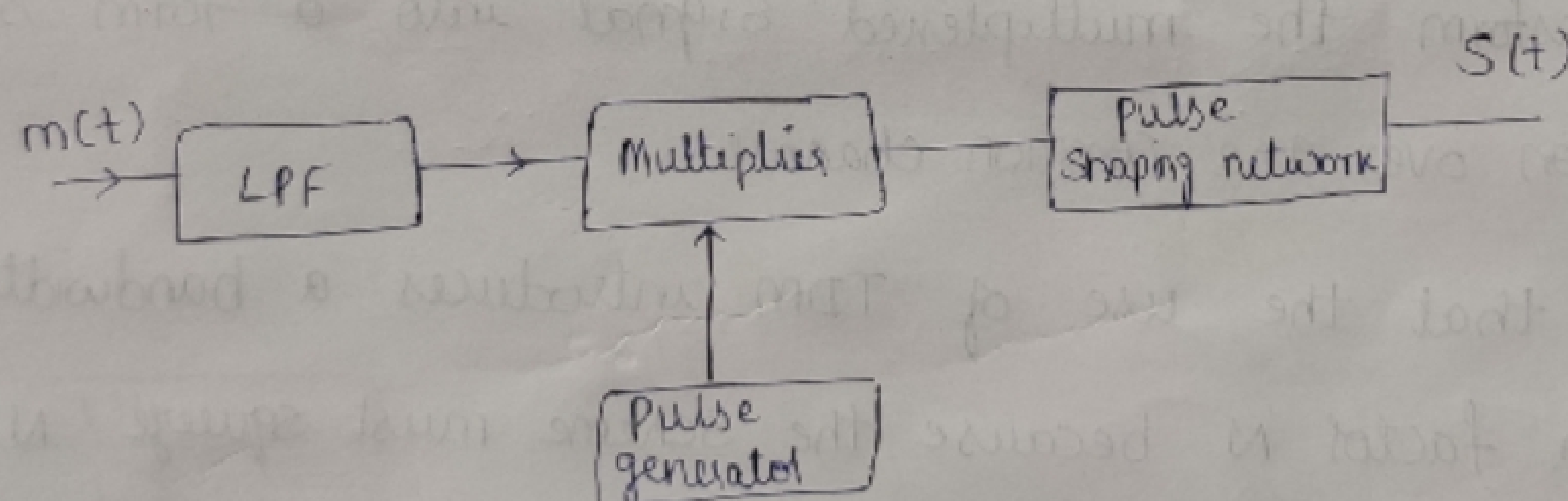
Pulse Modulation Techniques:

- Pulse Modulation
  - Pulse analog M.T
    - Pulse amplitude Modulation
    - Pulse Time Modulation
      - PWM/PDM/PLM
      - PPM
  - Pulse Digital M.T
    - PCM
    - DPCM
    - DM
    - ADM

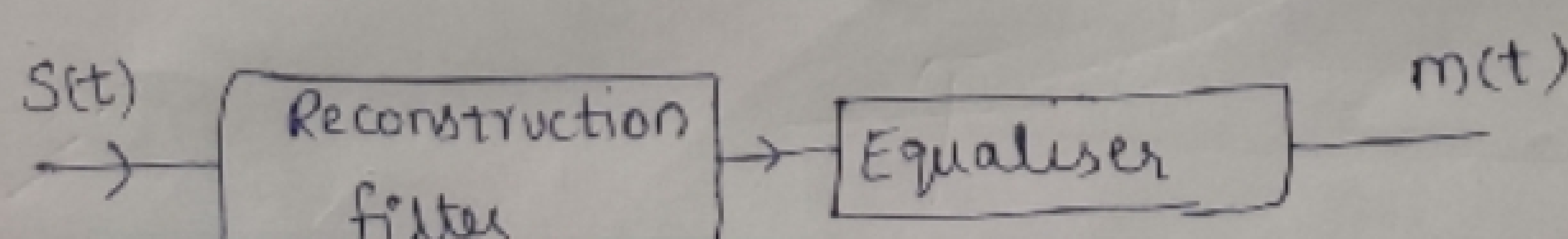
Pulse Amplitude Modulation (PAM):

In PAM, the amplitude of pulse signal is varied in accordance to the instantaneous sample values of a continuous message signal.

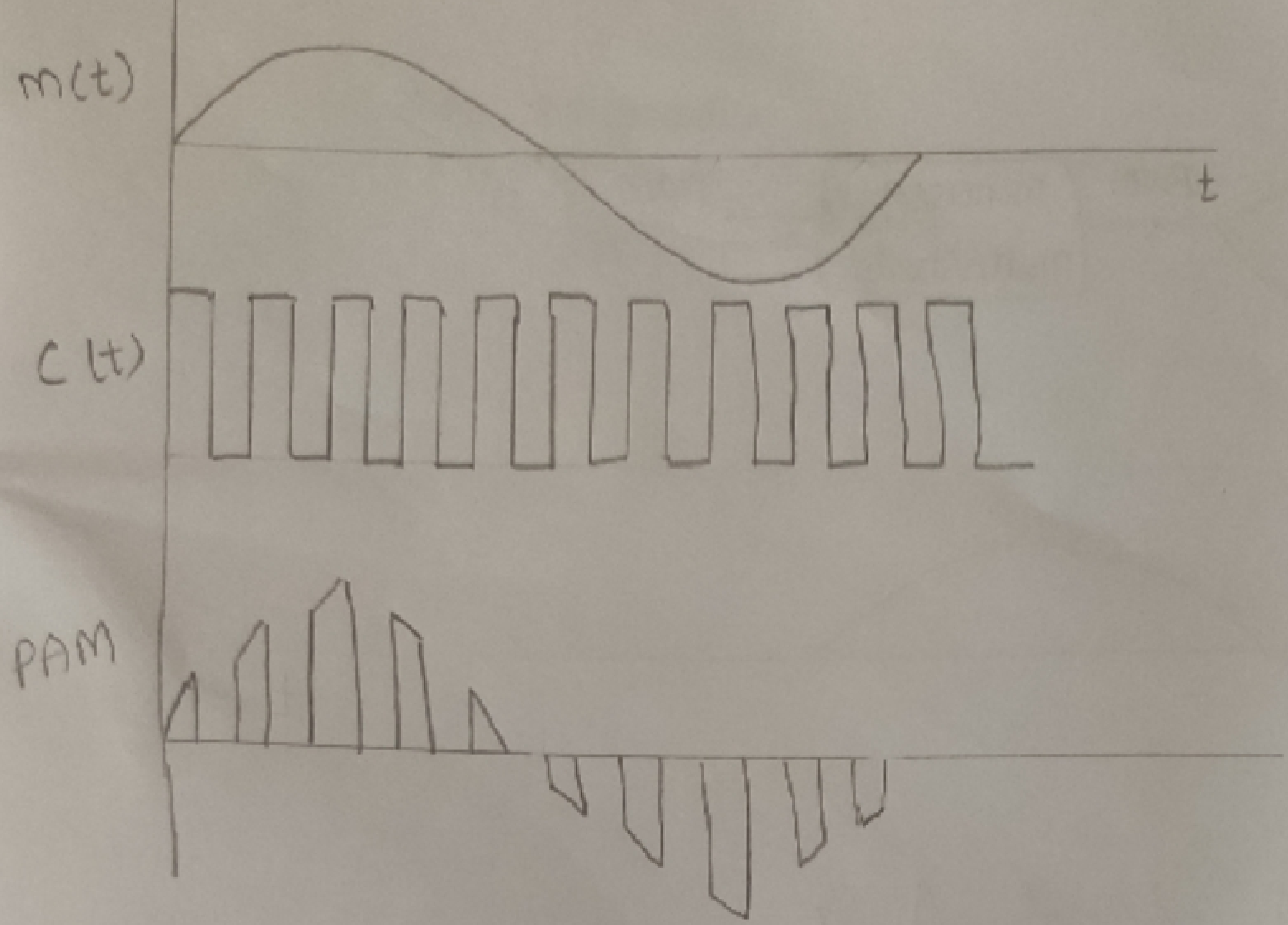
Generation :



Detection :



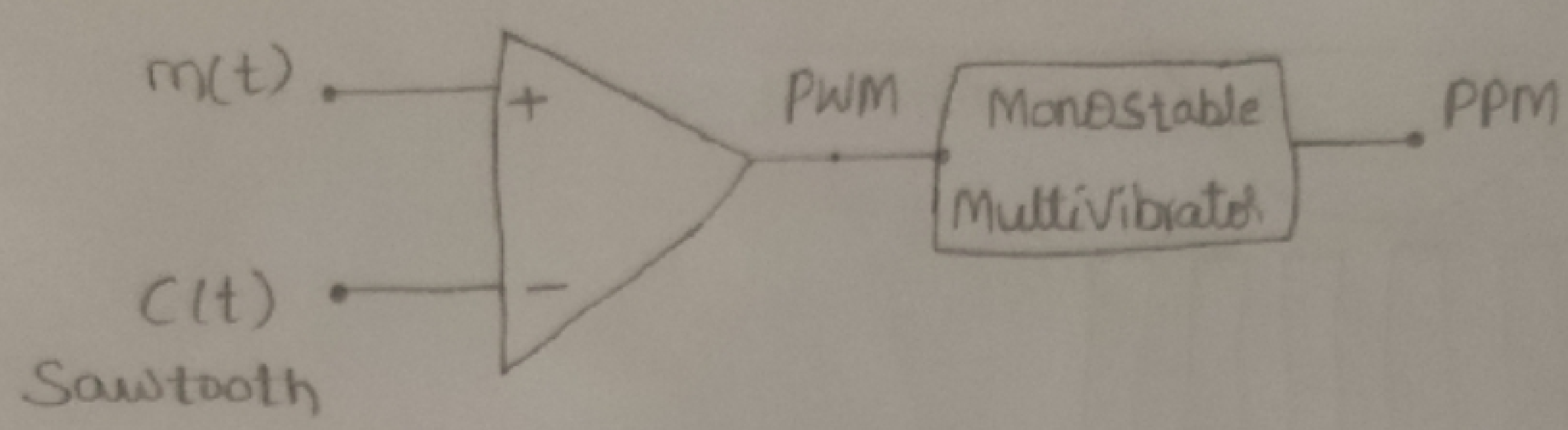
PAM Waveforms :

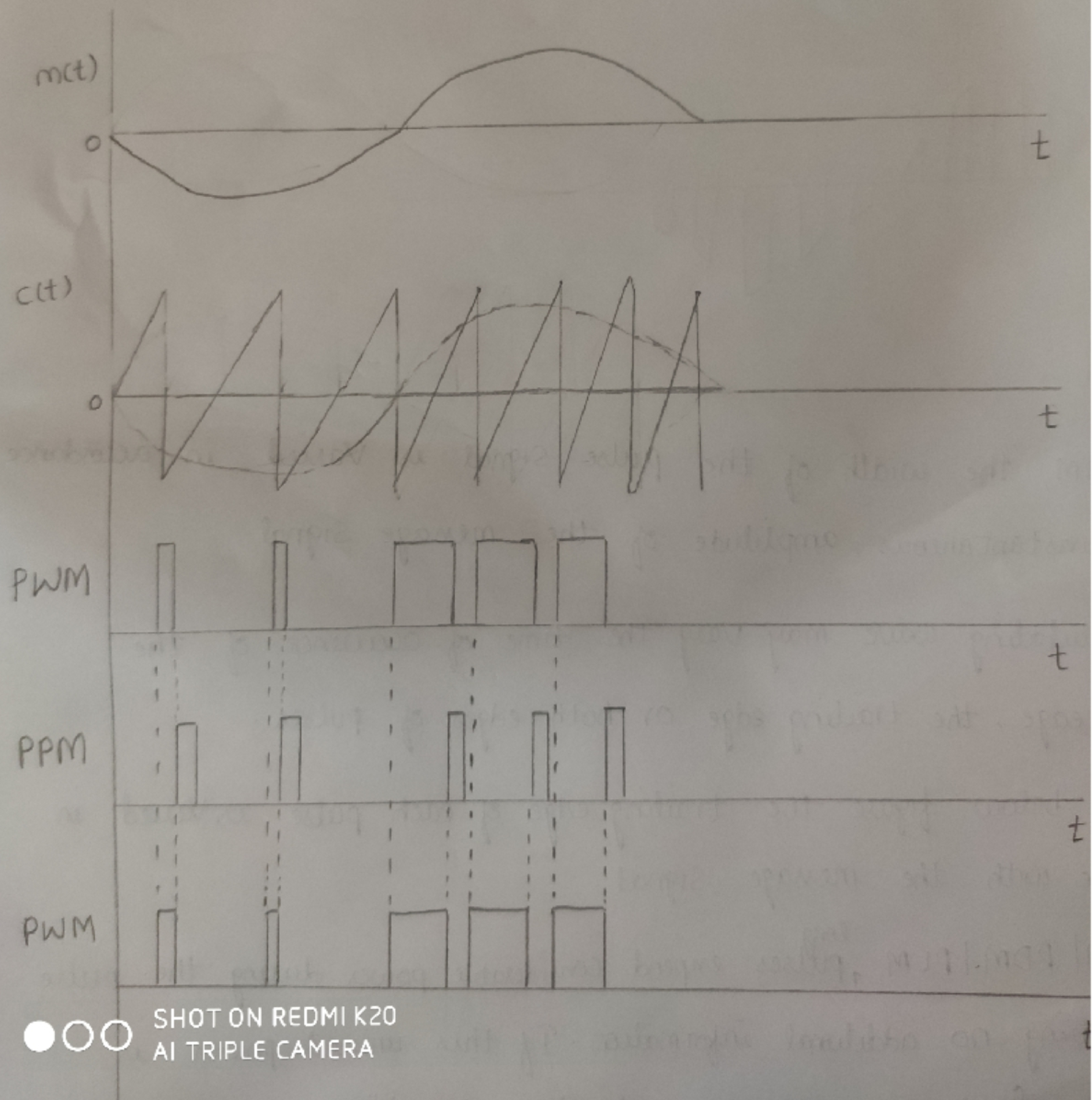


PWM :

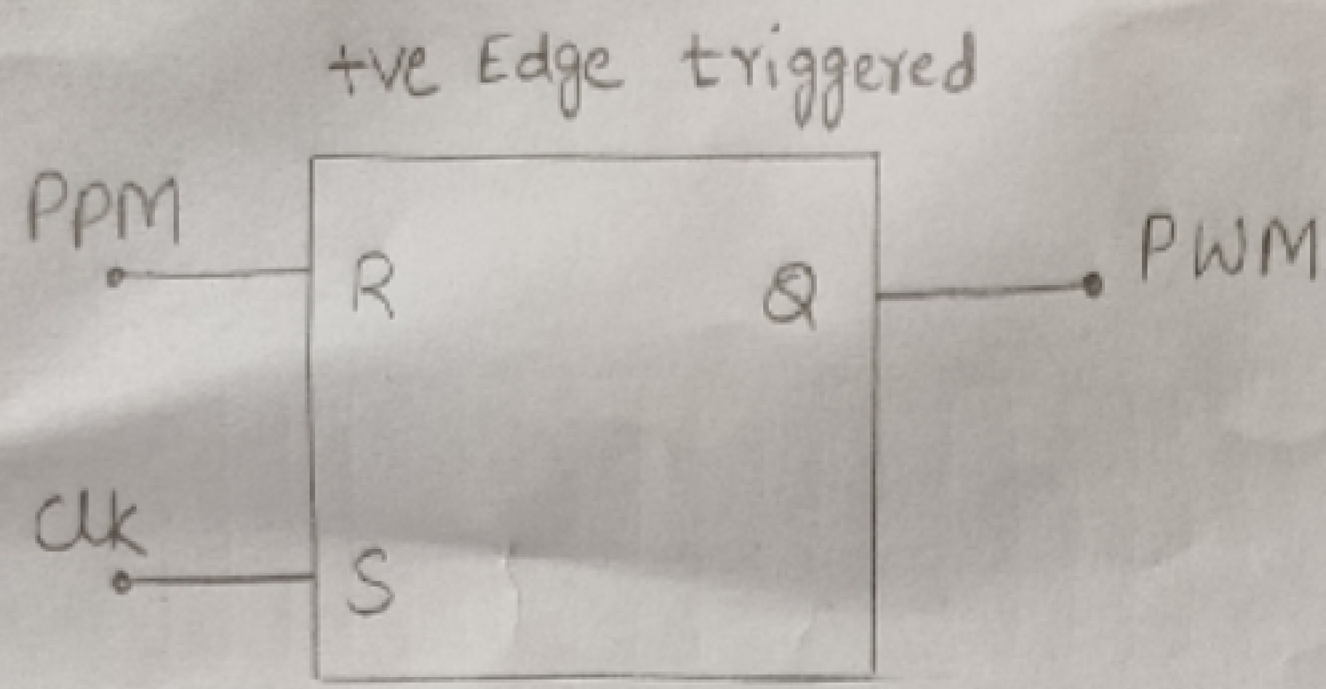
- In PWM, the width of the pulse signal is varied in accordance to the instantaneous amplitude of the message signal.
- The modulating wave may vary the time of occurence of the leading edge, the trailing edge or both edges of pulses.
- In the below figure the trailing edge of each pulse is varied in accordance with the message signal.
- In PWM/PDM/PLM, long pulses expend considerable power during the pulse while bearing no additional information. If this unused power is subtracted from PWM, so that only time transitions are preserved, we obtain a more efficient type of pulse modulation known as Pulse position Modulation.

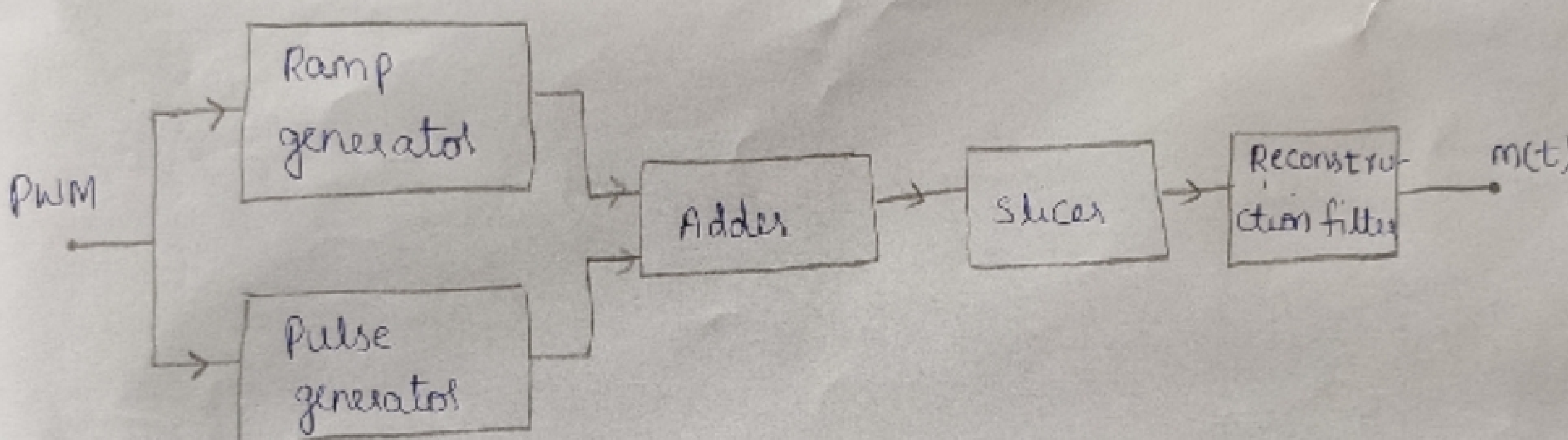
Generation of PWM & PPM :

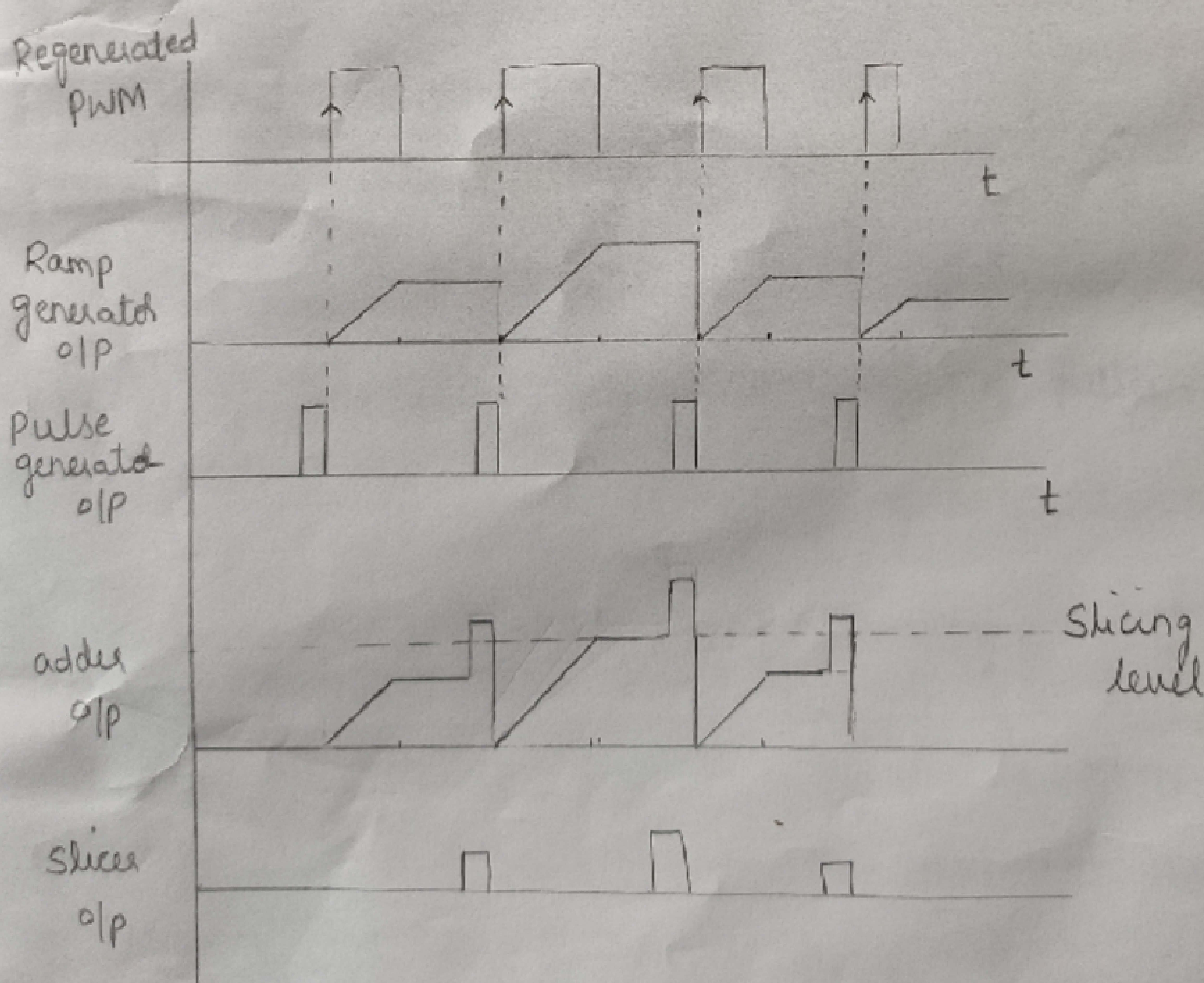




Demodulation of PPM & PWM :



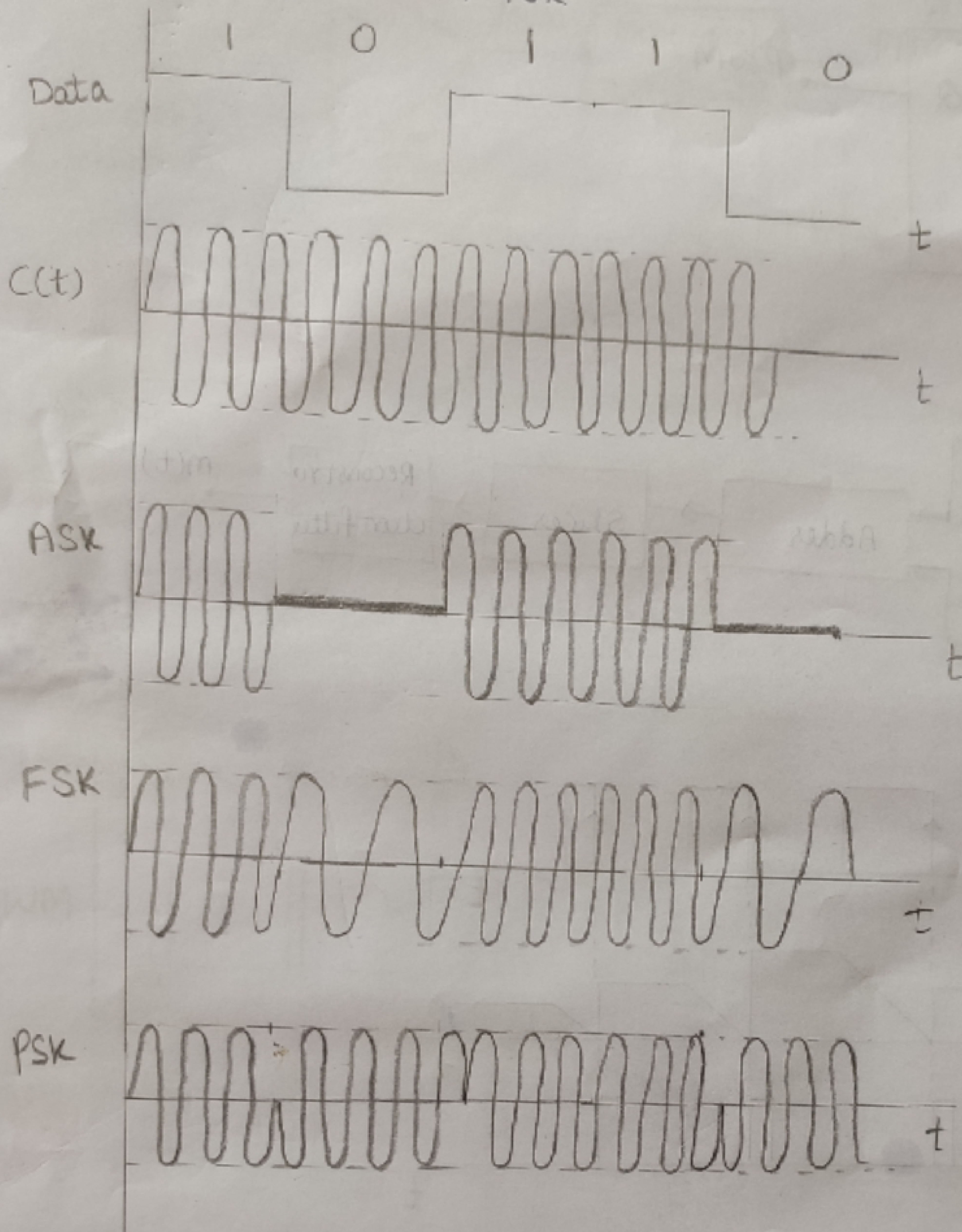




Unit - V

Digital Modulation Techniques:

1) ASK 2) FSK 3) PSK

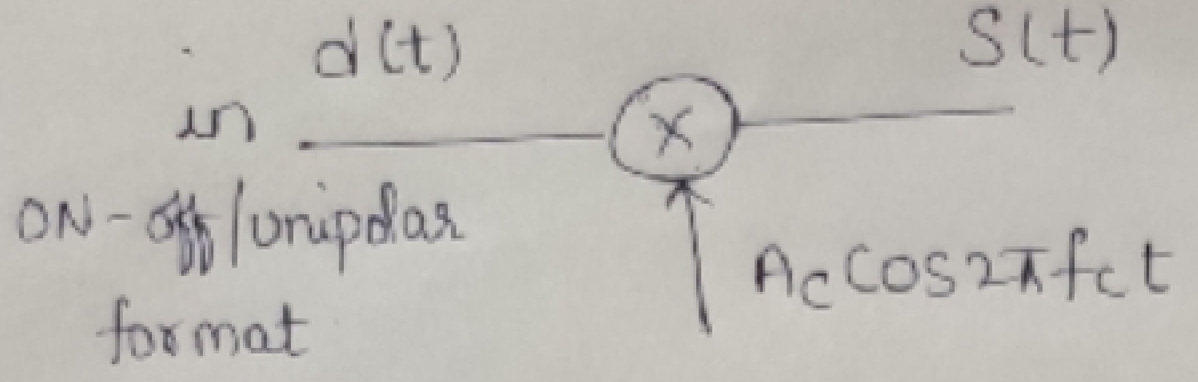


ASK [OOK]:

ASK stands for Amplitude Shift keying and it is also called as on-off keying. The carrier amplitude switches between two levels of digital signal in ASK. The time domain equation of ASK is given as

$$S(t) = \begin{cases} A_c \cos 2\pi f_c t & \text{for symbol } 1 \\ 0 & \text{for symbol } 0 \end{cases}$$

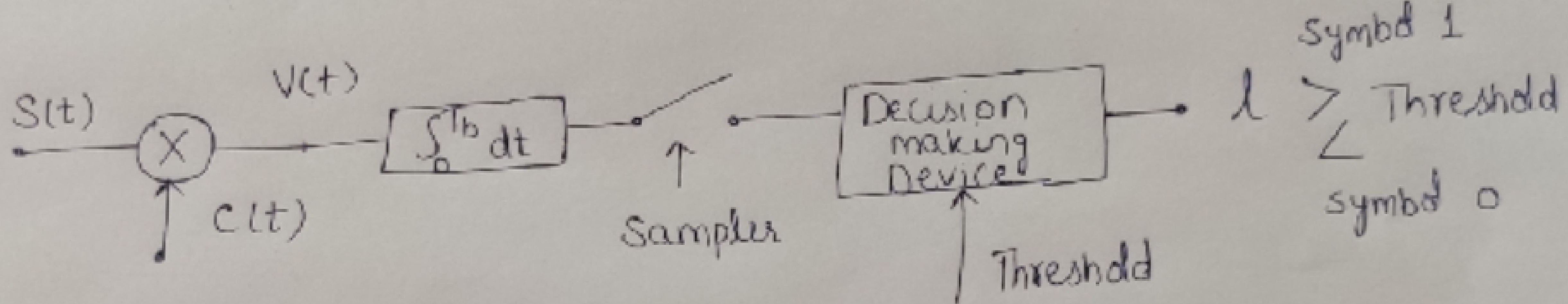
- Generation of ASK :



$$S(t) = \begin{cases} A_c \cos 2\pi f_c t & \text{if } d(t) \text{ is symbol } 1 \\ 0 & \text{if } d(t) \text{ is symbol } 0 \end{cases}$$

- Detection
  - coherent [carrier is required at Rxr in synchronous to TxR]
  - Non-coherent [carrier is not required]

Coherent Detection of ASK :-



$$V(t) = S(t) \times C(t)$$

$$= A_c \cos 2\pi f_c t \times A_c \cos 2\pi f_c t$$

$$= A_c^2 \cos^2 2\pi f_c t = \frac{A_c^2}{2}\left[1 + \cos 4\pi f_c t\right]$$

$$V(t) = \frac{A_c^2}{2}\left[1 + \cos 4\pi f_c t\right]$$

After passing v(t) through integrator for T_b duration high frequency components get attenuated.

The output voltage of DMD is compared with preset threshold value and decision is taken in favour of symbol 1 if the output voltage is greater than threshold value otherwise symbol 0.