Classification of Signal

Continuous time and Discrete time signals

Analog and Digital signals

Periodic and Aperiodic signals

Energy and Power signals

Deterministic and Random signals

Classification of Signal

Continuous time Signal

If the signal is specified for every value in time then it is known as the Continuous time signal

Fig. 1 (a)

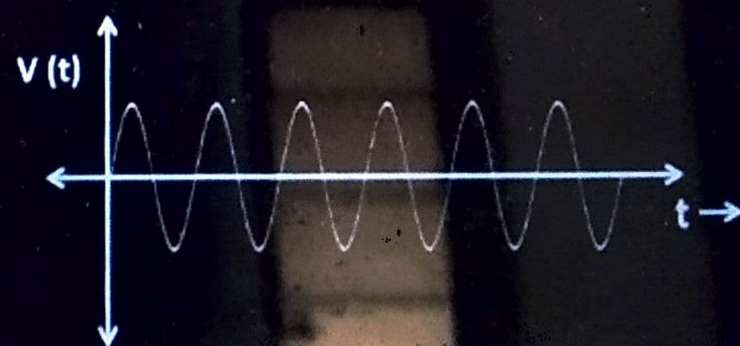
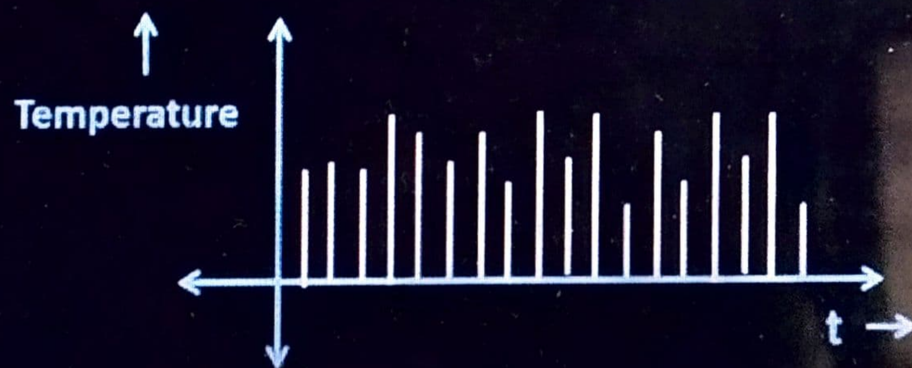


Fig. 1 (b)

Classification of Signal

Discrete time Signal

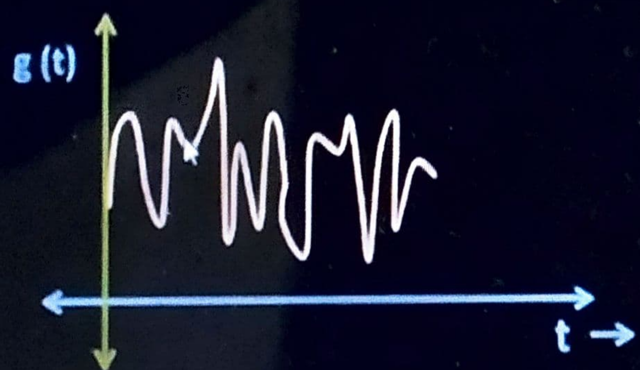
If the signal is specified only for discrete time instances then it is called Discrete time signal.

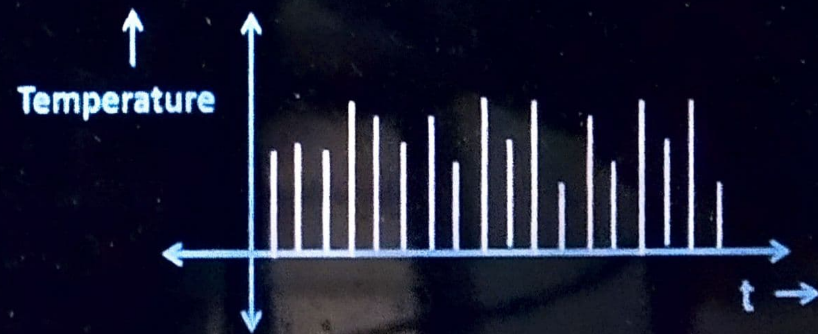


Classification of Signal

Analog Signal

A signal whose amplitude can take any value in the continuous range is the analog signal.

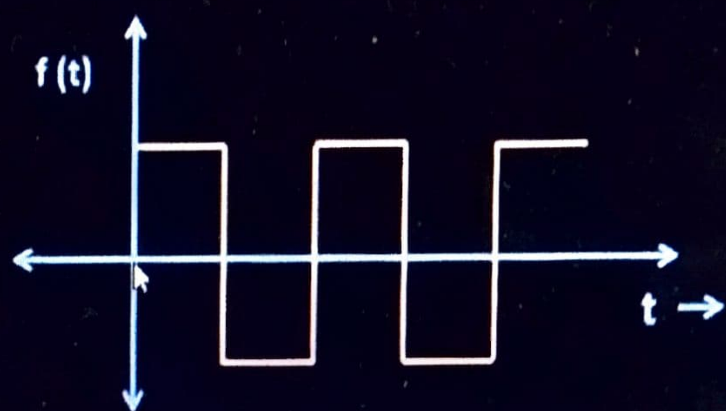


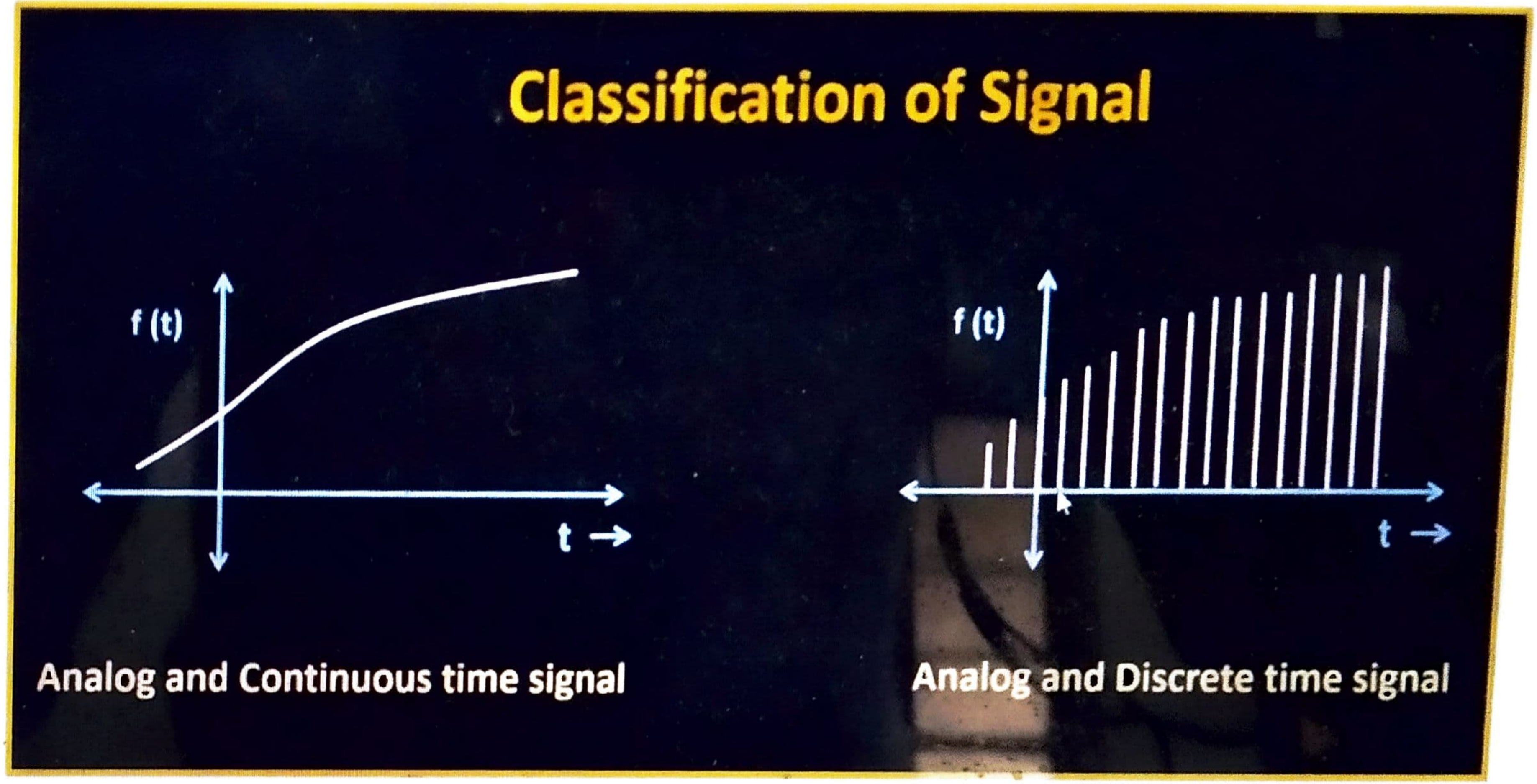


Classification of Signal

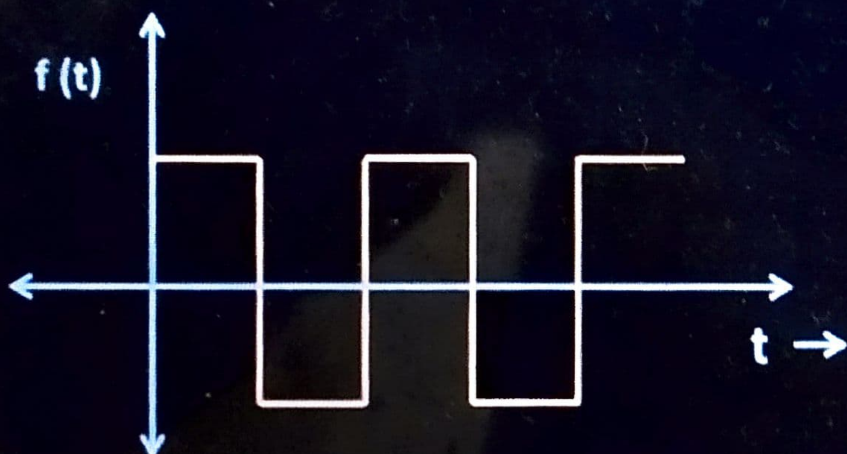
Digital Signal

A signal whose amplitude can take only finite number of values is the digital signal.

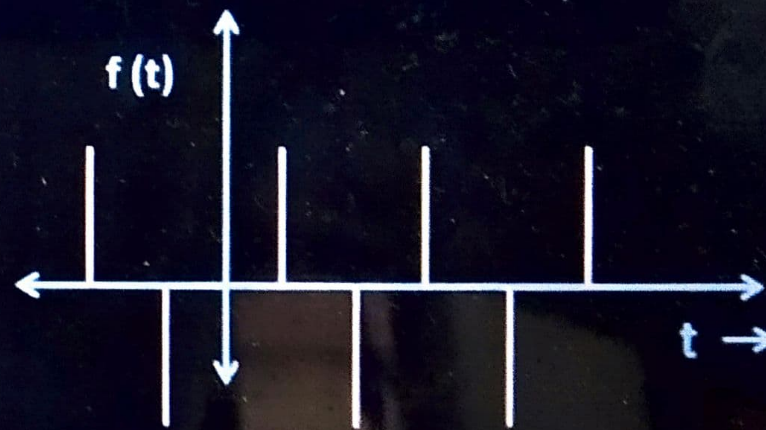



Classification of Signal
f (t)
t →
Analog and Continuous time signal
f (t)
t →
Analog and Discrete time signal

Classification of Signal



Digital and Continuous time signal

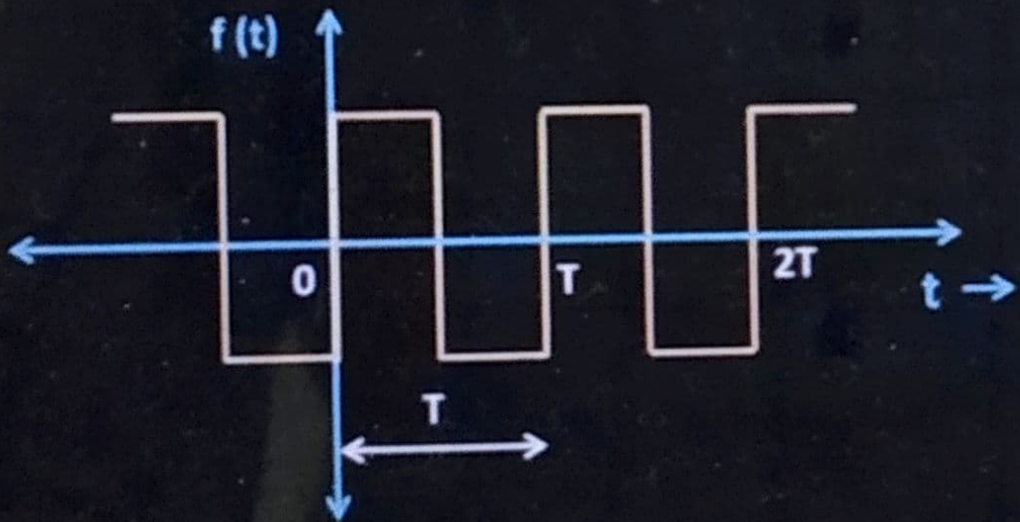


Digital and Discrete time signal

Classification of Signal

Periodic Signal

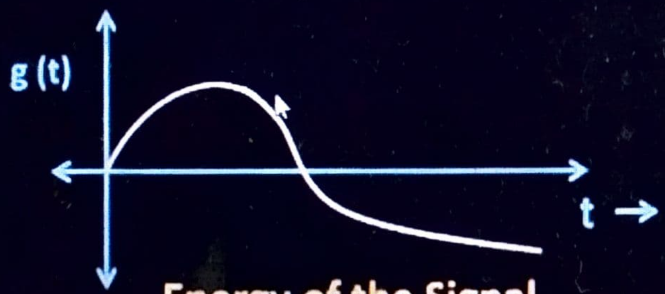
A signal which repeats itself after finite time T then it is called periodic signal.



$$f(t) = f(t + T)$$

Aperiodic Signal

Strength of the Signal

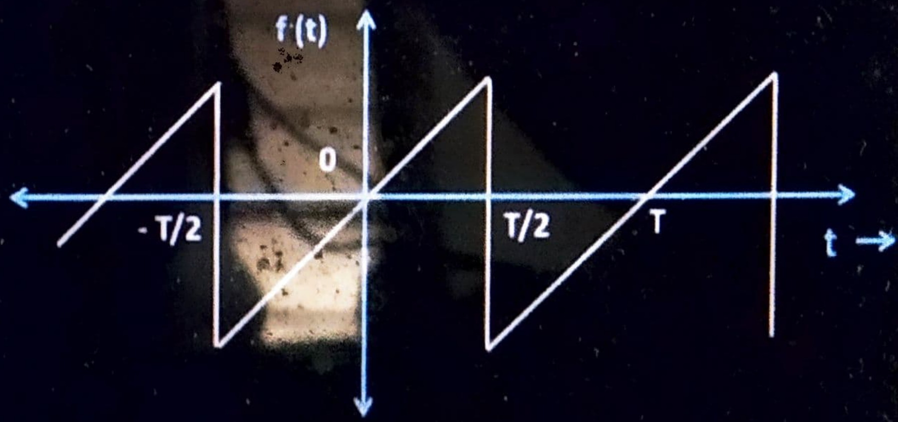


Energy of the Signal

$$Eg = \int_{-\infty}^{\infty} g^2(t)dt$$

Average Power of the Signal

$$Pg = \lim_{T \to \infty} \frac{1}{T} \int_{-T/2}^{T/2} g^2(t)\, dt$$



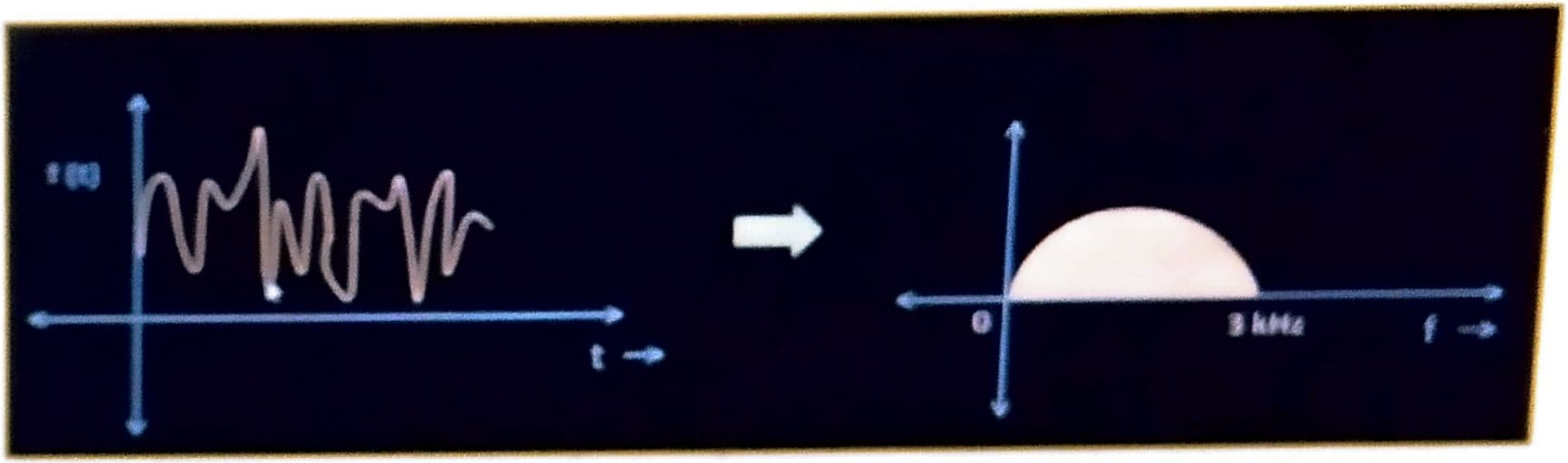
Classification of Signal

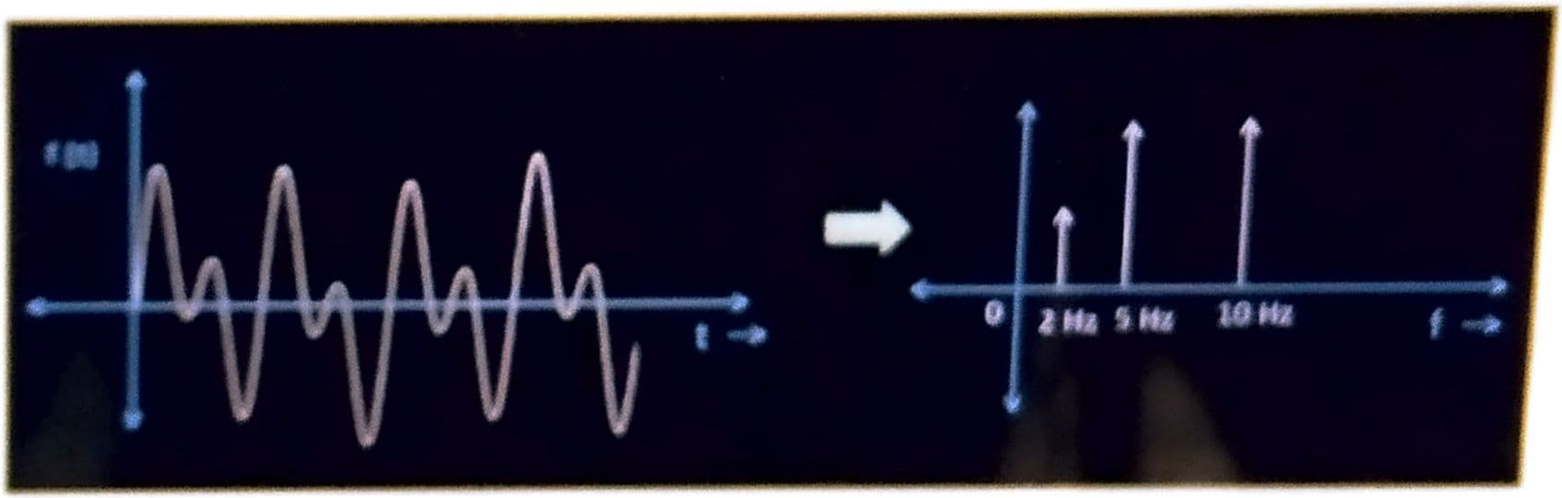
Deterministic Signal

A signal whose physical description is known completely either in mathematical form or graphical form is known as the Deterministic Signal.

Random Signal

A signal which is known only in terms of the probabilistic description like mean, mean square value and distributions is known as the Random Signal.


t →
0
3 kHz
f →


t →
0
2 Hz
5 Hz
10 Hz
f →

Trigonometric Fourier Series

Any periodic signal can be represented by the linear combination of sine and cosines which are harmonically related to each other

$$g(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega_0 t) + \sum_{n=1}^{\infty} b_n \sin(n\omega_0 t)$$

Exponential Fourier Series

Any periodic signal can be represented by the linear combination of complex exponentials.

$$g(t) = \sum_{n=-\infty}^{\infty} C_n e^{jn\omega_0 t}$$

$$\omega_0 = \frac{2\pi}{T}$$

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The Concept of Orthogonality

$$\int_{t_1}^{t_2} g(t)\, x(t)\, dt = 0$$

g (t) and x (t) are real signals

$$\int_{t_1}^{t_2} g(t)\, x^*(t)\, dt = 0 \quad \text{or} \quad \int_{t_1}^{t_2} g^*(t)\, x(t)\, dt = 0$$

g (t) and x (t) are complex signals

The Concept of Orthogonality

$x_1(t),\ x_2(t),\ x_3(t),\ x_4(t),$ ----- $X_n(t)$

$g(t) = c_1\, x_1(t) + c_2\, x_2(t) + c_3\, x_3(t) +$ ------ $+ C_n\, X_n(t)$

$$C_n = \frac{\int g(t)\, x_n^*(t)\, dt}{\int |x(t)|^2\, dt}$$

$$g(t) = e^{jn\omega_0 t}$$

$$x(t) = e^{jm\omega_0 t}$$

$$\int_{-\infty}^{\infty} g(t)\, x^*(t)\, dt = 0 \quad \text{or} \quad \int_{-\infty}^{\infty} g^*(t)\, x(t)\, dt = 0$$

$$\int_0^T g(t)\, x^*(t)\, dt = 0 \Rightarrow \int_0^T e^{jn\omega_0 t} \times e^{-jm\omega_0 t}\, dt = 0$$

$$\Rightarrow \int_0^T e^{j(n-m)\omega_0 t}\, dt \qquad n \neq m$$

$$\left[\frac{e^{j(n-m)\omega_0 t}}{j(n-m)\omega_0} \right]_0^T$$

$$= \frac{1}{j(n-m)\omega_0} \times \left[e^{j(n-m)\frac{2\pi}{T} \times T} - 1 \right]$$

$$= 0$$

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$$\int_0^T e^{jn\omega_0 t} \times e^{-jn\omega_0 t}\, dt = \int_0^T (1)\, dt = T \qquad n = m$$

$$n = -\infty \text{ to } \infty$$

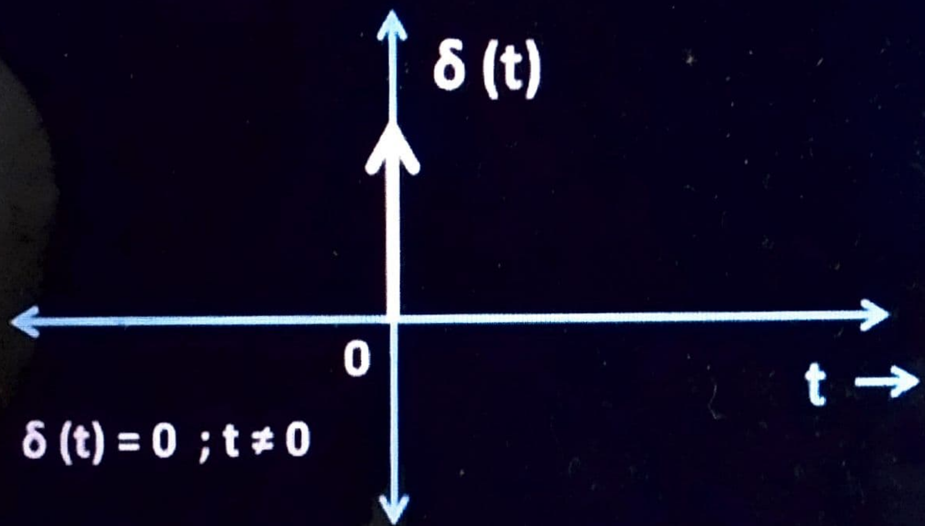
$$C_n = \frac{\int_T g(t)\, x_n^*(t)\, dt}{\int_T |x(t)|^2 dt = T}$$

$$x_n(t) = e^{jn\omega_0 t}$$

$$\omega_0 = \frac{2\pi}{T}$$

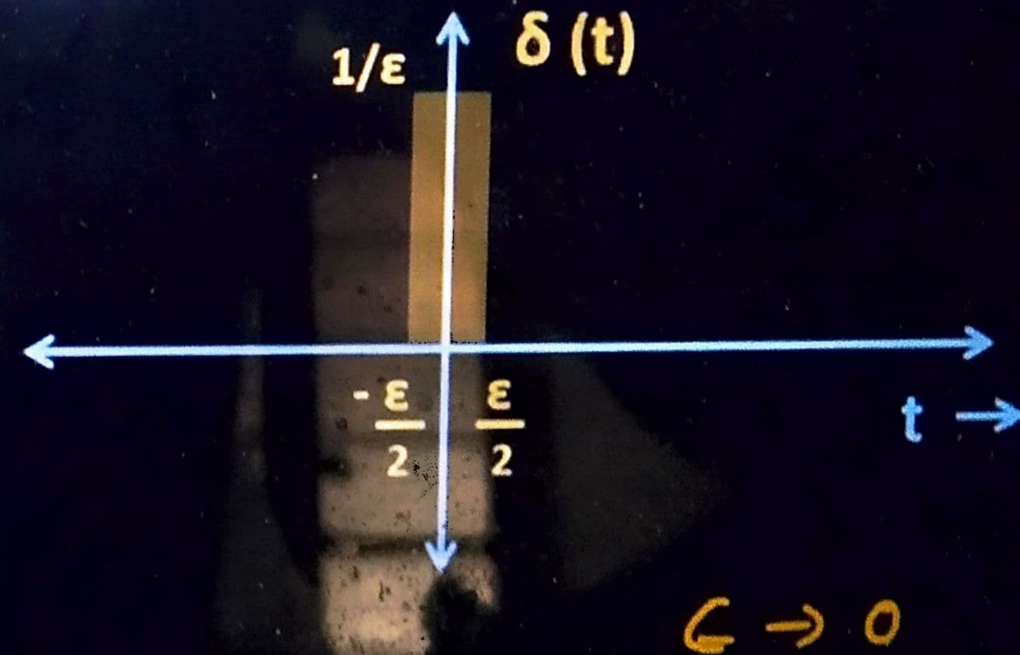
$$C_n = \frac{1}{T}\int_0^T g(t)\, e^{-jn\omega_0 t}\, dt$$

Unit Impulse Function



$\delta(t) = 0 \ ; t \neq 0$

$$\int_{-\infty}^{\infty} \delta(t)\, dt = 1$$



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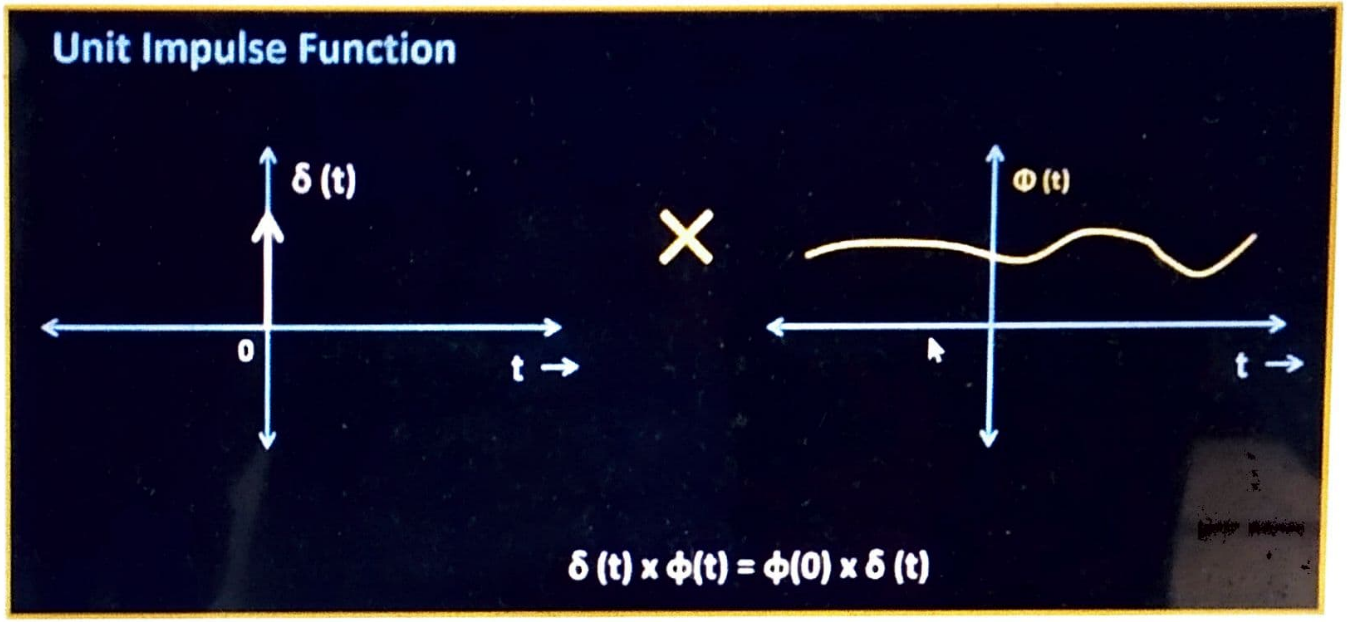
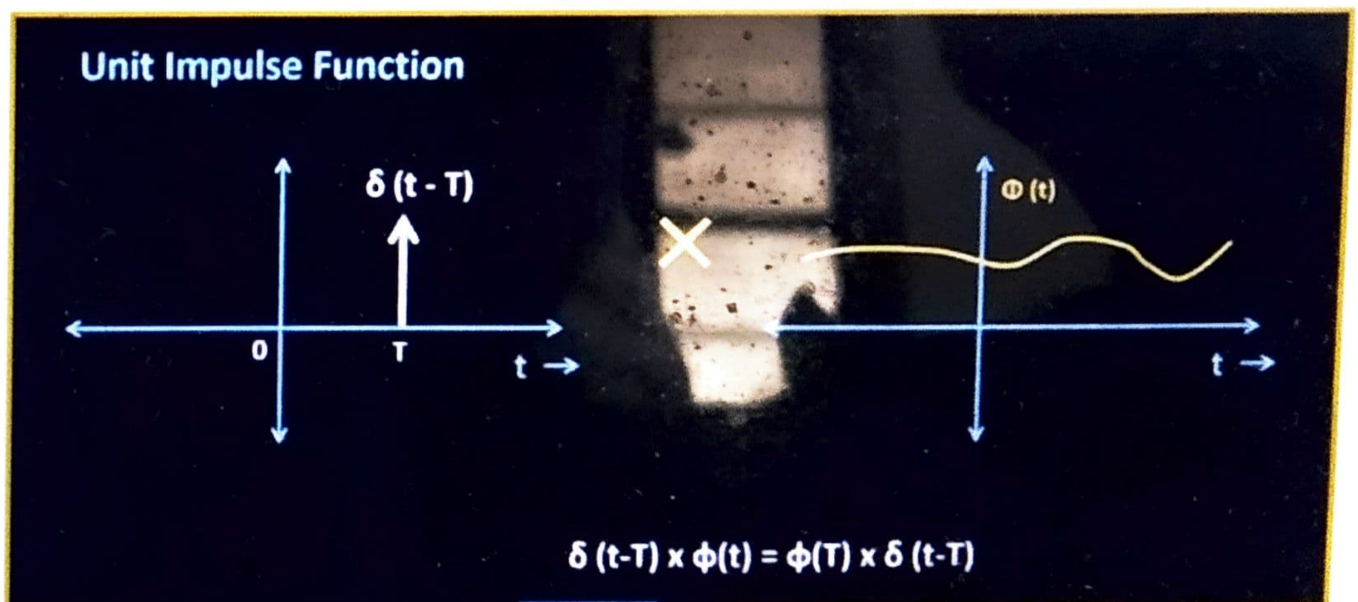
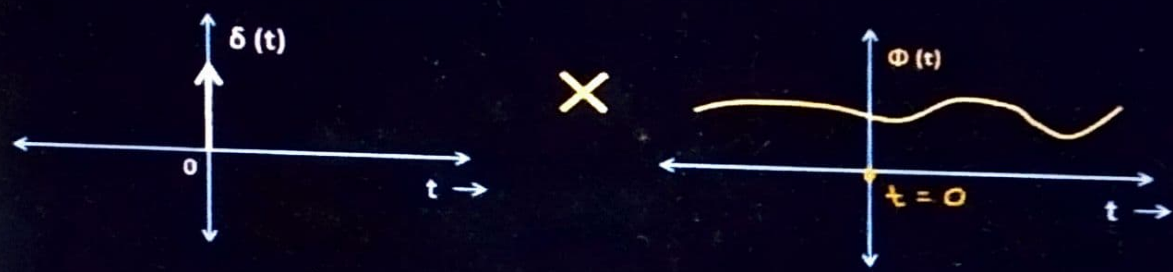

Unit Impulse Function
δ (t)
0
t →
Φ (t)
t →
δ (t) x ϕ(t) = ϕ(0) x δ (t)


Unit Impulse Function
δ (t - T)
0
T
t →
Φ (t)
t →
δ (t-T) x ϕ(t) = ϕ(T) x δ (t-T)

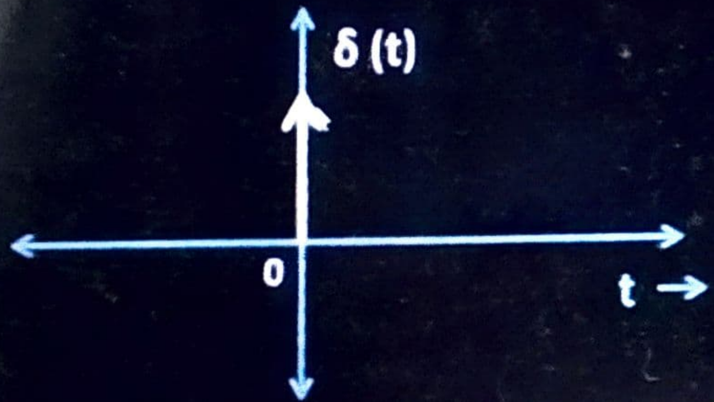
Unit Impulse Function



$$\int_{-\infty}^{\infty} \delta(t)\,\varphi(t)\,dt = \int_{-\infty}^{\infty} \delta(t)\,\varphi(0)\,dt = \varphi(0)\int_{-\infty}^{\infty} \delta(t)\,dt = \varphi(0)$$

Unit Impulse Function

Unit Impulse Function

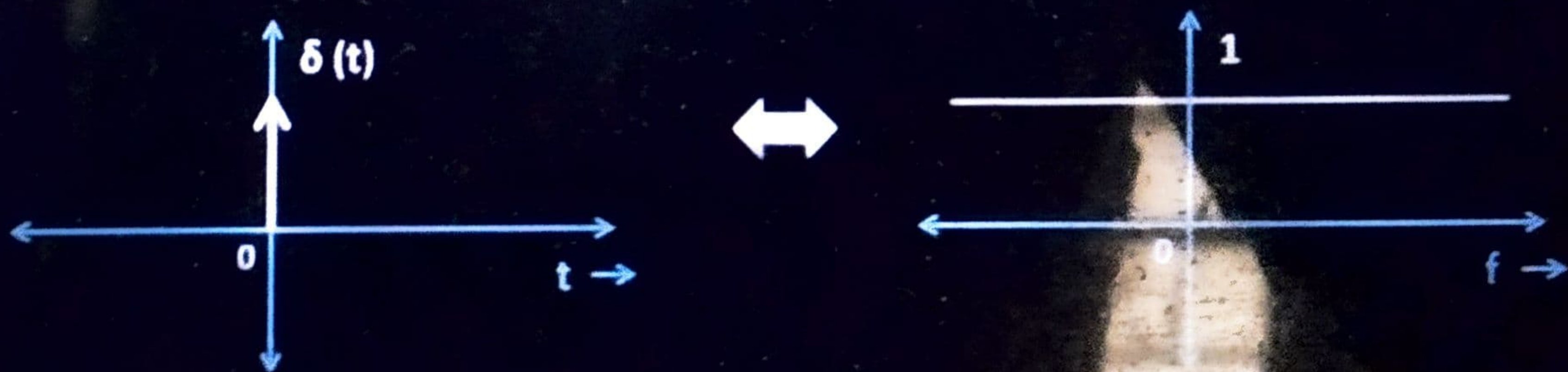


$$\mathcal{F}[\delta(t)]$$

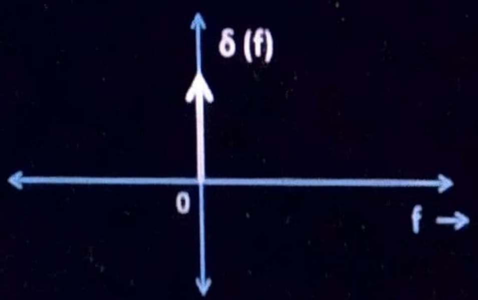
$$= \int_{-\infty}^{\infty} \delta(t) \cdot e^{-j\omega t} \, dt$$

$$= e^{0} = 1$$

Unit Impulse Function



Unit Impulse Function



$$F^{-1}[\delta(f)]$$

$$\int_{-\infty}^{\infty} \delta(f) \times e^{j2\pi ft} \, df$$

$$= e^{0} = 1$$

Unit Impulse Function